PAGES MISSING
WITHIN THE
BOOK ONLY

An Introduction to
Physical Anthropology

An Introduction to Physical Anthropology

A REVISED SECOND EDITION

By

M. F. ASHLEY MONTAGU
Professor of Anthropology
Rutgers University

CHARLES C THOMAS · PUBLISHER
Springfield · Illinois · U.S.A.

CHARLES C THOMAS · PUBLISHER
BANNERSTONE HOUSE
301-327 EAST LAWRENCE AVENUE, SPRINGFIELD, ILLINOIS

Published simultaneously in The British Commonwealth of Nations by
BLACKWELL SCIENTIFIC PUBLICATIONS, LTD., OXFORD, ENGLAND

Published simultaneously in Canada by
THE RYERSON PRESS, TORONTO

First Edition, 1945
Second Edition, 1951

Printed in the United States of America

TO

WILLIAM KING GREGORY

PREFACE TO THE SECOND EDITION

THE second edition of this work brings up to date a volume first published in 1945. Since then many new and important discoveries have been made which throw new light upon the evolution of man. These are incorporated in the present edition. The whole work has been thoroughly revised and much new material and many new illustrations added.

Professor Gabriel Lasker of Wayne University, Detroit, read the manuscript and made many useful suggestions. Professor Gerhardt von Bonin of the University of Illinois, not only performed a similar service, but also read the galleys and lent his expert knowledge to the checking of the accuracy of the brain drawings. Professor Theodosius Dobzhansky of Columbia University gave the sections on the mechanism of evolution the benefit of his critical reading. Professor William C. Boyd of Boston University and Dr. A. S. Wiener of New York kindly read the sections on the blood groups, and Dr. Stanley Garn of the Forsyth Infirmary, Boston, read the section on anthropometry. Professor Donald Hager of Princeton University, Professor J. N. Spuhler of Ohio State University, and Professor W. S. Laughlin of the University of Oregon, each read the galleys. Professor Laughlin also contributed the section on blood typing technique in the Appendix. Professor W. E. Le Gros Clark of Oxford University has been most helpful in sending me copies of his writings, even before they were published. Dr. Kenneth P. Oakley of the British Museum (Natural History), London, generously helped in a similar capacity. Dr. L. S. B. Leakey of Nairobi, East Africa, Professor Claude Levi-Strauss of the Musée de l'Homme, and Professor Henri Vallois of the Institut de Paléontologie Humaine, both of Paris, Dr. J. L. Angel, of Jefferson Medical College, Philadelphia; Dr. Robert Broom of Pretoria, South Africa; Professor Raymond Dart, University of Witwatersrand, South Africa; Sir Arthur Keith of Downe, Kent; Dr. Geoffrey Morant of London; Dr. William H. Sheldon of the Constitution Laboratory, Columbia University; Mr. J. C. Trevor of Cambridge University; and Mrs. H. M. Worthington of the University of Denver, Colorado, very kindly supplied photographs. For these friendly services I am grateful to each of them. To R. T. Simmons of the Commonwealth Serum Laboratories, Melbourne, I am much indebted for keeping me abreast of research on blood typing in the Pacific. To Dr. Alfred Wood of the Philadelphia General Hospital I am grateful for his careful reading of the page proof. Finally, I am obliged to the Research Council of Rutgers University for a grant which helped defray the cost of the illustrations.

M. F. ASHLEY MONTAGU

Department of Anthropology,
Rutgers University,
New Brunswick, New Jersey.

PREFACE TO THE FIRST EDITION

THIS little book has been written with the object of providing those who wish to learn something about the subject-matter of physical anthropology with a brief means of doing so. The work is not a text-book, but a general introduction to a rather young but enormously extended subject. Intended for the general reader, for the student, whether he be medical or interested in the social or anthropological sciences, I trust the work will also be found of value by students of the biological sciences, and finally by physicians, and psychologists.

Physical anthropology is a very large subject; to cover it at all adequately would take a work as large as the *Encyclopaedia Britannica,* and almost as many contributors to write it. In the present modest volume it has been possible to present only part of the subject-matter with which the science deals, and that, for the most part, in a general rather than in a detailed manner. I have, however, attempted to do more than merely introduce the reader to the subject. I have endeavored to give him a real grasp of the fundamental facts and problems which it is necessary for anyone to know who desires to understand man. I have not only set out these facts, but, wherever possible, have also explained their meaning.

The events of the last thirty years have made it abundantly clear that, if civilization is to continue, scientific thought must increasingly be applied to man himself. We stand badly in need of a saner distribution of scientific interests. If men of the scientific potentialities of those who today generally enter such fields as chemistry, mathematics, and physics, would apply their energies to the study of the social and physical sciences of man we should, I am convinced, be a great deal better off than we are at the present time.

At the base of all studies relating to man stands physical anthropology, the comparative science of man as a physical organism in relation to his total environment, social as well as physical. Those who are in any way concerned with the study of man do well to equip themselves with the facts it makes available. In this volume I have endeavored to provide some of those essential facts and to interpret them.

The book has greatly benefited from the critical reading which it received from a number of distinguished scientists, each one an eminent and creative worker in the different, though related, fields of science with which this book deals. For this service I am most grateful to my colleagues: Dr. L. J. Angel, Jefferson Medical College, Philadelphia; Professor and Mrs. W. C. Boyd, Boston University; Dr. P. B. Candela, New York Medical College; Professor D. S. Davidson, University of Pennsylvania; Professor Th. Dobzhansky, Columbia University; Professor W. K. Gregory, American Museum of Natural History and Columbia University; Professor A. I. Hallowell, Northwestern University; Professor M. J. Herskovits, Northwestern University; Professor E. A. Hooton, Harvard University; Professor C. Kluckhohn, Harvard University; Professor W. M. Krogman, University of Chicago; Mr. R. M. Snodgrasse, University of Chicago; Professor J. H. McGregor, Columbia University; Professor M. Steggerda, Kennedy School of Missions, Hartford, Connecticut; Dr. A. S. Wiener, Medical Examiner's Office, New York; and Professor Conway Zirkle, University of Pennsylvania.

For all errors and omissions, and other deficiencies (of which I am conscious there are many), I alone am responsible, and it should be added that the readers of the manuscript named above should not be held responsible for views with which they may well disagree. Unless otherwise attributed these views are my own.

M. F. Ashley Montagu

CONTENTS

Preface to the Second Edition vii
Preface to the First Edition ix
List of Figures xvii
List of Tables xxiii

CHAPTER

I. INTRODUCTION 5
  Physical Anthropology: Its Scope and Definition 5
  For Further Reading, Consult: 20
  Reference Works on Physical Anthropology 21
II. THE PRIMATES AS A ZOOLOGICAL GROUP 22
  The Order of Primates 23
    The Tree-Shrews 23
    General Description of the Primates 26
    Classification 28
    Prosimii 30
    The Tarsiiformes 39
    Anthropoidea 43
      Series Platyrrhini 43
        The Callithricidae 43
        The Cebidae 47
    Anthropoidea 58
      Series Catarrhini 58
        Cercopithecinae 63
        Semnopithecinae 65
    Anthropoidea 67
      Series Catarrhini 67
        Hylobatinae 72
        Ponginae 74
        Homo 84
  For Further Reading, Consult: 86
III. THE ORIGIN AND EVOLUTION OF THE PRIMATES 89
  For Further Reading, Consult: 124
IV. THE ORIGIN AND EVOLUTION OF MAN 127
  For Further Reading, Consult: 228
V. THE CRITERIA AND MECHANISM OF ETHNIC DIFFERENTIATION 232
    The Criteria of Analysis and Classification 234
    The Landsteiner Blood Groups A, B, AB, and O 240
    Blood Types M, N, and MN 252

The Rh Blood Types 254
The Blood Genes as Genetic Indicators 259
The Secreting Factor 265
Tasting and Non-Tasting 269
The Mechanism of Differentiation of the Divisions and Ethnic Groups of Man 271
Natural Selection 274
Mutation 278
Isolation 281
Genetic Drift 282
Hybridization 283
Sexual Selection 285
Social Selection 287
Definition of an Ethnic Group and Division 292
For Further Reading, Consult: 295
VI. THE DIVISIONS AND ETHNIC GROUPS OF MAN 299
The Divisions of Mankind 301
The Negroid Division 302
Geographic Distribution of African Negroids 302
The True Negroes 303
The Forest Negro 304
The Nilotic Negroes or Nilotes 304
The Half-Hamites 306
The Bantu-Speaking Negroes 306
Bushman-Hottentot 307
The Pygmies 311
The African Pygmy or Negrillo 312
The Asiatic Pygmies or Negritos 312
Andamanese 312
Semang 312
Aeta 314
The Oceanic Pygmies or Negritos 315
New Guinea Pygmies 315
Oceanic Negroids 316
Papuans 316
Melanesians 317
The Distribution of the Negroids 318
The Australoid or Archaic Caucasoid Sub-Division 318
The Australian Aborigines 318
The Veddahs 322
The Pre-Dravidians 323
The Ainu 325

The Caucasoid Division 326
Mediterranean 327
Basic Mediterranean 327
Atlanto-Mediterranean 328
Irano-Afghan Mediterranean 328
The "Nordic" 328
Alpine 329
Dinarics and Armenoids 331
Dinaric 332
Armenoid 334
East Baltic 335
The Lapps 335
Indo-Dravidians 338
Polynesians 339
The Mongoloid Division 340
The Central or Classical Mongoloid 342
The Arctic Mongoloids or Eskimoids 343
The American Indian or Amerindian 344
Indonesian-Malay 345
Conclusion 347
The Divisions and Ethnic Groups of Man 349
For Further Reading, Consult: 351
VII. THE SIGNIFICANCE OF ISOLATE DIFFERENCES OR THE RELATION BETWEEN BODY, MIND, AND CULTURE 352
The Racist View 352
The Genetic Facts 352
"Blood" 356
Spiritual Qualities, Genes, and Culture 358
Are There Any Mental Differences between the Divisions and Ethnic Groups of Mankind? 366
The Evolution of the Mental Characters of Mankind 368
The Isolate Effect in Cultural Differentiation 375
For Further Reading, Consult: 380
VIII. HEREDITY AND THE INFLUENCE OF THE ENVIRONMENT UPON MAN 382
The Twin Method of Studying the Effects of Heredity and Environment 382
Criminality in Twins 387
Constitution and Crime 389
Constitution and Disease 402
Sex Differences in Constitution 407

Sex-Linked, Sex-Influenced, and Sex-Limited Genetic Effects 409
  Penetrance, Expressivity, and Viability of Genes 414
Some Social Consequences of the Biological Differences Between the Sexes 415
The Influence of Environmental Factors Upon the Structure and Functions of Man 417
For Further Reading, Consult: 438

APPENDIX

A PRACTICAL SYNOPSIS OF METHODS OF MEASUREMENT IN PHYSICAL ANTHROPOLOGY 440
    The Measurement of Man 440
    Essential Historical Data 442
    Instruments in Somatometry 442
    Somatometry 444
  Measurements with Subject in Standing Position 444
      Transverse and Antero-Posterior Dimensions 446
      Girths 448
  Measurements with Subject in Sitting Position 449
      Sitting Heights 449
      Dimensions of the Hand and Foot 449
      Dimensions of the Head 449
      Cephalometry 452
      Measurements of the Head 452
      Girths 454
      Indices 454
    Cranial Capacity in the Living 457
    Anthropometric Observations 457
    Finger, Palm, Toe, and Sole Prints 462
  Physiometric Observations 464
  Blood Typing Technique 469
  Collection of Bone Samples for Typing 472
    Technique of Blood Typing Skeletons 473
    Anthropometric Recording Blanks 476
  Craniometry 476
      Why Measure Skulls? 476
  Definitions 477
  Landmarks 478
  General Comments 480
  Cranial Measurements 480

Craniometric Indices 484
Estimating Age of Skull 486
Approximate Age of Tooth Eruption 486
The Sex of the Skull 494
Cranial Recording Blanks 494
Postcranial Osteometry 494
Pedigrees for Genetic Studies 506
Works on Anthropometry and Anthroposcopy 506
Works on Statistics 507
Table of Weights and Measures 508
Dry Measure 508
Some Current Anthropological Periodicals Either Wholly or in Part Devoted to Physical Anthropology 509
BIBLIOGRAPHY 512
INDEX 525

LIST OF FIGURES

Figure — Page

1. Edward Tyson (1650-1708) 7
2. Louis-Jean-Marie Daubenton (1716-1799) 8
3. Johan Friedrich Blumenbach (1752-1840) 9
4. William Lawrence (1783-1867) 11
5. James Cowles Prichard (1786-1848) 12
6. Pierre Paul Broca (1824-1880) 14
7. Thomas Henry Huxley (1825-1895) 15
8. Alfred Cort Haddon (1855-1940) 16
9. Karl Pearson (1857-1936) 17
10. Franz Boas (1858-1942) 18
11. Sir Arthur Keith (b.1866) 19
12. Tree-shrew 23
13. Classification of the Primates 31
14. Ring-tailed Lemur (*Lemur catta*) 32
15. Brown Lemur (*Lemur macaco fulvus*) 34
16. Galago or Bush Baby (*Galago crassicaudatus*) 35
17. Slow Loris *(Nycticebus tardigradus)* 38
18. The Tarsier (*Tarsius spectrum*) 40
19. Common Marmoset (*Callithrix jacchus*) 44
20. Pygmy Marmoset (*Callithrix pygmaea*) 46
21. Owl Monkey (*Aotus trivirgatus*) 48
22. Owl Monkey (*Aotus trivirgatus*) 49
23. An Old World or Catarrhine Monkey (*Macaca*) and a New World or Platyrrhine Monkey (*Cebus*) showing the difference in the arrangement of the nostrils 50
24. Woolly Saki Monkey *(Pithecia monachus)* 51
25. Ouakári Monkey (*Cacajao calvus*) 52
26. Squirrel Monkey (*Saimiri sciureus*) 53
27. White-throated Sapajou (*Cebus capucinus*) 54
28. Hooded Sapajou (*Cebus fatuellus*) 55
29. Spider Monkey (*Ateles ater*) 56
30. Woolly Monkey, Immature (*Lagothrix humboldti*) 57
31. Black Guenon (*Cercopithecus nigrigenis*) 59
32. De Brazza Guenon (*Cercopithecus brazzae*) 60
33. Java Macaque or Java Monkey (*Macaca irus*) 61
34. Barbary Ape (*Macaca sylvana*) 62
35. Gelada Baboon (*Theropithecus gelada*) 64
36. Hamadryas Baboon (*Papio hamadryas*) 65

FIGURE PAGE
37. Chacma Baboon (*Papio porcarius*) 66
38. Mandrill (*Mandrillus sphinx*) 67
39. Guereza Monkey (*Colobus abyssinicus*) 68
40. Main Divisions of the Primate Suborder Anthropoidea .. 70
41. White-handed Gibbon with Baby (*Hylobates lar*) 71
42. Gibbons on Monkey Island (*Hylobates lar*) 73
43. Female Orang-Utan with Young from Borneo (*Pongo pygmaeus*) 75
44. Chimpanzee Mother and Young One (*Pan satyrus*) 77
45. Chimpanzee (*Pan satyrus*) 78
46. Male Gorilla (believed to be *Gorilla gorilla beringei*, the mountain gorilla) 80
47. Geological Time-scale of the Appearance of Various Representative Forms of Life 91
48. Skulls of Eocene and Modern Lemurs 92
49. The Tree-shrew (*Tupaia ferruginea*) 93
50. A comparison of the brains of eight different types of primates 97
51. *Proconsul africanus* 101
52. *Australopithecus africanus* (right side reversed) 104
53. *Plesianthropus transvaalensis* (reconstruction using parts of the right and left sides) 105
53A. Skull of *Plesianthropus transvaalensis* 107
53B. Frontal view of skull of *Plesianthropus transvaalensis* .. 107
53C. Inner side of right pelvic arch of *Plesianthropus transvaalensis* 108
53D. Outer side of right pubic arch of *Plesianthropus transvaalensis* 108
54. *Paranthropus robustus* 109
55. *Australopithecus prometheus* 111
56. Craniograms of *Australopithecus africanus* (infant), *Australopithecus prometheus* ♀, and *Paranthropus robustus* ♂ 112
57. Craniograms of *Australopithecus prometheus, Plesianthropus transvaalensis* ♂, and *Paranthropus robustus* ♂ 113
58. Left lateral views of innominate bones in chimpanzee, *Australopithecus prometheus* and Bushman 118
59. Upper jaw of a newborn male (Negro) showing a portion of the premaxilla upon the facial aspect of the skull and

FIGURE PAGE

the whole of the ascending process of the premaxilla within the nasal fossa ... 118

60. Cranio-facial aspect of the skull of a white infant aged about 11 months showing the apical portion of the premaxilla separated from the maxilla ... 120

61. Chronological-Cultural Table of the Divisions of Prehistory and of the Historic Period ... 122

62. A reconstruction of the skull of *Pithecanthropus erectus I* 136

63. Lateral and vertical views of the cranium of *Pithecanthropus erectus II* ... 139

64. Map of central and East Java, showing the chain of volcanoes and the Valley of the Bengawan (Solo) River with sites of the human finds marked by a cross ... 140

65. Artifacts of Soan culture group ... 141

66. Reconstruction of a female *Sinanthropus* skull (somewhat modified after Weidenreich) ... 143

67. Stone tools of Pekin Man ... 144

68. Mid-sagittal craniograms of Keilor skull and the Wadjak skull II, both superimposed on the glabella-opisthocranion line and the opisthocranion ... 145

69. Transverse diagram of the Keilor skull and the Wadjak skull I, both superimposed on the interporion line ... 146

70. Abbevillian tools ... 147

71. Clactonian and Tayacian artifacts ... 148

72. The skull of Rhodesian Man ... 150

73. The Heidelberg Jaw ... 152

74. One type of Neanderthal Man. The Old Man of La Chapelle-aux-Saints ... 156

75. Mousterian industries ... 159

76. The Steinheim skull ... 160

77. The Steinheim skull. Frontal view ... 161

78. Tabūn I ... 162

79. Skhūl V (right side reversed) ... 163

80. Left lateral craniograms of four types of fossil skull ... 164

81. The Châtelperron skull ... 166

82. The skull of a Cro-Magnon male ... 169

83. Upper Paleolithic flint tools ... 171

84. Superpositions of engravings ... 172

85. Craniogram of a Cro-Magnon compared with that of the Neanderthal skull of La Chapelle-aux-Saints ... 174

FIGURE PAGE
86. Upper Paleolithic home art 176
87. Reconstruction of the Piltdown skull 177
88. Left outer and right inner side view of lower jaw of Piltdown Man compared with that of chimpanzee, Heidelberg Man and Modern Man 180
89. Bone implement from Piltdown, made from the thigh-bone of an elephant, and retaining part of the concave inner wall of the marrow cavity, the smooth hinder surface and the outer edge, including the third trochanter 181
90. A comparison of the brains, mid-sagittal sections of the skulls, and inner sides of lower jaws of anthropoids and man 182
91. A comparison in brain sizes 183
92. The Swanscombe skull 185
93. Acheulian hand-axes associated with the Swanscombe skull 186
94. The Swanscombe endocranial cast of the brain and its reconstruction together with the mid-sagittal section of the parietal and occipital bones as the basis for a reconstruction of the frontal and facial portions of the skull (reconstruction of the brain after Le Gros Clark) 187
95. The Swanscombe parietal and occipital bones with the conjectured neanthropic face added 188
96. Left parietal bone of the Swanscombe skull, seen from behind, placed in apposition to the right parietal bone of a modern European skull 189
97. The Bury St. Edmunds skull fragment 189
98. The Galley Hill skeleton 191
99. The Galley Hill skeleton 192
100. The Wallbrook frontal bone 197
101. The Wallbrook frontal bone 198
102. The Wallbrook frontal bone and Swanscombe parietal bone approximated at the region of the coronal suture .. 199
103. The Wallbrook frontal bone and Swanscombe parietal bone approximated at the region of the coronal suture .. 200
104. The Fontéchevade skull II 201
105. The phylogenetic relationships of the primates in their geological background 203
106. Seven forms of fossil man 205
107. Artifacts of fossil man in Africa 207
108. The Kanam Mandible 210
109. The Florisbad skull 212

FIGURE PAGE
110. Distribution and Suggested Relationships of the Cultural Traditions of Early Man 214
111. Relative Chronology of Paleolithic Man and His Industries 218
112. Migration routes available to primitive colonists in Late Glacial and Early Post-Glacial Time 219
113. Map of areas of Indian culture and principal tribes in North America 220
114. Map of areas of Indian culture and principal tribes in South America 221
115. Folsom point and associated bison ribs imbedded in matrix 223
116. Map of the Southwest showing sites from which archeologic evidences of ancient cultures have been recovered 225
117. Chromosome diagram showing the transmission of the genes in the mating of two persons, one of blood group A and the other of blood group B, each being heterozygous for blood group O 246
118. Blood groups of the Basque People 264
119. A Nilotic Negro of the Tagala People of the Anglo-Egyptian Sudan 305
120. Hamiticized Nilote of Assouan, Anglo-Egyptian Sudan .. 305
121. Old Hottentot Man and Woman, South-west Africa 307
122. Hottentot Woman showing steatopygia 308
123. Three Hottentot girls 310
124. A young Andaman male 313
125. Young Negrito male, from Zambales, Philippine Islands .. 314
126. Map showing the Ethnological Divisions of Oceania 315
127. Frontal and right lateral views of Papuan male, aged 35 years, from New Guinea 317
128. Frontal and lateral views of an Australian aboriginal male, aged 30 years, height 5 feet 6 inches 319
129. Frontal and left lateral views of young Australian aboriginal female 321
130. Frontal and right lateral views of Tasmanian male 321
131. Truganini, female Tasmanian aboriginal 322
132. Map showing the average head indices of the recent populations of Eastern Asia, Australia and Oceania 324
133. Diagram showing the divisions and ethnic types of man usually recognized, together with certain of their physical characters 330
134. Map showing the average head indices of the recent popu-

FIGURE PAGE

lations of Europe, Africa, and Western and Central Asia 333
135. Young Javanese male from Bautam 341
136. Some relationships of varieties of mankind to one another, and those which have entered into formation of U. S. population 346
137. Somatotype 7-4-1. Mesomorphic endomorph 393
138. Somatotype 3-7-1. Endomorphic mesomorph 393
139. Somatotype 4-3½-4. Balanced 395
140. Somatotype 1½-1½-6½. Strong ectomorph 395
141. Diagram of the X- and Y-chromosomes, showing the portions involved in sex-linkage 410
142. Head breadth taken as a per cent of head length (cephalic index) in immigrants and their descendants 419
143. The seasonal incidence of some diseases 427
144. Cretins from Urnatsch Almshouse, Appenzelle Canton, Switzerland 430
145. Average length of life from Ancient to Modern Times .. 432
146. Sliding compass and spreading calipers 443
147. Landmarks of the body (after Martin) 447
148. Landmarks in frontal and lateral views of the head 452
149. The Human skull 455
150. Skin folds over the upper eyelid in man 459
151. The palmaris longus muscle 467
152. Showing the buttresses of the skull and the directions of distribution of the forces transmitted from the lower first through the upper first molar tooth 478
153. Basilar view of the skull showing directions in which compressive strains transmitted through the first upper molar are taken up by the zygomatic buttress, while those from the back of the skull pass down toward the external occipital protuberance 481
154. Suture closure of the skull 488
155. The Human skeleton 491
156. The Human skeleton (anterior view) 495
157. The Human skeleton (posterior view) 497
158. Skeleton of the leg 498
159. Skeleton of foot 500
160. Sample genetic pedigree chart 504
161. Nomograph for determining cephalic index 505

LIST OF TABLES

TABLE PAGE

1. The Agglutinogens and Agglutinins of Blood Groups A, B, AB, and O 241
2. Determination of Blood Groups with Two Test Sera, Anti-A and Anti-B 242
3. Determination of Blood Groups of Sera with Known Blood Corpuscles A and B 242
4. The Usual Effect of Adding a Donor's Blood to a Receiver's Serum 243
5. Determination of Genetic Constitution of Humans with Regard to Blood Groups 244
6. The Gene Combinations or Genotypes Yielding the Phenotypes or Blood Groups 245
7. Distribution of the Blood Groups in Random Samples of Human Populations 247
8. Blood Group Frequencies in New Zealanders, English and Scotch, and Unmixed and Mixed Maori 249
9. The Heredity of Blood Types M, N, and MN 253
10. Percentage Distribution of the Blood Types M, N, and MN 253
11. Rh Blood Types, Genotypes and Phenotypes 256
12. Distribution of the Rh Blood Types 258
13. Gene Series O, A_2, A_1, B 260
14. Distribution of the Subgroups of A and AB 261
15. The Genotypes and Phenotypes of the Secreting Factor ... 266
16. Distribution of Sicklemia in Uganda 268
17. The Genotypes and Phenotypes of Tasting and Non-Tasting PTC 269
18. Ability to Taste Phenyl-Thio-Carbamide in Human Populations 271
19. Average Cranial Capacities in Anthropoids and Man 336
20. Criminal Behavior of Twins 387
21. Sheldon's Classification and Somatotypes 396
22. The Scale for Temperament 398
23. Mortality Rates of Males and Females According to Organ System Involved (U.S.) 406
24. Sex Differences in Mortality Rates (U.S.) 407
25. Sexual Differences in Susceptibility to Disease 408
26. Some Human Traits Reported as Dependent Upon Sex-Linked Genes 411

TABLE PAGE
27. Conditions Reported as Due to Lethal Genes 415
28. Some Presumed Social Consequences of the Biological Differences between the Sexes 416
29. Increase (+) or Decrease (—) in Measurements of Children of Immigrants Born in the U. S. Compared with Those of Immigrants Born in Europe 419
30. Expectation of Life at Birth by Sex in Various Countries for Specified Periods 431
31. Ratio of Annual per Capita Volume of Disability in U.S. for Low Income Groups to That in the Highest Income Groups 433
32. Height and Weight of Glasgow School Children by Ascending Order of Socio-economic Status of School 435
33. Percentages of Children Under Average Height, Classified by Country and Socio-economic Status 436
34. Concentrations of P.T.C. Solutions 466
35. Ectocranial Suture Closure in Males 489

An Introduction to
Physical Anthropology

"Never forget this when the talk is clever:
Wisdom must be born in the flesh or wither,
And sacred order has been always won
From chaos by some burning faithful one
Whose human bones have ached as if with fever
To bring you to these high triumphant places.
Forget the formulas, remember men."

MAY SARTON*

---

* From the poem "The Sacred Order," by permission of the author and Rinehart & Co., from May Sarton's *The Lion and the Rose.*

Chapter I

INTRODUCTION

PHYSICAL ANTHROPOLOGY: ITS SCOPE AND DEFINITION

ANTHROPOLOGY is the science of man, the science devoted to the comparative study of man as a physical and cultural being. The physical anthropologist studies man's physical characters, their origin, evolution, and present state of development, while the cultural anthropologist studies man as a cultural being in all the varieties which his cultures take.[1] Both physical and cultural anthropology are conveniently recognized as separate, though interrelated and interdependent, subdivisions of anthropology which should never be permitted to become too detached from one another.

The task of the physical anthropologist is not merely to study man as a physical being, but to round out the picture of man from the biological side which the cultural anthropologist endeavors to complete from the cultural side.

Since man, in all his variety, examined at any given moment,

---

[1] ***Ethnography*** is the description of the cultural characteristics of a people.

Ethnology is the historical reconstruction of the cultural relationships of a people to other peoples; the comparative study of culture.

Social Anthropology is concerned with the phenomena of culture which can be summarized in terms of generalizations or laws, which are true of all cultures in which a specific phenomenon is manifested.

Society denotes that complex of fundamentally cooperative interactions or inter-relations which exist between and among the members of a group.

A society, as distinct from society, is a group the members of which consciously or unconsciously cooperate to maintain a common life.

By ***social*** is meant all those interactive relations between individuals or groups in which needs are satisfied.

A culture is the particular form which characterizes the learned, shared, and transmitted social activities of a group. In this connection it will be helpful to remember that society is a generic term and that culture is a species of society.

Archeology is the ethnology and ethnography of cultures which no longer exist—at least in precisely the same form—based on the study of, and inferences from, cultural products and subsistence remains recovered by excavation and similar means.

may be regarded as a complex of the effects of past causes and of the operation of present ones, it is possible to study him both from the historical and contemporary viewpoints. From the historical viewpoint the anthropologist asks: How did man come to be the kind of physical organism he is, and how did he come to develop his particular type of culture? From the contemporary viewpoint he asks: "What is the nature of the conditions which have made man what he is here and now in all his wonderful variety?" These, briefly, are the questions which, out of the great orbit of human inquiry, have fallen to the lot of anthropology for investigation and answer.

To learn more or less precisely how much of the biological enters into the expression of any social process, and how much of the social enters into the expression of any biological process is one of the principal aims of physical anthropology. Hence, the physical anthropologist must be something of a social biologist.

Man lives in a physical environment which varies in different lands and often in neighboring localities of the same lands. The seasons, sunlight, temperature, humidity, barometric pressure, rainfall, water, soil, foods, and a thousand and one other factors, are all to be taken into consideration in the study of the mental and physical development of man. Man, in short, must always be studied in relation to his environment, past as well as present.

Physical anthropology, then, is the comparative science of man as a physical organism in relation to his total environment, social as well as physical.

Within the same ethnic group, and in different ethnic groups, striking differences may be present in skin and hair color, in hair form, eye color, stature, weight, and in numerous other characters. How did these different characters come into being, and what are the factors which account for their present distribution?

The attempt to return an answer to such questions is again one of the most important tasks of the physical anthropologist. Many methods have been utilized in this attempt with but moderate success. In recent years, however, a new instrument of investigation has become available in the form of the genetic method of analysis. The application of such genetic methods to the solution of the problems of human variability has already made something

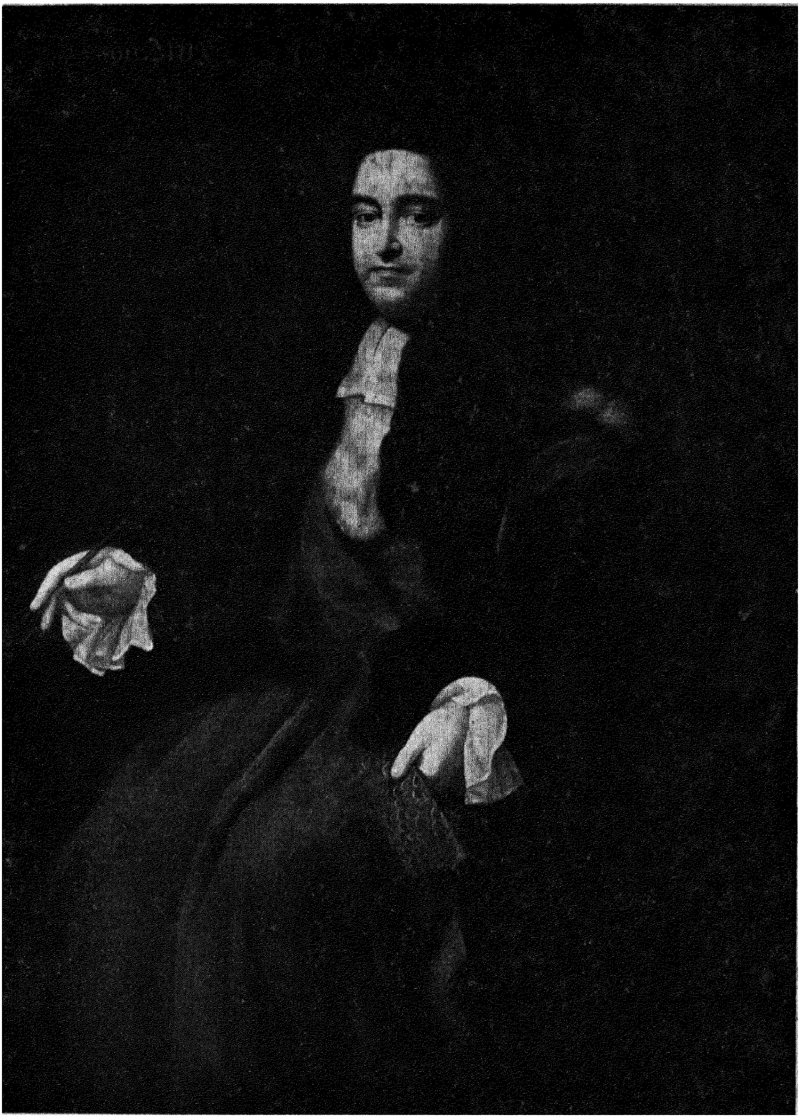


FIG. 1. Edward Tyson (1650-1708). Father of Primatology, author of the first comparative anatomy of an ape, *Orang-Outang, Sive Homo Sylvestris*, London, 1699. (From the portrait in the Royal College of Physicians, London, probably by Sir Godfrey Kneller. Courtesy, Royal College of Physicians, London.)

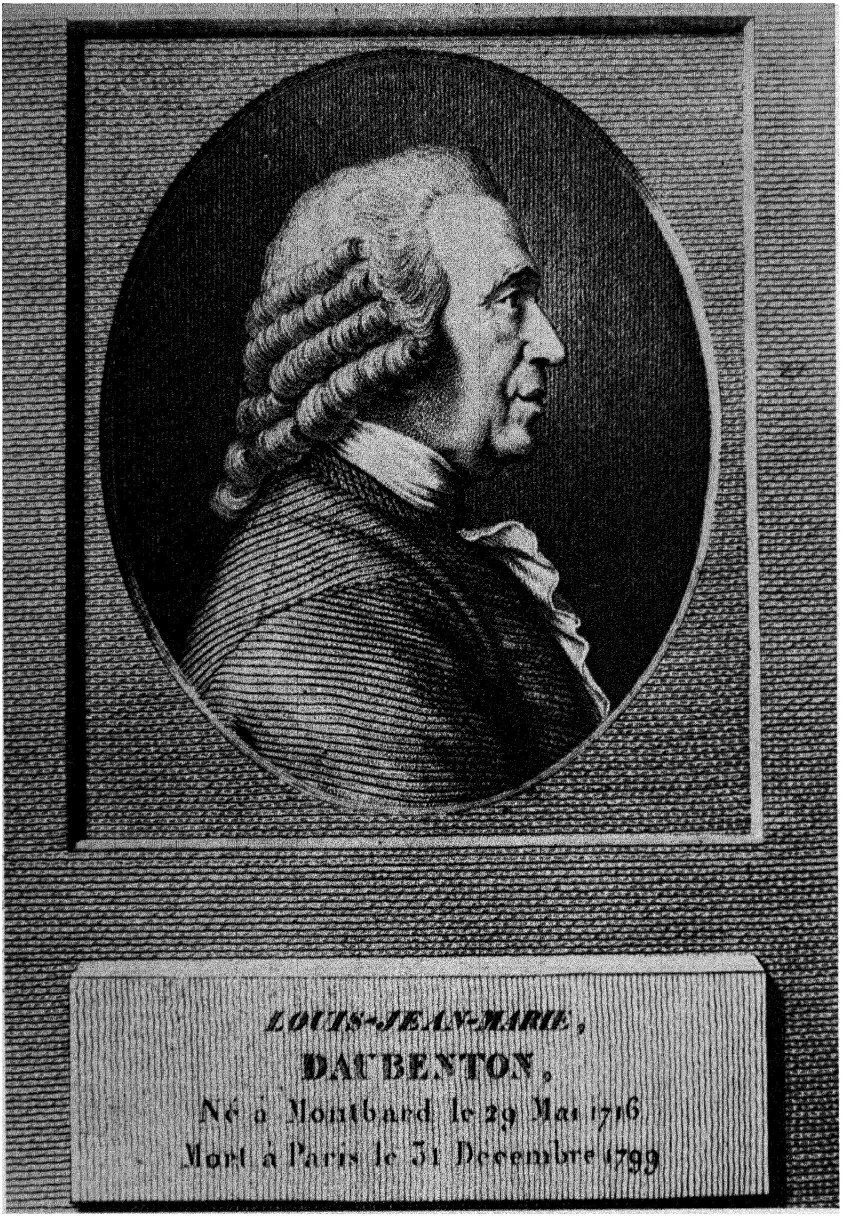


FIG. 2. Louis-Jean-Marie Daubenton (1716-1799). Eminent comparative anatomist who, in addition to many fundamental contributions, provided much of the basic data for Buffon's *Natural History*.

FIG. 3. Johann Friedrich Blumenbach (1752-1840). The "Father" of Physical Anthropology. (From an engraving by Wachsmann after a painting by Grimm.)

of a beginning, and holds great promise for the future. The investigation and analysis of the mechanism of heredity has steadily yielded valuable information concerning the individual as well as the race. By the use of genetic methods we may hope to solve the problems of the detailed causes of individual variation and the diversification of the different varieties of men.

Our purpose in such studies is to draw up a reasonably reliable history of the origin and evolution of the human species and all its varieties, and ideally of each living person. This we can ultimately hope to do by breaking down in greater and greater detail each of the problems confronting us, not so much by investigating the end-effects of evolution, such as the shape of the head or the nose, or the color of the eyes and hair, as by investigating the causes which produce these end-effects. The question of questions which the physical anthropologist asks is no less than this: What are the causes which produced, and which continue to produce, man in all his variety? It is a powerfully big question, but can there be one surpassing or even equalling it in interest?

Man is an animal whose closest kinship is with the apes and monkeys, and with them he is classed in the mammalian Order of Primates. The study of the monkeys and apes is known as the science of *primatology*. While man is distinctly a primate of the primates it is convenient to apply the term primatology to the non-human primates alone. This is merely an arbitrary distinction for the purposes of convenience and no more. The study of man as a purely zoological species may be recognized as the science of *human biology*. Primatology is fundamental to the study of human biology. The study of the anatomy, physiology, and behavior of non-human primates throws an invaluable light upon the evolution of man. Without the knowledge obtained from these studies we should be virtually wholly in the dark concerning the pre-human history of man. Hence, primatology is an indispensable part of the equipment of every physical anthropologist.

Not only is the study of the living primates a necessary division of physical anthropology, but equally important, in another way, is the study of extinct or fossil primates which are ancestral or related to those living today, and which flourished many millions of years ago, long before the appearance of man upon the earth. This constitutes the study of *primate paleontology*.

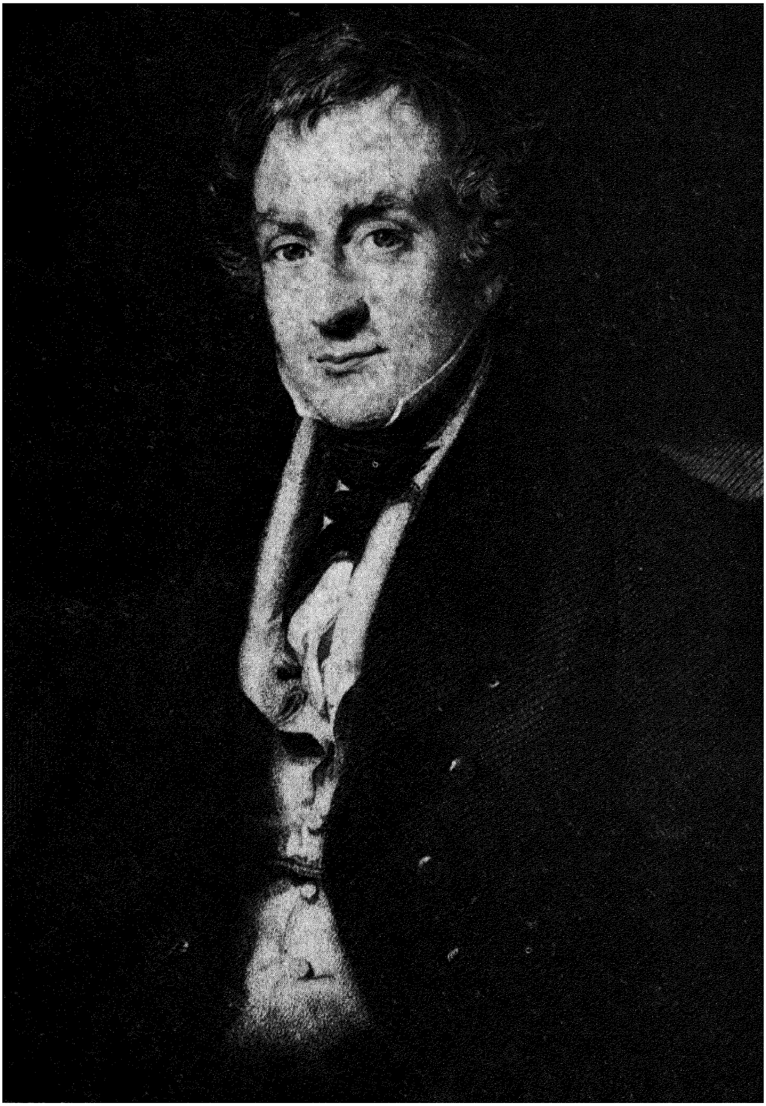


FIG. 4. William Lawrence (1783-1867). Distinguished anatomist, surgeon, and physical anthropologist whose *Lectures on Physiology, Zoology, and the Natural History of Man,* first published at London in 1822, is one of the great classics of physical anthropology.

Primate paleontology necessitates some knowledge of general paleontology, but particularly of stratigraphical geology and the various geological eras and periods. From primate paleontology to the study of prehistoric man, through his fossil remains, we are brought to the earliest history of man himself.

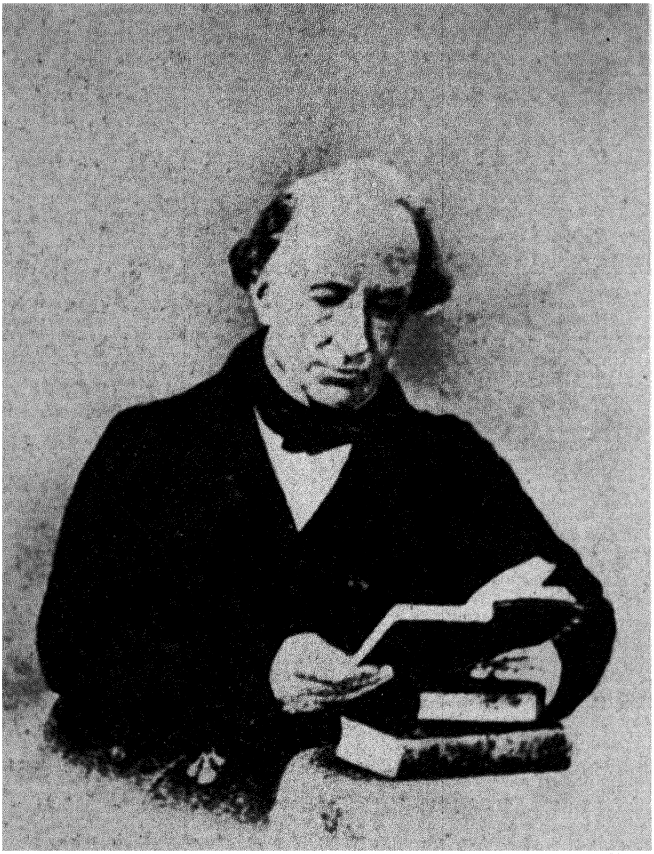


FIG. 5. James Cowles Prichard (1786-1848). Distinguished physical anthropologist and alienist. Author of the celebrated work *Researches into the Physical History of Mankind,* London, 1813, and *The Natural History of Man,* London, 1843.

It is the principal ambition of the physical anthropologist, in his studies of prehistoric man, *paleoanthropology,* to trace the origin of mankind back to that non-human primate stock from which he emerged, and then from that stage to trace the evolution of man, in his different varieties, up to the present time. As we shall see in later chapters some progress has been made during the last thirty years towards the realization of this ambition.

The proper evaluation of the status of the remains of fossil man in the evolutionary reticulum demands a good knowledge of human and comparative anatomy, including embryology or developmental anatomy, and the anatomy and physiology of growth.

From the study of our prehistoric ancestors to the study of the origins and relationships of the existing varieties of man is but a logical step. Very gradually we are beginning to untangle the strands which have entered into the network of the evolution of our species, and there is every reason to believe that we shall some day be able to give a fairly complete account of the fibers and strands which as vital dynamic reticulate processes have gone into the making of mankind.

The study of the existing varieties of man is generally known as the study of *race*. But since this term has become more closely identified with social pathology rather than with scientific usage, modern physical anthropology is beginning to devote more and more attention to a re-examination of the meaning of the term in the light of modern knowledge, and to re-study and analyze the varieties of man, in order that the real significance of such differences as they exhibit may be properly interpreted and clearly understood. Anthropology regards as unscientific and vicious the view that there can be one kind of history for ourselves and another kind for other peoples. It is, indeed, through the bold and untiring labors of anthropologists that the great truth has been discovered that the same evolutionary principles have governed the development of all men, past and present, and that such differences as the existing varieties now exhibit are not of a kind which, upon any scientific system of biological or even social values, would justify any one of them as being distinguished as biologically superior or inferior to any other. If physical anthropology had achieved nothing else, this discovery alone would forever have justified its labors, for the concept of the natural unity of mankind provides the basis for the conception of the social unity of mankind, a conception which may some day be universally realized.

Hence, physical anthropology has an important contribution to

FIG. 6. Pierre Paul Broca (1824-1880). Great neurosurgeon and physical anthropologist. Founded the first anthropological society in Europe at Paris in 1859. (Photo, Courtesy Musée de l'Homme, Paris.)

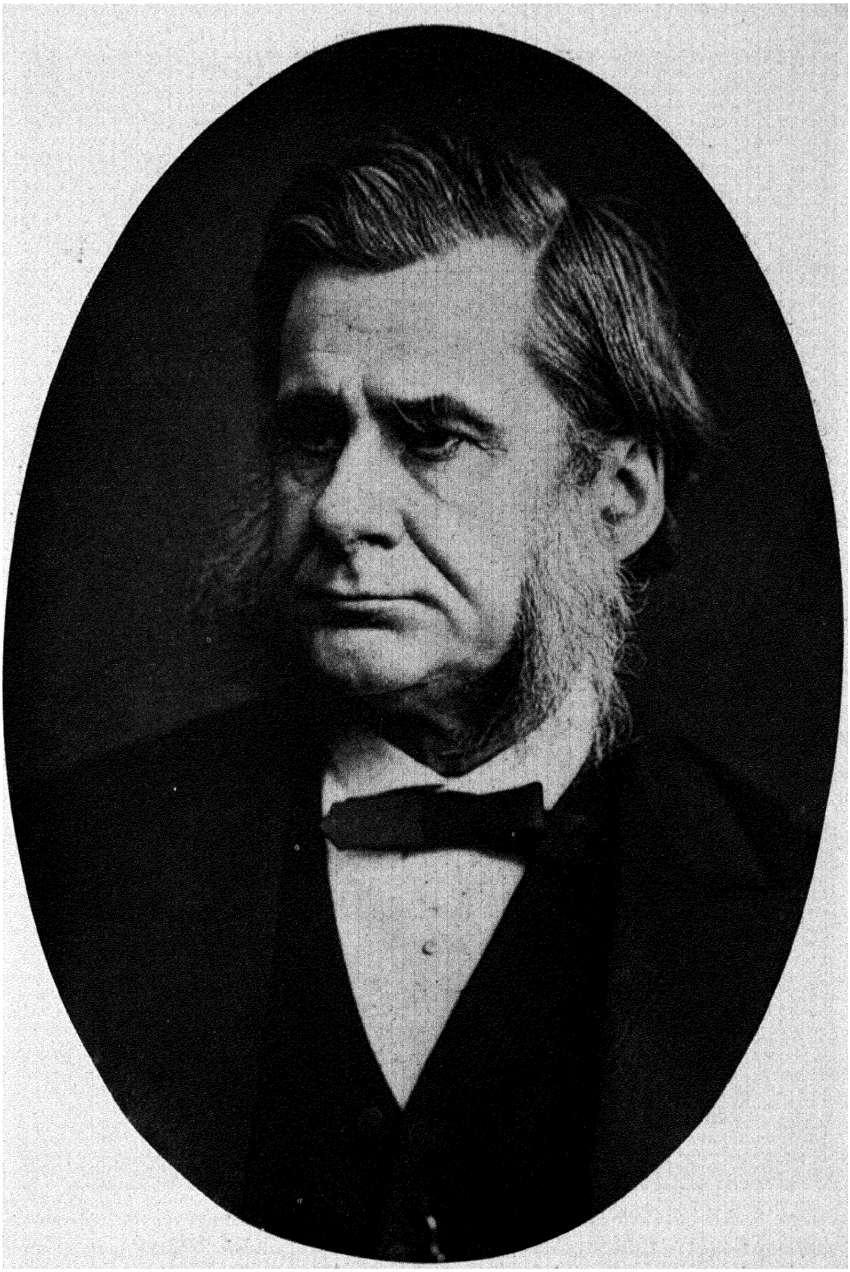


FIG. 7. Thomas Henry Huxley (1825-1895). Great comparative anatomist whose *Man's Place in Nature,* London 1863, and numerous other writings place him in the forefront of 19th Century physical anthropologists.

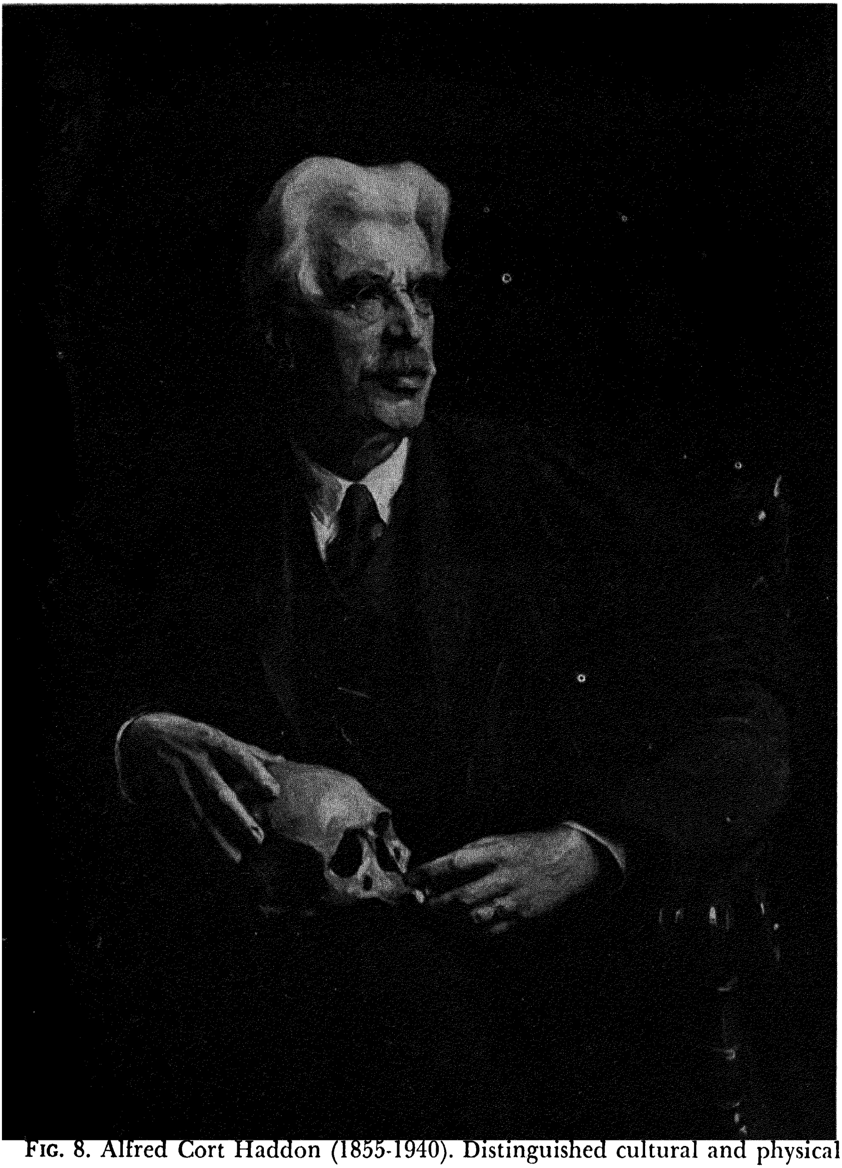


FIG. 8. Alfred Cort Haddon (1855-1940). Distinguished cultural and physical anthropologist. Holder of the first chair in anthropology at Cambridge University. (From the portrait by Philip de Laszlo. Courtesy, University Museum of Archaeology and Ethnology, Cambridge, England.)

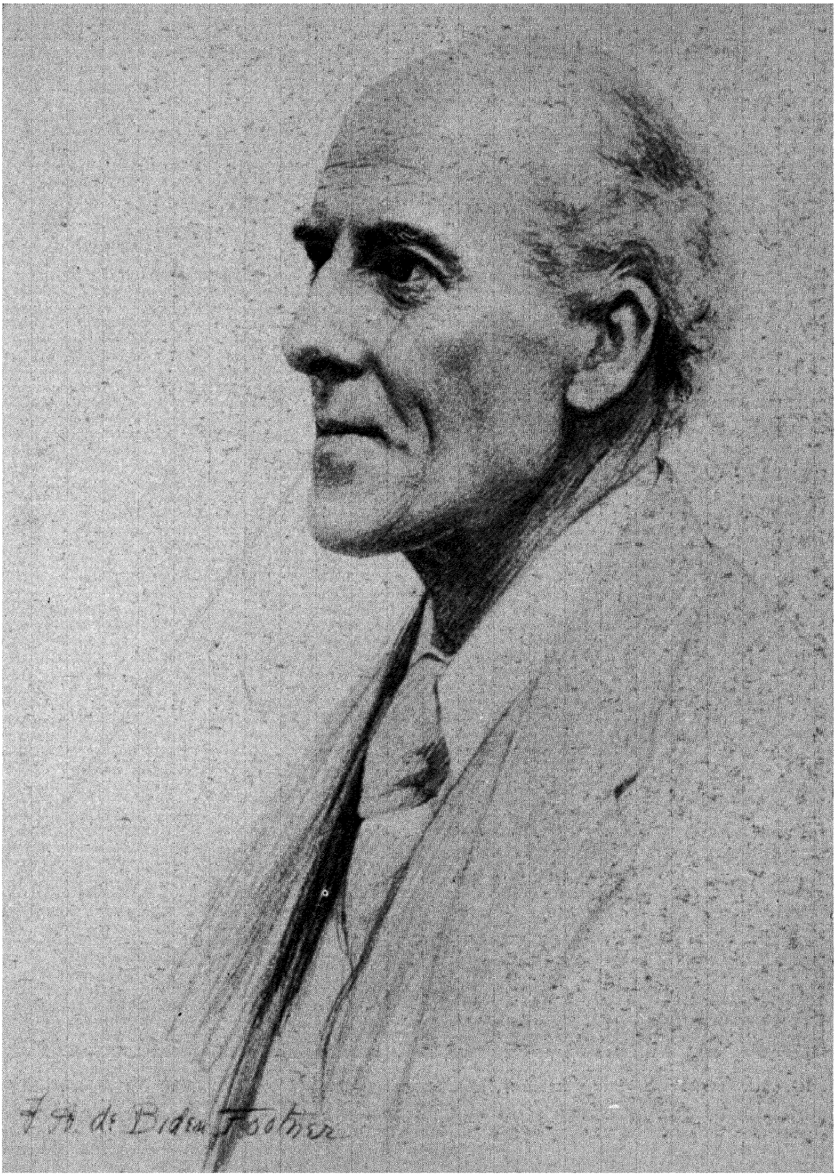


Fig. 9. Karl Pearson (1857-1936). Principal founder and most distinguished worker in the modern school of biometrics. (From a pencil drawing made in 1924 by Miss F. A. de Biden Footner. Courtesy, Cambridge University Press.)

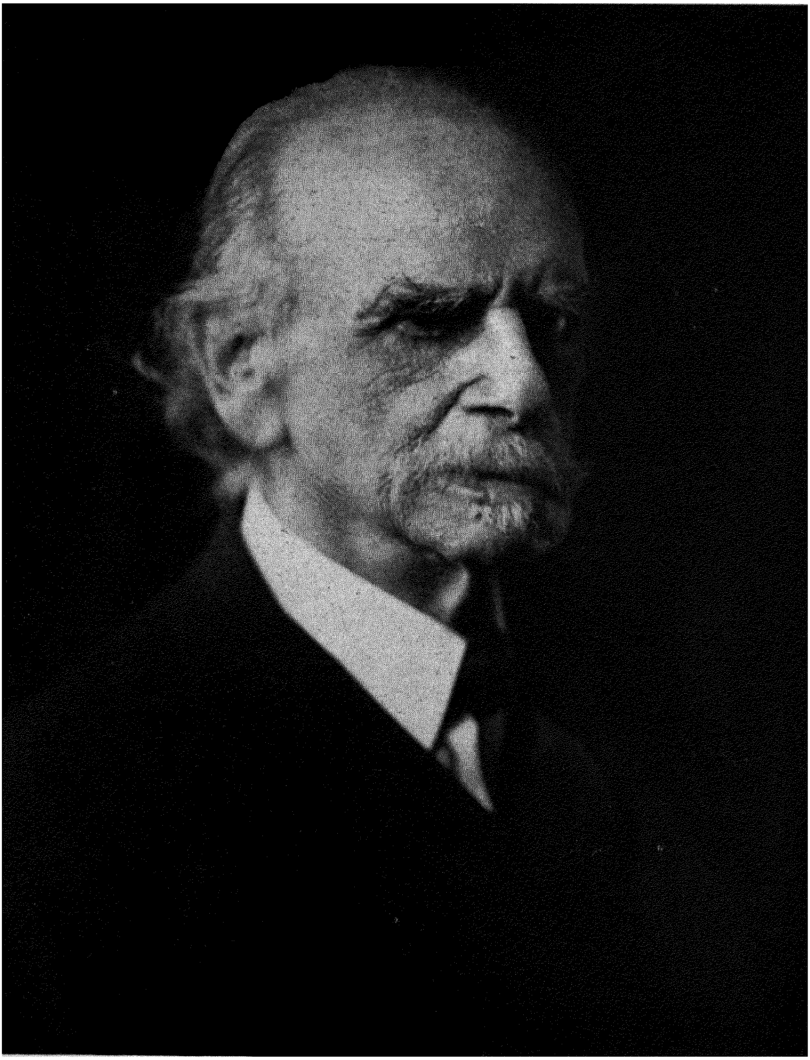


FIG. 10. Franz Boas (1858-1942). Great cultural and physical anthropologist. Founder of the American school of anthropology. (Courtesy, Dr. Ernst Boas.)

make towards the improvement of the social order. This is not simply because of the grandeur of the story it has to tell, but by virtue of the very appreciable contribution it makes to the better understanding of ourselves and of our fellow men, in a world in which such understanding is not too widely distributed. Further-

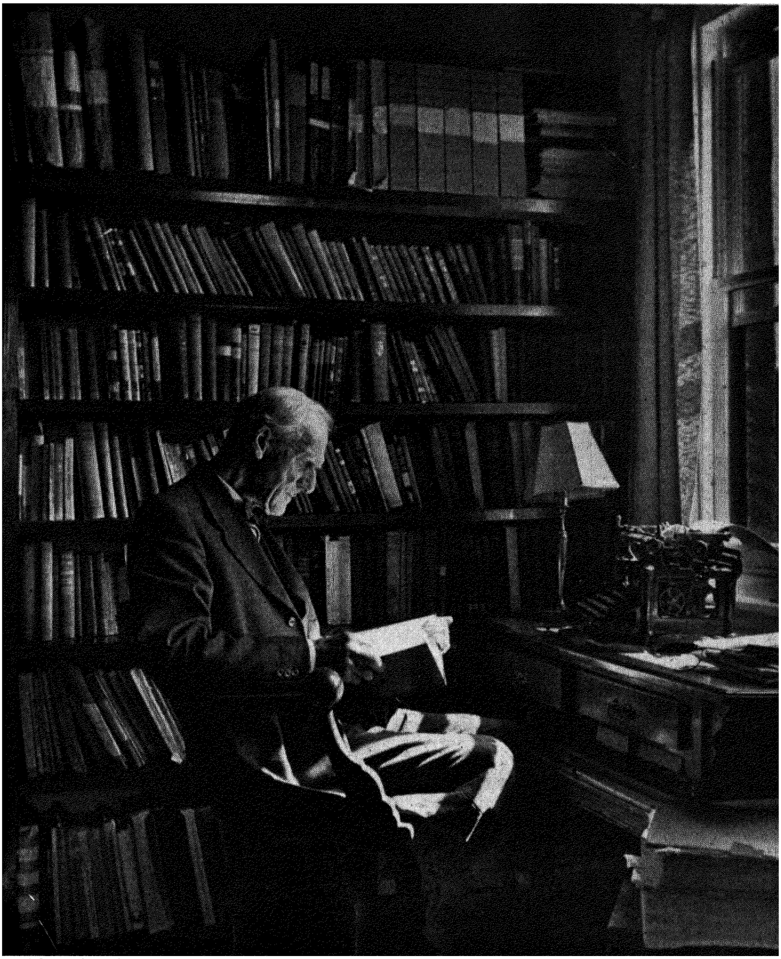


FIG. 11. Sir Arthur Keith (b. 1866). Distinguished physical anthropologist. Author of *The Antiquity of Man*, London, 1925. (Photo by J. R. Miller.)

more, the value of physical anthropology for the analysis and ability to direct the growth and development of the individual here and now cannot be overestimated, not to mention the promise which the science holds for the regulation and direction of human evolution in the future.

Writing in 1889 to a young man (A. C. Haddon) who later became a distinguished anthropologist, T. H. Huxley penned the following words:

"I know of no department of natural science more likely to reward a man who goes into it thoroughly than anthropology. There is an immense deal to be done in the science pure and simple and it is one of those branches of inquiry which brings one into contact with the great problems of humanity in every direction."

These words will always remain true, just as the service of the physical anthropologist to humanity will, among other things, always be to show that the proper study of mankind is to discover man as a human being, no matter what the texture of his hair, the color of his skin or the shape of his skull.

FOR FURTHER READING, CONSULT:

BENDYSHE, T.: The history of anthropology. *Mem. Anthropol. Soc., London, 1*:335-458, 1863.

An invaluable account of early thought on the origin and development of man, containing translations of the most important anthropological writings of the 17th and 18th centuries.

BOAS, F.: *Anthropology and Modern Life* (2nd edition). New York, Norton, 1932.

A valuable and interesting discussion of the problems of modern life in the light of the results of anthropological studies.

CASSON, S.: *The Discovery of Man.* New York, Harper, 1940.

An absorbingly interesting and authoritative account of the history of man's researches into his own origins.

HADDON, A. C.: *History of Anthropology* (2nd edition). London, Watts, 1934.

A short but remarkably full book. The first half is devoted to the history of physical anthropology and the second half to the history of social anthropology.

HALLOWELL, A. I.: Personality structure and evolution. *Am. Anthropologist, 52*:159-173, 1950.

An excellent presentation of the point that the definition of man involves more than morphological criteria.

HUXLEY, T. H.: *Man's Place in Nature.* New York, Appleton, 1896.

First published in 1863 this is one of the classics of physical anthropology which should be read not only for its historical interest, but also for its genuine contribution to the understanding of contemporary problems of physical anthropology.

KLUCKHOHN, C.: *Mirror For Man.* New York, Whittlesey House, 1949.

By far and away the best general introduction to anthropology for the layman and the student.

LOWIE, R. H.: *The History of Ethnological Theory.* New York, Farrar & Rinehart, 1937.

A distinguished history of ethnology.

MONTAGU, M. F. ASHLEY: A cursory examination of the relations between physical and social anthropology. *Am. J. Phys. Anthropol. 26*:41-61, 1940.

———: Physical anthropology and anatomy. *Am. J. Phys. Anthropol.* *28*:261-271, 1941.

Two papers by the author of the present book discussing the status of the science of physical anthropology and its relation to other sciences.

———: *Edward Tyson, M.D., F.R.S., (1650-1708): And the Rise of Human and Comparative Anatomy in England.* American Philosophical Society, Philadelphia, 1943.

The history of the rise of human and comparative anatomy with special reference to the origin and development of the interest in the relation of the apes to man, written around the life of the founder of primatology, Edward Tyson (1650-1708). Useful background reading.

Mühlmann, W. E.: *Geschichte der Anthropologie.* Bonn Universitäts Verlag, 1948.

A brief but rather wide coverage of the whole field of anthropology from the viewpoint of the anthropologist interested in the history and development of the subject.

Penniman, T. K.: *A Hundred Years of Anthropology.* New York, Macmillan, 1935.

A readable and informative history covering more than the last hundred years, with a useful chronological table, and lists of anthropological congresses, societies and periodicals, in various countries of the world.

REFERENCE WORKS ON PHYSICAL ANTHROPOLOGY

Krogman, W. M.: *A Bibliography of Human Morphology, 1914-1939.* Chicago, University of Chicago Press, 1941.

A valuable bibliography covering most publications in the field of physical anthropology from the year 1914 to the year 1939.

Langer, W. L. (editor): *An Encyclopedia of World History.* Boston, Houghton Mifflin, 1940.

An indispensable revised and modernized version of Ploetz's famous *Epitome.* The biography of man from prehistoric times to the present day, chronologically arranged.

Martin, R.: *Lehrbuch der Anthropologie* (2nd edition), 3 vols., Jena, Fischer, 1928.

The standard reference work on the methods and subject matter of physical anthropology, profusely illustrated. The third volume is entirely devoted to the bibliography of the subject.

Stewart, T. D. (editor): *Hrdlička's Practical Anthropometry* (3rd edition). Philadelphia, Wistar Inst., 1947.

A standard work on the measurement of the living body and of the skeleton.

Chapter II

THE PRIMATES AS A ZOOLOGICAL GROUP

WARM-BLOODED animals possessing a four-chambered heart, breathing by lungs, exhibiting a growth of hair over the body, and which suckle their young, are distinguished by taxonomists as belonging to the Class Mammalia. Within this Class eighteen living Orders of mammals are recognized. The two most important for our purposes are the Order Insectivora, which comprises the European hedgehogs, the shrews, and moles, and the Order Primates which comprises the lemurs, tarsiers, monkeys, apes, and men.

Zoological classifications are based almost entirely upon structural characters, and these characters are of such a nature in the lemurs, tarsiers, monkeys, apes, and men, as to leave no doubt about their common membership in the Order of Primates. Realizing this, Linnaeus, in 1758, took the bold step of putting them all into the same Order, a decision which subsequent researchers have fully justified. In giving this Order the name Primates, Linnaeus meant to suggest that the animals which it embraced ranked first in the order of importance of all the creatures of the animal kingdom. This, of course, is a purely anthropocentric view, and one with which the members of the rest of living creation, could they be heard upon the subject, would doubtless not agree. Certainly Linnaeus's bestowal of the term "sapiens," upon man, *Homo sapiens,* "man the wise," has not yet been fully merited, though in bestowing it Linnaeus had in mind the powers of discrimination and judgment in which man so much exceeds the rest of the animal kingdom.

It is, however, one of the merits of the study of our evolutionary history and genealogical relationships that it teaches us that there is hope for even such a sadly misunderstood, and misunderstanding, creature as man. Bearing this in mind, let us attempt to trace the story of his emergence into the world, for the problem of his origin is the principal reason for our interest, in this chapter, in the primates.

THE ORDER OF PRIMATES

The Tree-Shrews

Before proceeding with the description of the primates it is desirable to give an account here of a group of animals which stands at the base of the primate stem, and which many modern authorities would include within the primate group, but which other zoologists continue to describe as the oriental tree-shrews of the Order Insectivora. This group of tree-shrews is very squirrel-like in appearance, and comprises the single living Family Tupaiidae, including two subfamilies, of which some six genera and far too many (47) species have been described. While the tree-shrews are all arboreal to a varying extent, they are not nearly as much so as was at one time believed, the smaller species being more arboreal

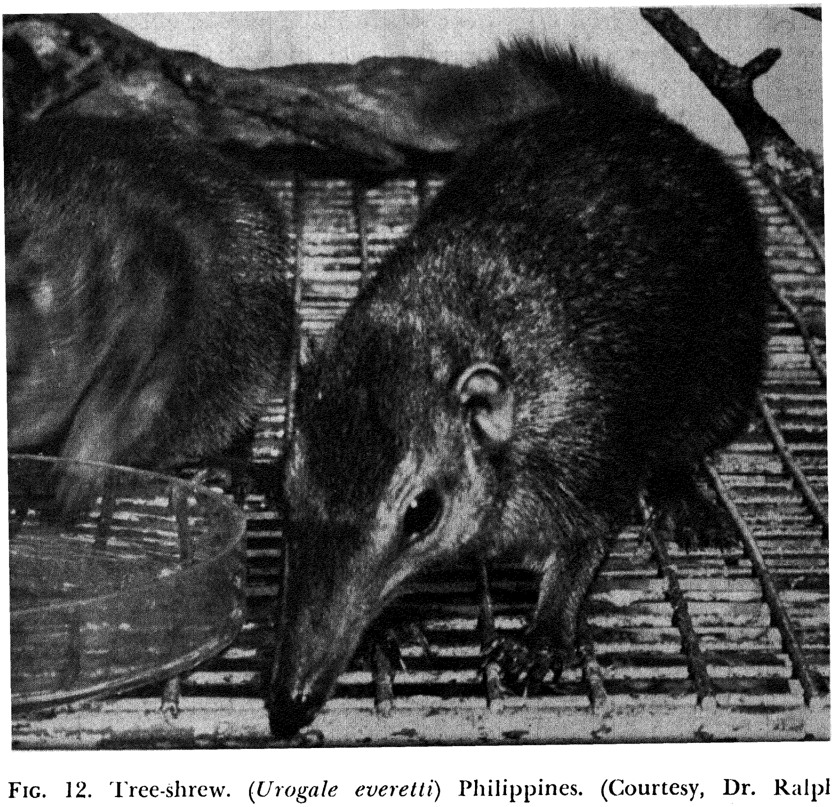


FIG. 12. Tree-shrew. (*Urogale everetti*) Philippines. (Courtesy, Dr. Ralph Buchsbaum.)

than the larger ones, the latter generally inhabiting the undergrowth in the bush or the lower branches of the trees. The smaller species (such as *Tupaia minor*) appear to be crepuscular or nocturnal animals, while the larger (e.g., *Tupaia ferruginea*) are diurnal in their habits. The typical dental formula for the group is $I\,\frac{2}{3}$, $C\,\frac{1}{1}$, $PM\,\frac{3}{3}$, $M\,\frac{3}{3}$.* The manus (hand) and pes (foot) are adapted for grasping, and both pollex (thumb) and hallux (big toe) show some degree of opposition to the other digits for the purposes of grasping. All the digits are provided with sharp curved claws. In the early Oligocene tupaioid *Anagale gobiensis,* discovered in Mongolia, the terminal phalanges of the fingers were provided with claws while those of the toes were almost certainly furnished with nails. [illegible]

The tail, which is not prehensile, is used as a balancing organ, and is wholly bushy or close-haired in the subfamily Tupaiinae, the hairy-tailed tree-shrews, and naked but tufted at the terminal portion in the Ptilocercinae, the pen-tailed tree-shrews.

The skull bears a remarkable resemblance to that of the lemurs (see Fig. 48) although the orbits are directed rather more laterally, as in the insectivores proper. As in the lemurs, the rhinarium or external nose is naked, moist, and glandular, and the commencement of the tear duct is situated outside the orbit on the face.

The average numbers of vertebrae are seven cervical, 13 thoracic, six lumbar, three sacral, and about 25 caudal (tail) in the Tupaiinae, and seven cervical, 14 thoracic, five lumbar, three sacral, and about 32 caudal in the Ptilocercinae.

The brain is of primitive form in the pen-tailed tree-shrews, and though of somewhat more complex form in the hairy-tailed tree-shrews the advance is very slight. In both subfamilies the olfactory lobes are well developed, though in comparison with other insectivores somewhat reduced in *Tupaia.* A shallow sylvian fissure is present in *Tupaia.* The occipital poles of the cerebral hemispheres fail to overlap all but the most anterior parts of the cerebellum.

---

* In the dental formula the letters I, C, PM, and M stand for incisors, canines, premolars, and molars respectively. The numbers above the line refer to one side of the upper jaw, the numbers below the line to one side of the lower jaw. The opposite side is, of course, identical.

The diet of tree-shrews is largely insectivorous and partly frugivorous. Pregnancy lasts about five months, and two young usually, sometimes one, and sometimes four, are born at a birth. There are from one to three pair mammae at which the young are suckled for several months. These animals appear to breed throughout the year.

The tree-shrews live in small groups or in pairs, and build their nests in hollow bamboos or fallen timber on the ground.

A synoptic classification of the tree-shrews follows:

Synopsis of the Living Tree-Shrews

SUBORDER TUPAIOIDEA

THE ORIENTAL TREE-SHREWS

FAMILY TUPAIIDAE

SUBFAMILY TUPAIINAE

The hairy-tailed tree-shrews
Genus *Tupaia*. Malaysia, India, Burma, and China
Genus *Anathana*. Indian Peninsula, South of Ganges
Genus *Dendrogale*. Borneo, French Indo-China
Genus *Tana*. Borneo, adjacent islands, and Sumatra
Genus *Urogale*. Mindanao, Philippine Islands

SUBFAMILY PTILOCERCINAE

The pen-tailed tree-shrew
Genus *Ptilocercus*. Borneo, Sumatra, and Southern Malaysia

It will be noted from the above synopsis, and from others which are given in the following pages, that while sometimes used with suborders the names of superfamilies terminate in the letters "oidea," the names of families in "idae," and the names of subfamilies in "inae." Names of genera are given as proper names without adding any consistent termination to the stem, and in the Linnaean system of classification in universal use the name of the species follows the generic name. As a rule only the names of genera, species, and subspecies are written in *italics*. The scientific designation of animals is uninominal (one name) for subgenera and all higher groups, binominal (two names) for species, and trinominal (three names) for subspecies.

It has already been remarked that the tendency among many modern authorities is to class the tree-shrews with the primates as the most primitive members of the order. But precisely how they are to be situated within the order is a matter which is still under debate. Wood Jones regards the tree-shrews as primitive lemurs, and unites them and the lemurs in a single group which he excludes from the assemblage of the primates. Carlsson, Le Gros Clark, and Simpson class the tree-shrews together as members of the lemuriform series within the primate order. But as Straus has pointed out, the fundamental differences between the tree-shrews and the lemurs in such characters as placentation, the chondrocranium (the cartilaginous skull), ankle and wrist bones, musculature, viscera, and many other features, render such jointures of these groups open to serious question. Straus suggests that the tree-shrews are best treated as constituting a separate primate suborder, the Tupaioidea, distinct from all other suborders of the primates.

The closest affinities of the tupaioids are with the lemurs of Malaysia. The many lemur-like characters of the tupaioids suggest that these were acquired after the line leading to the primates had become distinct. This line, in turn, arose from some insectivorous preprimate. The appreciable number of lemur-like characters of the early Oligocene tupaioid *Anagale* supports the suggestion that the tupaoids arose from primitive lemuriforms, slightly diverging from the lemurs proper while retaining most of their ancestral characters.

The tupaioids would, then, appear to belong properly within the order of primates as a distinct suborder, the Tupaioidea. Since, however, this is a view which is not yet generally accepted we shall proceed with the description of the primates according to the conventions prevailing at the present time.

General Description of the Primates

The Order Primates embraces the lemurs, tarsiers, monkeys, apes, and man. These forms share the following features: relatively large and complicated brains, hands and feet prehensile or clearly derived from the prehensile type; the presence of a clavicle (collar-bone); free mobility of the digits, and opposability of either the thumb or big toe or both; flattened nails instead of claws on some or all fingers and toes; the presence of, as a rule, only two mammae.

Our present purpose in studying the non-human primates, as well as man himself, is to throw light upon the physical and social evolution of man. Even if the fossil record of the ancestry of man were complete—which it is not—it would still be necessary to study the living primates for the very good reason that while the fossil record yields us the bones alone of dead animals, the existing primates yield all the knowledge that we are capable of gleaning from living animals. Dead primates enable the primatologist to make detailed studies of their anatomy, so that this may be compared and evaluated for whatever light such comparisons may throw upon the significance of various characters in any or all of the primates, and upon the evolutionary relationships of these animals to one another, to earlier forms, and to man past and present. It may at once be said that such studies have richly fulfilled the purposes for which they have been undertaken, though a vast amount of work still remains to be done.

As many as 600 species of living primates, not counting synonyms, have been recognized by D. G. Elliot in his *A Review of the Primates*. There can be little doubt that the true number is very considerably less. The primates as a whole exhibit a high degree of morphological variability. This fact taken together with a mid-nineteenth century species concept which was for the most part based on the study of skins and skeletons in museums led to a regular orgy of classificatory speciation. Differences were sought rather than likenesses, and more and more refined morphological distinctions between groups were recognized. The excesses thus committed led to the creation of numerous species in every animal group. Today careful field studies and analyses of their findings by biologists with a fuller understanding of the nature of variation than the nineteenth century taxonomist could possibly have had, have been responsible for something of a reversal of this tendency.

Linnaeus's rather static morphological conception of a species underwent a considerable enlargement in the nineteenth century as a consequence of the publication of Darwin's epoch-making *Origin of Species* (1859). It was not, however, until the first half of this century, with the development of the science of genetics and the increase in our knowledge of the processes of speciation which this brought us, that we have been able to achieve a biologically sound conception of a species.

To the modern biologist a species is a more or less temporary eddy in the stream of evolution. A species is not a fixed, static, sharply delimitable group, but a more or less definable result of the process of speciation. This process is to some extent observable in the resulting variation presented by geographically but not reproductively separated groups. Such groups were formerly described as species, today they are recognized as geographic variant representatives or types of a single species, that is to say as representatives of a single *polytypic* species. Some species are *monotypic,* that is to say, all their members closely resemble one another. Monotypic species generally occupy a limited range, and since there is an absence of geographic barriers there is no opportunity for reproductive separation and hence geographic variation. Whether a species is polytypic or monotypic can only be determined when populations are studied with respect to their variability, their geographic distribution, and their reproductive relationship to other groups. Such studies are yet to be made on the primates, but there can be no doubt that most primates are members of polytypic species.

A species may be defined as a group of actually or potentially interbreeding natural populations, which is reproductively isolated from other such groups. The actually or potentially interbreeding populations may be recognized as subspecies or geographic races. It is quite likely that as many as three-fourths of the primate species which have been described are, in fact, no more than geographic races of their species. Clearly the whole subject of the classification of the primates requires reinvestigation in terms of the new systematics.

Classification

It has been well said that the principal purpose of classification is to provide a simple practical means by which students of any group may know what they are talking about and others may find out. It is with this end in view that the following revised classification is offered.

Two suborders of the primates are recognized, the Prosimii and the Anthropoidea. The Prosimii include the three infraorders Lemuriformes (Madagascar lemurs), Lorisiformes (African and Asiatic lemurs), and the Tarsiiformes (Malaysian and Philippine tarsiers). The Anthropoidea embraces the monkeys, apes, and man.

The suborder Anthropoidea is divisible into two main series, and three superfamilies. The New World Monkeys comprise the series Platyrrhini (= "broad" + "nose") and constitute the superfamily Ceboidea. The Old World Monkeys comprising the superfamily Cercopithecoidea, and the apes and man comprising the superfamily Hominoidea, constitute the series Catarrhini (= "down-pointing" + "nose"). In the Platyrrhini the nostrils are generally separated by a relatively broad external septum and tend to be directed forwards and almost vertically parallel, while in the Catarrhini the septum is generally quite narrow, the nostrils tending to be directed slightly more downwards and to assume a "V" form.

The apes together with man are often referred to as the Anthropomorpha as a synonym for the superfamily name of Hominoidea. The monkeys may be distinguished from the Prosimii on the one hand and from the Anthropomorpha on the other by the term Pithecoidea, without, however, recognizing them as a separate infraorder as the term might suggest.

Painter has found that in the only Ceboid thus far studied, *cebus sp.,* the chromosome number was 28 pairs, while in the Rhesus monkey (*Macaca mulatta*) and in the chimpanzee, the chromosome number was 24 pairs, precisely as in man.

It may assist the reader to have this classification set out in schematic form. (See page 30.)

For the purposes of convenience one may speak of the prosimian group or of the prosimians, the pithecoid groups, the anthropomorphous group, and the platyrrhine and catarrhine series of the primates.

Each suborder is divided into families, and the latter are sometimes further subdivided into subfamilies, these or the families are still further subdivided into genera, and the latter into species, species into subspecies or races, and the latter sometimes into clines and habitat forms.

ORDER PRIMATES

SUBORDER: PROSIMII

Lemurs, Lorises, and Tarsiers

SUBORDER: ANTHROPOIDEA

New World Monkeys
Platyrrhini
Ceboidea

Pithecoidea

Catarrhini

Old World Monkeys
Cercopithecoidea

The tailless or manlike apes

Anthropomorphous or anthropoid apes

Man

Hominidae

Hominoidea
Anthropomorpha

All the living primates, save man, are limited to the tropical continents, to the Oriental, Ethiopian, and Neotropical (South American) regions.

PROSIMII. ***The Lemuriformes and Lorisiformes***

The lemurs are the most primitive of the existing primates; they are small creatures, the smallest, the mouse lemurs (*Cheirogale*), are only about four inches in body length; the largest, the endrinas (*Indri*), attain a body length of about 24 inches. Lemurs look not unlike squirrels with fox-like heads. There are five families, including some 17 genera, and an undetermined number of species (some 86 or more were described by the older taxonomists). Morphologically the suborder exhibits a considerable range of variability. The lemurs are almost entirely arboreal creatures, and are mostly nocturnal in their activities, a fact which seems to be associated with their rather large eyes. The hands and feet are adapted for grasping, and the thumb and big toe are

Sub-order	Infra-order and Series	Super-family	Family	Subfamily	Genus	Common Name
PROSIMII	LEMURIFORMES		Lemuridae	Lemurinae	Lemur	True Lemurs
					Hapalemur (Myoxicebus)	Gentle Lemurs
					Lepilemur	Sportive Lemurs
					Mixocebus	Hattock
				Cheirogaleinae	Cheirogaleus	Mouse Lemurs
					Microcebus	Dwarf Lemurs
					Opolemur (Altililemur)	Fat-tailed Lemurs
	LORISIFORMES		Indriidae		Indris	Endrina
					Propithecus	Sifaka
					Lichanotus	Woolly Avahi
			Daubentoniidae		Daubentonia	Aye-Aye
			Galagidae	Galaginae	Galago	Bush Baby
					Hemigalago	Lesser Bush Baby
			Lorisidae	Lorisinae	Loris	Slender Loris
					Nycticebus	Slow Loris
					Arctocebus	Angwantibo
					Perodicticus	Potto
	TARSII-FORMES		Tarsiidae		Tarsius	Tarsier
ANTHROPOIDEA	PLATYRRHINI	CEBOIDEA	Callithricidae	Callithricinae	Callithrix	True Marmoset
					Oedipomidas	Pinché Marmoset
					Leonticebus	Tamarin
			Cebidae	Callimiconinae	Callimico	Callimico
				Aotinae	Aotes	Night Monkey
					Callicebus	Titi Monkey
				Pithecinae	Pithecia	Saki Monkey
					Cacajao	Ouakári Monkey
				Cebinae	Saimiri	Squirrel Monkey
					Cebus	Capuchin Monkey
				Atelinae	Lagothrix	Woolly Monkey
					Ateles	Spider Monkey
					Brachyteles	Woolly Spider Monkey
				Alouattinae	Alouatta	Howler Monkey
	CATARRHINI	CERCOPITHECOIDEA	Cercopithecidae	Cercopithecinae	Cercopithecus	Guenons
					Erythrocebus	Red-haired Patas
					Cercocebus	Mangabey
					Macaca	Macaque
					Cynopithecus	Celebes or Black Ape
					Theropithecus	Gelada Baboon
					Papio	Typical Baboon
					Mandrillus	Mandrill and Drill
				Semnopithecinae	Semnopithecus	Langur
					Colobus	Guereza
					Rhinopithecus	Snub-nosed Langur
					Nasalis	Proboscis Monkey
		HOMINOIDEA	Hylobatidae	Hylobatinae	Hylobates	Common Gibbon
					Symphalangus	Siamang
			Pongidae	Ponginae	Pongo	Orang-Outang
					Pan	Chimpanzee
					Gorilla	Gorilla
			Hominidae		Homo	Man

FIG. 13. Classification of the Primates

characterized by a high degree of mobility. All the digits of the hand and foot, with the exception of the second digit of the foot, which bears a sharp curved claw, are provided with flat nails. The typical dental formula is I $\frac{2}{2}$, C $\frac{1}{1}$, PM $\frac{3}{3}$, M $\frac{3}{3}$, though in the family of Indriidae this is modified to I $\frac{2}{2}$, C $\frac{1}{1}$, PM $\frac{2}{2}$, M $\frac{3}{3}$.

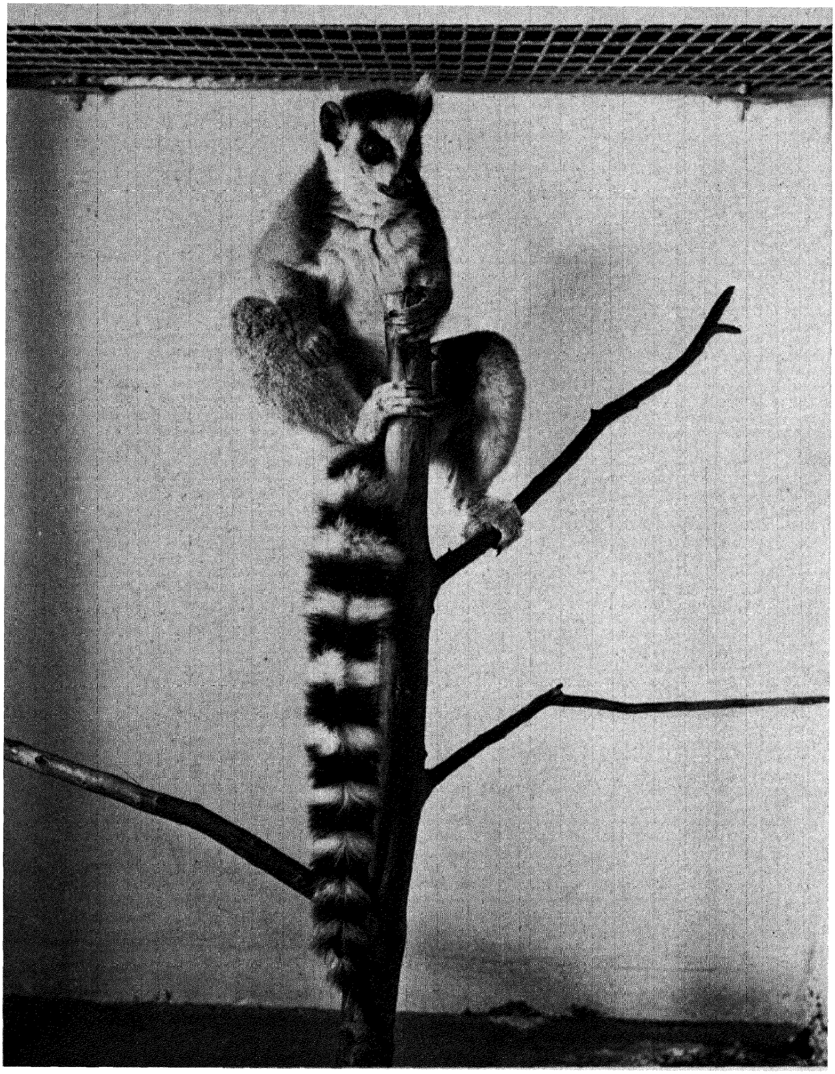


FIG. 14. Ring-tailed Lemur (*Lemur catta*). (Photo, New York Zoological Society.)

In the typical lemurs the anterior teeth in the lower jaw are procumbent, the incisors and canines being situated in a row at the front of the jaw; these are separated by a wide gap from the first premolars which are rather canine-like in form. The true canines are so much like incisors that many authorities have described them as such. The tail is not prehensile, but when functional is used as a balancing or stabilizing organ.

A unique and extraordinary lemuroid is the "aye-aye" (*Daubentonia*) of Madagascar. Not only are all the digits, save the big toe, provided with claws, but this unusual primate has incisor teeth which continue to grow as they wear, a characteristic which it shares with the rats and other rodents. The dental formula is $I\,\frac{1}{1}$, $C\,\frac{0}{0}$, $PM\,\frac{1}{0}$, $M\,\frac{3}{3}$, a total of 18 teeth. Furthermore, the third finger of each hand is elongated and thin and is used in skewering grubs, the favorite food of this peculiar species.

The jaws in the lemurs are generally elongated in a fox-like muzzle, but it is in the possession of the typical rhinarium and crescentic nostrils of less specialized mammals that the lemurs exhibit their truly primitive character and difference from all other primates. In other words, the rhinarium or skin around the nostrils is almost exactly like that seen in the dog or cat. Instead of completely ringed nostrils, there are two crescentic slits, and the surrounding skin, as well as the middle part of the upper lip, is naked, moist, and glandular. A septum on the deep surface binds the lip to the gum of the upper jaw for almost the whole of its length, a feature which determines the lemuroid method of drinking by lapping instead of sucking.

The commencement of the tear duct is situated outside the orbit on the face, but as in all other primates it opens within the nasal cavity.

In the skull there are many primitive mammalian features, such as the presence of a large palatine bone in the inner wall of the orbit, the general absence of an external auditory meatus, the complete absence of a post-orbital wall—rendering the orbit and the

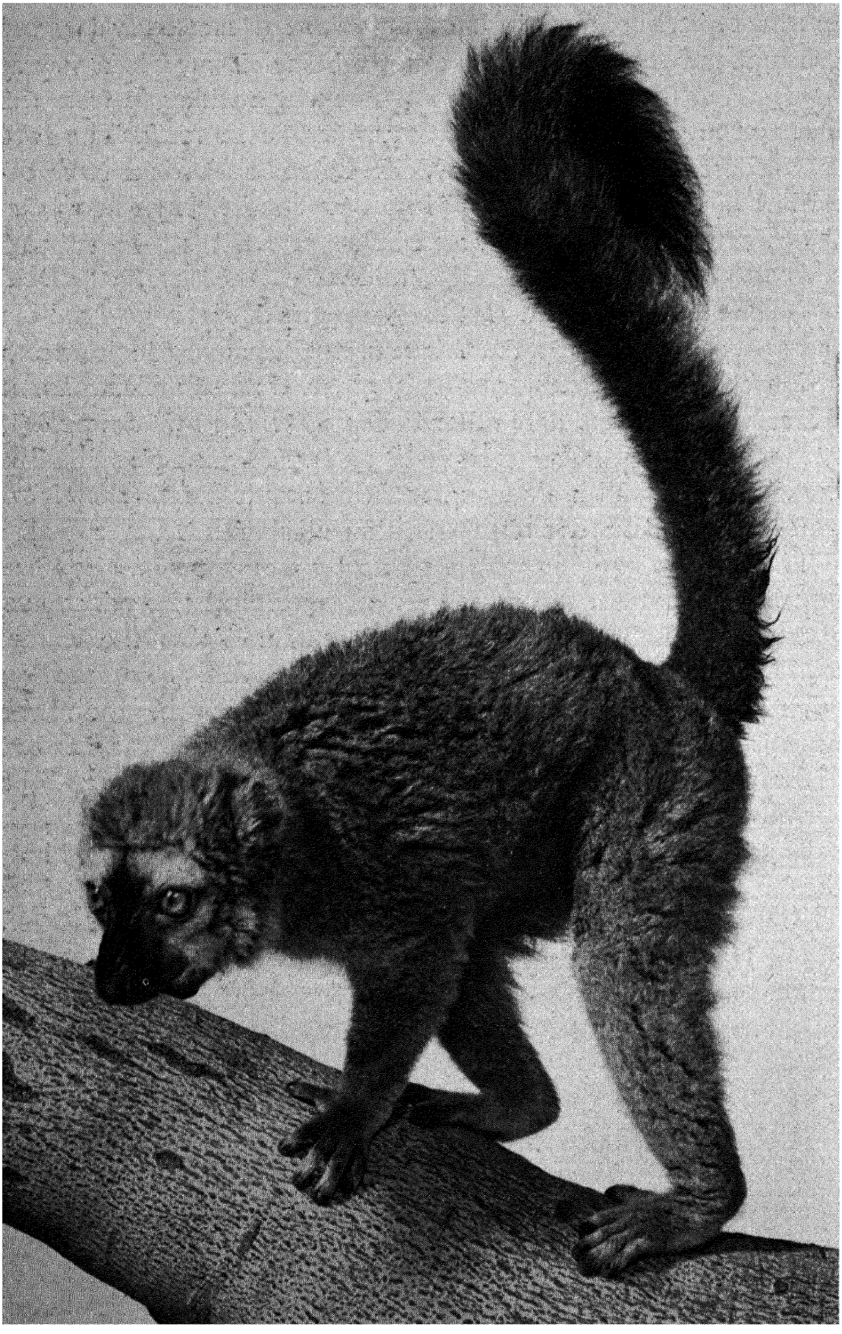


FIG. 15. Brown Lemur (*Lemur macaco fulvus*). (Photo, New York Zoological Society.)

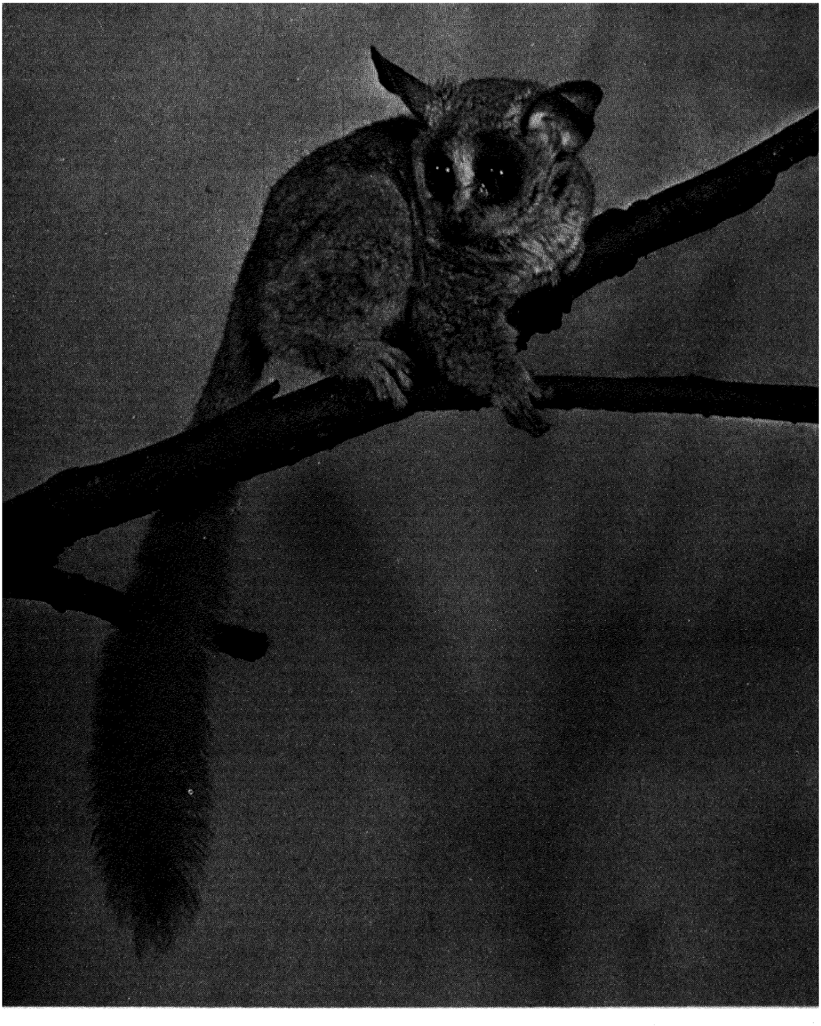


FIG. 16. Galago or Bush Baby (*Galago crassicaudatus*). (Photo, New York Zoological Society.)

temporal fossae (the regions below the temple) confluent; the orbits, though directed somewhat laterally, have eyeballs mounted in them in a manner such that the eyes look forward and not to the side, a distinct advance upon the condition encountered in the insectivores. The inner ear preserves the lower mammalian character in the presence of an auditory bulla, a large, spherical, inflated chamber on the base of the skull within which lies the tympanic ring, which in the catarrhini assists in forming the external auditory meatus.

The number of cervical vertebrae regularly is seven, whereas the numbers of post-cervical vertebrae exhibit great generic variability (Schultz and Straus). The thoracic vertebrae range from averages of 12 (*Daubentonia, Lemur, Hapalemur, Lepilemur, Lichanotus*) to 16 (*Nycticebus*); the lumbar vertebrae from six (*Galago*) to nine (*Lepilemur*); the sacral vertebrae from three (most genera) to six (*Nycticebus, Perodicticus*); and the caudal vertebrae from five (*Loris*) to 28 (*Hapalemur*).

Compared with that of other mammals of the same body size the brain is relatively large; the olfactory parts are, however, well developed, and the cerebral hemispheres are so small that they fail to cover a considerable part of the cerebellum. The fissuration and gyri of the cerebrum are of the simplest type, and the visual area of the brain approximates in structure more nearly to that of the lower mammals than to that of the apes.

A synoptic classification of the lemurs follows:

Synopsis of the Living Lemurs

SUBORDER PROSIMII

Infraorder Lemuriformes

The Lemurs of Madagascar and the Comoro Islands
The Malagasy Lemurs

I. FAMILY LEMURIDAE

Subfamily Lemurinae

Genus *Lemur*. The true lemurs
Genus *Hapalemur*. The gentle lemurs
Genus *Lepilemur*. The sportive lemurs
Genus *Mixocebus*. The hattock

Subfamily Cheirogaleinae

Genus *Cheirogale*. The mouse lemurs
Genus *Microcebus*. The dwarf lemurs
Genus *Opolemur*. The fat-tailed lemur

II. FAMILY INDRIIDAE

Genus *Indris.* The endrinas
Genus *Propithecus.* The sifakas
Genus *Lichanotus.* The woolly avahi

III. FAMILY DAUBENTONIIDAE

Genus *Daubentonia.* The "aye-aye"

Synopsis of Living Lorises

SUBORDER PROSIMII

INFRAORDER LORISIFORMES

The Lemurs of Africa and Asia
The Non-Malagasy Lemurs

I. FAMILY GALAGIDAE

Subfamily Galaginae
  Genus *Galago.* The bush babies (East Africa, Zanzibar, Fernando Po)

II. FAMILY LORISIDAE

Subfamily Lorisinae
  Genus *Loris.* The slender loris (Ceylon and Southern India)
  Genus *Nycticebus.* The slow loris (Eastern India and Malaya)
  Genus *Arctocebus.* The angwantibo (West Africa)
  Genus *Perodicticus.* The potto (Sierra Leone and the Gaboon)

It has already been remarked that the lemurs are almost exclusively arboreal creatures, that they are mostly nocturnal in their activities, and spend the greater part of the daylight hours in sleep. Interestingly enough, there seems to be an association between sleeping habits or waking activity, size of eyes, body size, and social habits, for the small lemurs are those which are most definitely nocturnal, have the largest eyes, and are given to living in small social units or in family groups. The larger lemurs, on the other hand, are frequently quite active by day or in twilight, have small eyes, and more often tend to live as members of a community of their own species. This suggests that increase in body size may have been a prepotent factor in releasing the early primates from their nocturnal or crepuscular habits, by enabling them to hold their own against most aggressors, and that this further led to the development of more extended social relations with animals of their own species. In practically all animals that are habitually nocturnal the eyes are large.

FIG. 17. Slow Loris (*Nycticebus tardigradus*). (Photo, courtesy of late Dr. Charles Hose.)

The diet of lemurs is varied. Most are largely frugivorous. Many eat both animal and vegetable foods. The Indriidae are primarily leaf eaters, while the Lorisidae and the "aye-aye" are mainly insectivorous.

Lemurs do not menstruate. Pregnancy lasts about five months, and one young is usually, though two are not infrequently, born at a birth. The infant is suckled for about six months, and the young generally cling in a horizontal position across the lower abdomen of the mother. The Malagasy lemurs (and probably the galagoes) would appear to have a circumscribed breeding season falling between March and the end of June, with a peak in mid-April.

The lorises probably breed throughout the year.

Since a fovea and a macula—the small pit in the yellow spot of the retina, and the yellow spot itself—are absent from the retina in all lemurs these animals are believed to be incapable of stereoscopic vision, and there is also some evidence which suggests that the lemurs are only feebly, if at all, capable of color vision.

Lemurs appear to be quite incapable of facial expression.

Unquestionably the living lemurs represent a most primitive branch of the primates, but each of the existing kinds of lemurs is characterized by specializations of its own, a fact which very definitely removes the infraorder as a whole from the direct line of man's ancestry.

The Tarsiiformes

The living tarsiers are represented by a single species, *Tarsius spectrum*, which ranges through the Malayan islands from Sumatra, Java, Banka, Billiton, and Borneo to the Celebes, Salayer and Sangir, and to the Philippines.

Synopsis of the Living Tarsiers

SUBORDER PROSIMII

INFRAORDER TARSIIFORMES

The Tarsiers of the Malay Archipelago and the Philippines

I. FAMILY TARSIIDAE

Genus *Tarsius*. The spectral tarsier

The adult tarsier has a body length of about 8 inches, a long tail the under portion of which is relatively bare and tufted at the tip, opposable thumbs and big toes, with nails on all digits excepting the second and third of the feet which bear claws. The leg bones, the tibia and fibula, are fused together at their lower ends. The feet are very long owing to the remarkable elongation of the heel bone (calcaneus) and the bone on the inner side of the foot obliquely in front of it, the navicular, which together form part of the tarsus. This specialization of the foot is associated with the frog-like leaping mode of progression of the tarsier, and it is from this

FIG. 18. The Tarsier (*Tarsius spectrum*). (Photo, Zoological Society of Philadelphia.)

unique feature that the species takes its generic name. The palmar surfaces of the hands and the plantar surfaces of the feet are highly specialized, presenting round pads at the tips of all digits, with four interdigital pads on the hands, while on the plantar surfaces of the feet there are three large interdigital pads of highly specialized form. Since the tarsiers are completely arboreal and nocturnal creatures, these pads are of great service in the grasping activities of the animals, for they are capable of holding fast by something like a vacuum suction of these pads.

The nose is quite unlike that in the lemurs; only a narrow strip of naked skin marks the opening of the widely separated nostrils, and the hairy upper lip shows a continuous smooth surface uninterrupted by a median groove. The lip is muscularized and freely mobile, not being bound to the gum as it is in the lemurs. Nevertheless, *Tarsius* drinks by lapping. The disappearance of the rhinarium proper in *Tarsius* may be regarded as the outward manifestation of the retrogression of the olfactory apparatus, the reduction in the importance of the sense of smell. This is also reflected in the marked reduction of the snout, for the face of *Tarsius* is relatively flat. On the other hand, the eyes are perfectly enormous in size, being the largest, relative to the size of the head, to be found in any of the primates. The eyes do not, however, possess a fovea or macula, and hence the tarsiers, like the lemurs, are thought to be incapable of stereoscopic vision. These animals have, however, developed a peculiar specialization of the central region of the retina, at which point the layer of rod cells is thrown into convoluting folds, and the ganglion cells are more numerous. This is very different from anything found in the higher primates, but parallels conditions found in certain bats. The retina possesses no cone cells. Possibly as a compensation for its lack of stereoscopic vision *Tarsius* has developed the ability to turn its head around so that its nose is in line with its spinal column, an excursion of 180 degrees! This accomplishment has been worthily celebrated in a limerick:

> The Tarsier, weird little beast
> Can't swivel his eyes in the least,
> But when sitting at rest
> With his tummy due west
> He can screw his head round to face east.

The brain, which is rather broader than it is long, is smooth. It shows a considerable reduction in its olfactory portions, and an increase in the regions associated with vision, particularly in the occipital lobe which extends over the cerebellum and covers the latter.

The palate bone forms a small part of the inner wall of the orbit, and the orbit is quite separated from the temporal fossa by a post-orbital wall. The orbits are directed completely forward, more markedly so than in the lemurs. The upper opening of the tear duct (naso-lacrimal duct) lies on the face outside the orbit, as in the lemurs. The dental formula is $I\,\frac{2}{1}\ C\,\frac{1}{1}\ PM\,\frac{3}{3}\ M\,\frac{3}{3}$.

The tympanic annulus or ear ring has migrated outside the auditory meatus, but the bulla or auditory chamber itself is still large and inflated.

There are seven cervical, and an average of 13 thoracic, six lumbar, three sacral, and 28 caudal vertebrae. Tarsiers exhibit a monthly estrous cycle with sexual skin swelling, and it has recently been demonstrated that vaginal bleeding of a non-menstrual kind occurs. There is no special breeding season. Tarsiers appear always to live in pairs or together with a single offspring, that is to say, in single family units, in small groups. A single offspring is produced at a birth, and this clings at first to the abdominal hair of the mother, and later rides on her back.

The diet of tarsiers appears to be insectivorous, but in captivity they will eat baby mice, meal-worms, and lizards.

Tarsiers are capable of a fair amount of facial expression.

In many fundamental characters, such as the morphology of the brain and skull, the reduced snout, the retrogression of the olfactory organs, in the dentition, the form of the nose and lips, the tarsiers make a much closer approach to the Anthropoidea than do any of the other Prosimii. Indeed, the Tarsioidea serve as good generalized early primates from which all the higher primates may have taken origin, that is to say, not from the existing types, but from some early tarsioid form very like the modern tarsiers. Some students, like Wood Jones, have gone so far as to suggest that the lines which led on the one hand to the Anthropoidea and on the other to man, originated independently from some tarsioid stock. The consensus of scientific opinion is, however, against this theory. The interpretation of the evidence generally accepted at the present time supports the theory that the tarsioids gave rise to the platyrrhine and catarrhine monkeys, and possibly to the gibbons, and that it was from the catarrhine monkey stock that the early anthropoids arose, and that these, in turn, gave rise to the modern anthropoids on the one hand and to the Hominidae on the other.

ANTHROPOIDEA

SERIES PLATYRRHINI

SUPERFAMILY CEBOIDEA

The New World Monkeys comprise two distinct families, the marmosets or Callithricidae, with three genera and an undetermined number of species (some 40 have been described), and the typical South American monkeys, the Cebidae, with 11 genera and an undetermined number of species (more than 100 have been described). Their range is from Southern Mexico to Rio Grande do Sul on the border between Brazil and Uruguay.

Synopsis of the Living New World Monkeys

SUBORDER ANTHROPOIDEA

SERIES PLATYRRHINI

The Marmosets and Tamarins

I. SUPERFAMILY CEBOIDEA

I. FAMILY CALLITHRICIDAE

- Genus *Callithrix*. The true marmosets (Mexico to Amazon Basin)
- Genus *Oedipomidas*. The pinché marmosets (Costa Rica to Colombia)
- Genus *Leontocebus*. The tamarins (Costa Rica to Southern Brazil)

THE CALLITHRICIDAE

The marmosets are small animals, about the size of squirrels. The long non-prehensile tail is covered with hair though rather sparsely on its under surface, and is usually tufted at the tip. The hindlimbs are considerably longer than the forelimbs, the tibia and fibula are quite separate, and all the digits bear sharp, laterally

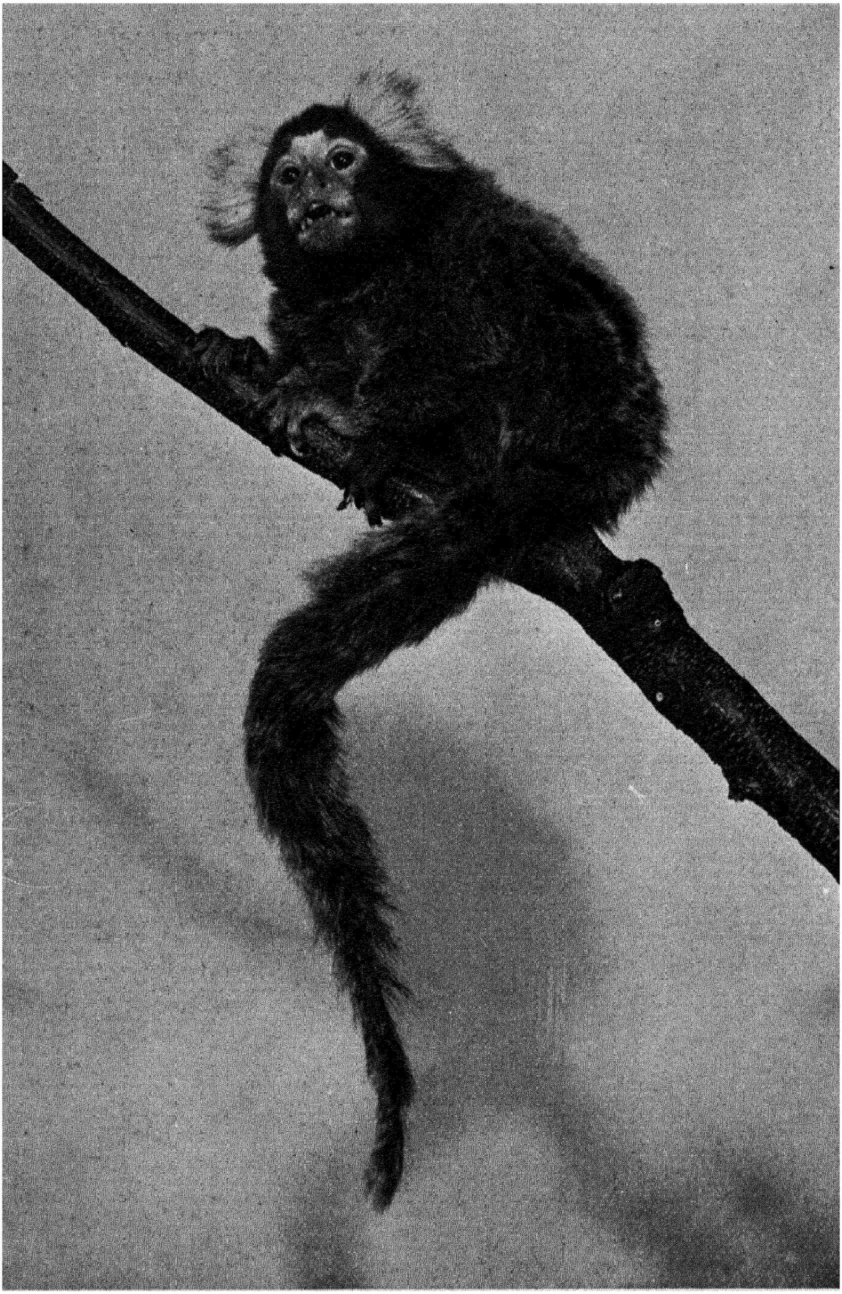


Fig. 19. Common Marmoset *(Callithrix jacchus)*. (Photo, New York Zoological Society.)

compressed claws, with the exception of the big toe which bears a flattened nail. The digital claws are doubtless associated with the squirrel-like habit of marmosets of running spirally up and down large tree trunks. The thumb is not opposable, but the big toe, which is situated rather low on the foot, is capable of a considerable degree of mobility.

The face is relatively flat, the eyes rather large, a primitive fovea and macula are present in the retina, so that marmosets are presumed to be capable of some stereoscopic vision. The brain, in proportion to size of the body, is remarkably voluminous, with well developed frontal lobes which give the skull a very human-like appearance. The occipital lobes completely cover the cerebellum, and the olfactory parts of the brain are very markedly reduced. The surface of the brain is, however, quite free of convolutions, except for a well marked sylvian fissure, separating the temporal from the parieto-frontal portion of the brain. In the development of its frontal and parietal association areas, the marmoset brain exhibits a considerable advance upon the prosimian brain.

There is no muzzle or snout, the nose is of distinctive primate or haplorrhine type, the oval nostrils being widely separated, the tip being grooved, and the lips freely mobile. The auditory bulla is inflated, but the tympanic ring is extended outside the bulla to form an abbreviated external auditory meatus. The orbit is separated from the temporal fossa by the markedly developed zygomatic or malar bone. The latter establishes a broad contact with the parietal bone, a characteristic feature of the platyrrhine skull which, interestingly enough, is also seen in some 10 per cent of gibbon crania.

The canine teeth are well developed, and the dentition is peculiar in that most marmosets have lost the third molar tooth, hence, the dental formula is $I\,\frac{2}{2}$, $C\,\frac{1}{1}$, $PM\,\frac{3}{3}$, $M\,\frac{2}{2}$.

There are seven cervical, and an average of 12 or 13 thoracic, seven or six lumbar, three sacral, and 30 to 33 caudal vertebrae.

The marmoset is the only monkey which normally produces more than a single young at a birth, the usual number being two or three. There is no restricted breeding season and pregnancy lasts five months and one week. Vaginal bleeding of a non-menstrual kind occurs, and swelling of the perineal skin, known as the "sexual skin," has been recorded. Interestingly enough, the young are generally carried by the father, to whose chest hair the young one clings, gradually shifting to the father's back as it grows older. The mother receives the infant only when sustenance is required. Quite frequently the carrying of the infant is left by the parents to the older preceding siblings.

FIG. 20. Pygmy Marmoset (*Callithrix pygmaea*). (Photo, New York Zoological Society.)

Marmosets are diurnal and arboreal in their habits, and subsist principally upon fruit and insects. These animals are climbers and do not indulge in the flying leaps so characteristic of the Cebidae.

Marmosets are capable of a limited range of facial expression. They habitually live in pairs, or in single family groups, as part of a larger community.

The New World Monkeys

II. FAMILY CEBIDAE

Subfamily Callimiconinae

Genus *Callimico.* (Upper Amazon)

Subfamily Aotinae

Genus *Aotes.* The douroucouli or night monkeys (Nicaragua, Peru, Amazon)
Genus *Callicebus.* The titi monkeys (Panama to Brazil)

Subfamily Pithecinae

Genus *Pithecia.* The saki monkeys (British Guiana to Lower Amazon)
Genus *Cacajao.* The ouakári or short-tailed monkeys (Amazon Basin)

Subfamily Cebinae

Genus *Saimiri.* The squirrel monkeys (Costa Rica to Brazil and Bolivia)
Genus *Cebus.* The capuchin monkeys (Nicaragua to Southern Brazil)

Subfamily Atelinae

Genus *Ateles.* The spider monkeys (Mexico to Amazon Basin)
Genus *Brachyteles.* The woolly spider monkey (South-Eastern Brazil)
Genus *Lagothrix.* The woolly monkeys (Ecuador, Venezuela, Bolivia)

Subfamily Alouattinae

Genus *Alouatta.* The howler monkeys (Eastern Guatemala to Paraguay)

The Cebidae

The 11 genera of monkeys embraced in the family Cebidae constitute a varied assortment of animals which are, however, readily distinguishable from the marmosets. The cebids are larger in size than the callithricids, but not as large, on the whole, as the monkeys of the Old World. The dental formula is $I\frac{2}{2}$, $C\frac{1}{1}$, $PM\frac{3}{3}$, $M\frac{3}{3}$. The digits all bear nails which, with the exception of the first,

Fig. 21. Owl Monkey (*Aotus trivirgatus*). (Photo, New York Zoological Society.)

are generally somewhat arched or laterally compressed. Claws do not occur. The thumb is never opposable but is used as a finger, while in the spider monkeys (*Ateles* and *Brachyteles*) there are only four digits on the hand, the external thumb being absent or reduced to a mere nailless stub or tubercle, a condition which may be significantly associated with the highly developed prehensile tail in this group, a tail which has been described as a "fifth hand."

FIG. 22. Owl Monkey (*Aotus trivirgatus*). (Photo, New York Zoological Society.)

The thumb is similarly reduced in the catarrhine genus *Colobus*, a group in which the tail, however, is not in the slightest degree prehensile. The big toe in the cebids is always opposable. The long tail is prehensile in only half the genera, namely, in *Cebus, Lagothrix, Ateles, Brachyteles,* and *Alouatta*. In the ouakári monkeys (*Cacajao*) the tail is very short. In the spider monkeys (*Ateles*) the forelimb exceeds the hindlimb in length. In the woolly monkeys (*Lagothrix*) fore and hindlimbs are almost equal in length, and in all other genera the hindlimb exceeds the forelimb in length.

There are seven cervical, and an average of 13 or 14 thoracic, from four to seven lumbar, and from 24 to 31 caudal vertebrae.

There is no muzzle, the projection of the jaws being appreciably less than in most Old World monkeys. The nasal cavities are also much reduced. The skull typically exhibits the articulation of the malar bone with the parietal bone. The palate is comparatively short. The auditory bulla is large and inflated, and the tympanic ring remains outside the bulla, but an external auditory meatus is not formed. The surface of the brain is richly convoluted, the fissural pattern bearing a surprising resemblance to that of the brains of Old World monkeys, especially in the smaller forms of the latter such as occur in the genera *Cercocebus* and *Macaca.* This resemblance has been interpreted as due to evolutionary convergence or parallelism, that is, the process whereby two separate stocks independently develop similar structures. Since all the evidence indicates that the Ceboidea and Cercopithecoidea originated independently from some tarsioid stock, probably in the Oligocene, it is most likely that convergence in this, and in many other characters, almost certainly occurred. The fissural pattern of the brain of the larger forms such, for example, as *Ateles,* the spider monkey, and *Papio,* the baboon, show unmistakable differences.

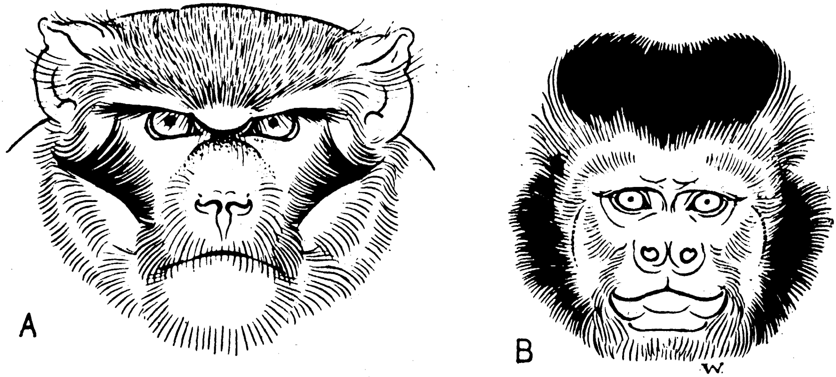


FIG. 23. A, An Old World or Catarrhine Monkey (*Macaca*) and B, a New World or Platyrrhine Monkey (*Cebus*) showing the difference in the arrangement of the nostrils. (From Le Gros Clark, *History of the Primates,* 1949. Courtesy, British Museum [Natural History].)

With the exception of the night monkeys (*Aotes*), which as their

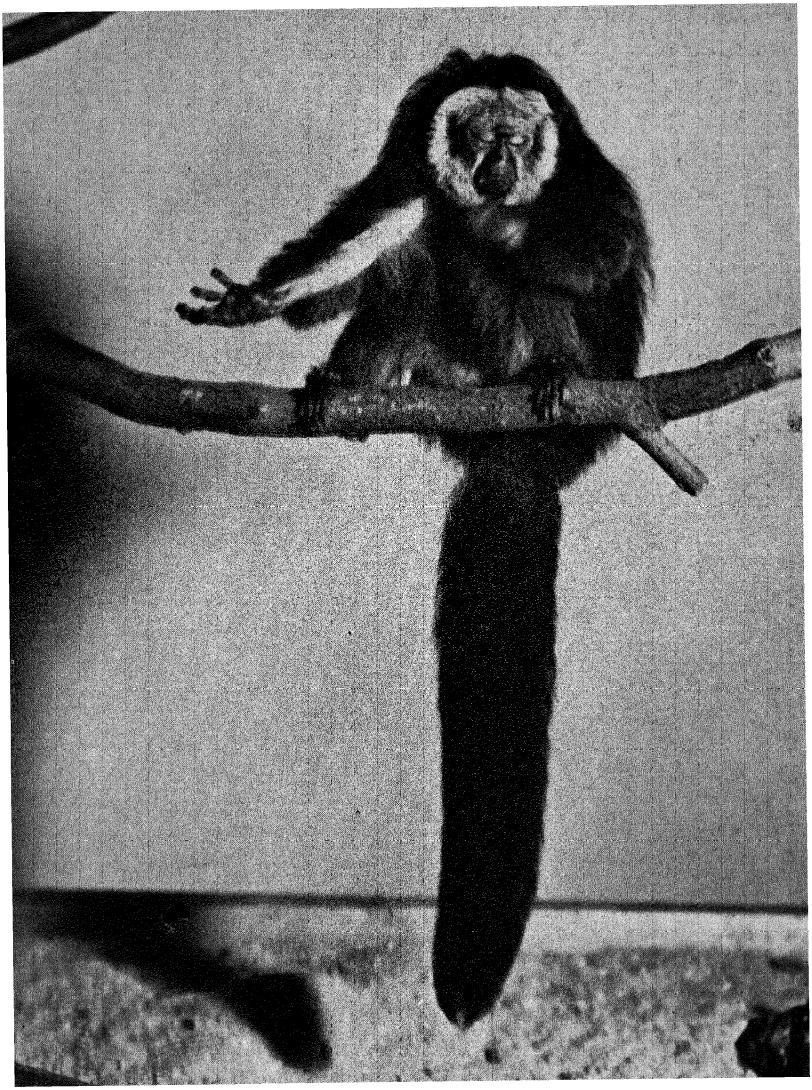


FIG. 24. Woolly Saki Monkey (*Pithecia monachus*). (Photo, New York Zoological Society.)

name implies are nocturnal animals, all the Cebidae are possessed of a well developed fovea and macula, and are capable of stereoscopic vision. The few members of the Cebidae thus far investigated were found to be capable of color vision.

All the Cebidae are arboreal in their habits, and with the exception of the night monkeys (*Aotes*) which are nocturnal creatures, all are diurnal. It is of interest to note that the night monkeys are among the smallest, in body size, of the Cebidae, that they live in pairs or in small family groups, have a limited areal range, and that they have the relatively largest eyes.

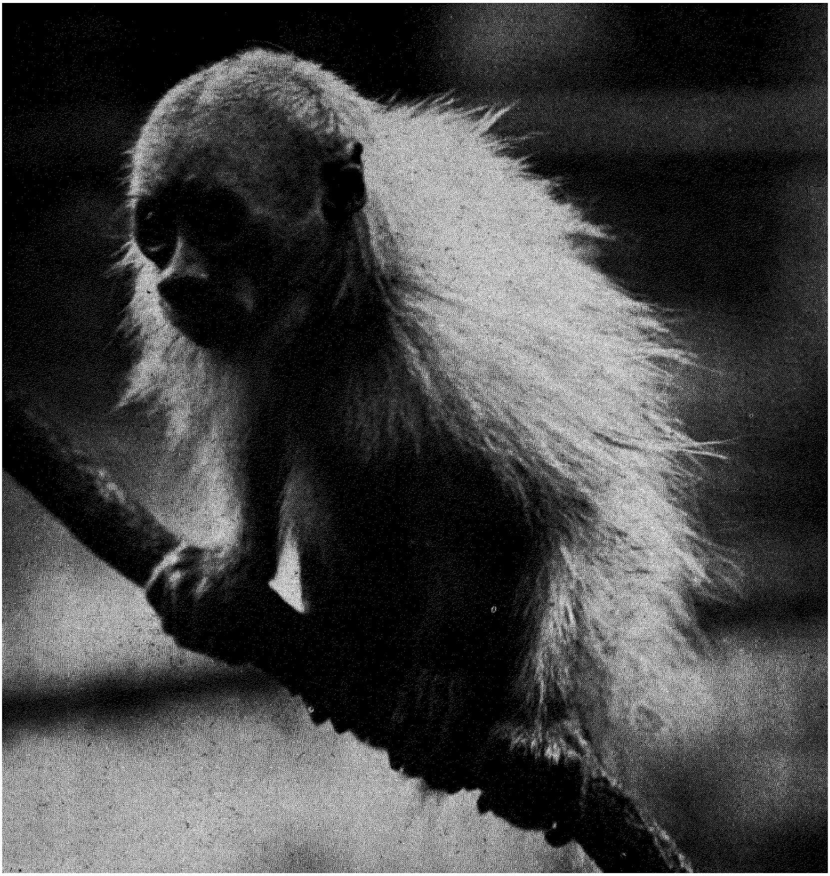


FIG. 25. Ouakári Monkey (*Cacajao calvus*). (Photo, New York Zoological Society.)

One young is usually born at a birth, and it is normally carried by the mother on her back; in *Saimiri* and *Cebus* the father generally carries the infant on his back, the infant returning to the mother only for suckling.

The female experiences a definite estrous cycle, that is to say, a monthly period of physiological change during which the animal undergoes all those changes which lead to ovulation, to heat, and to sexual behavior. In *Ateles* and in *Cebus,* at least, a scanty menstruation occurs fairly regularly.

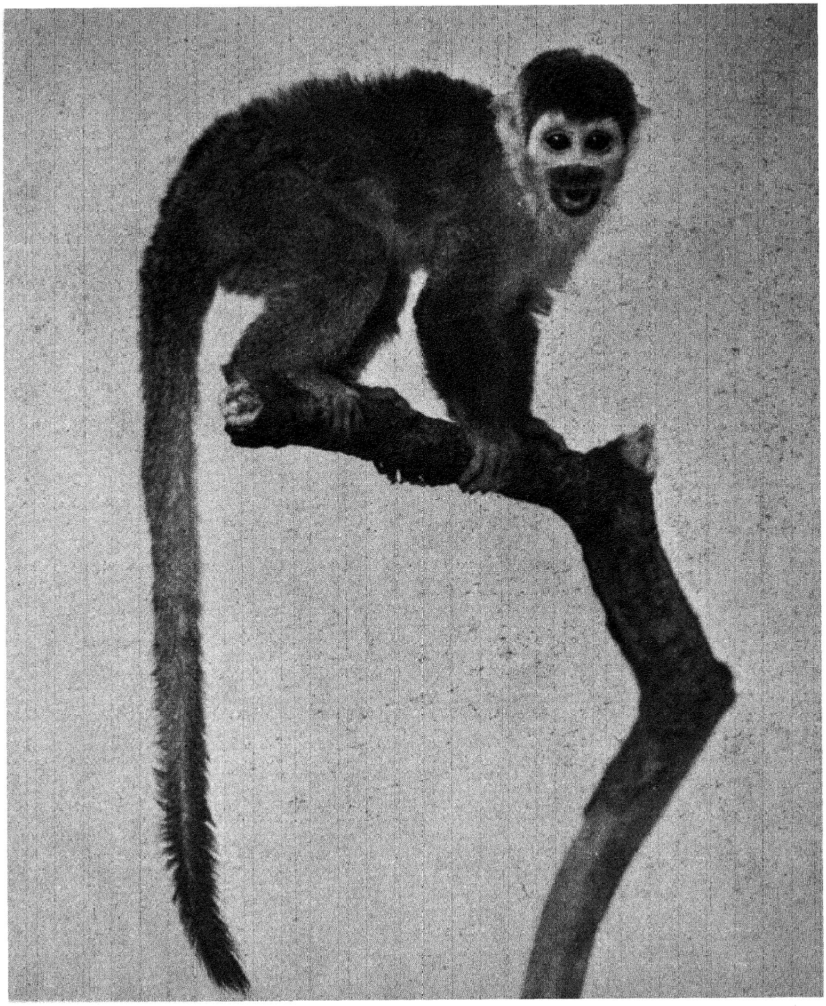


FIG. 26. Squirrel Monkey (*Saimiri sciureus*). (Photo, New York Zoological Society.)

With the exception of the night monkeys the cebids live in

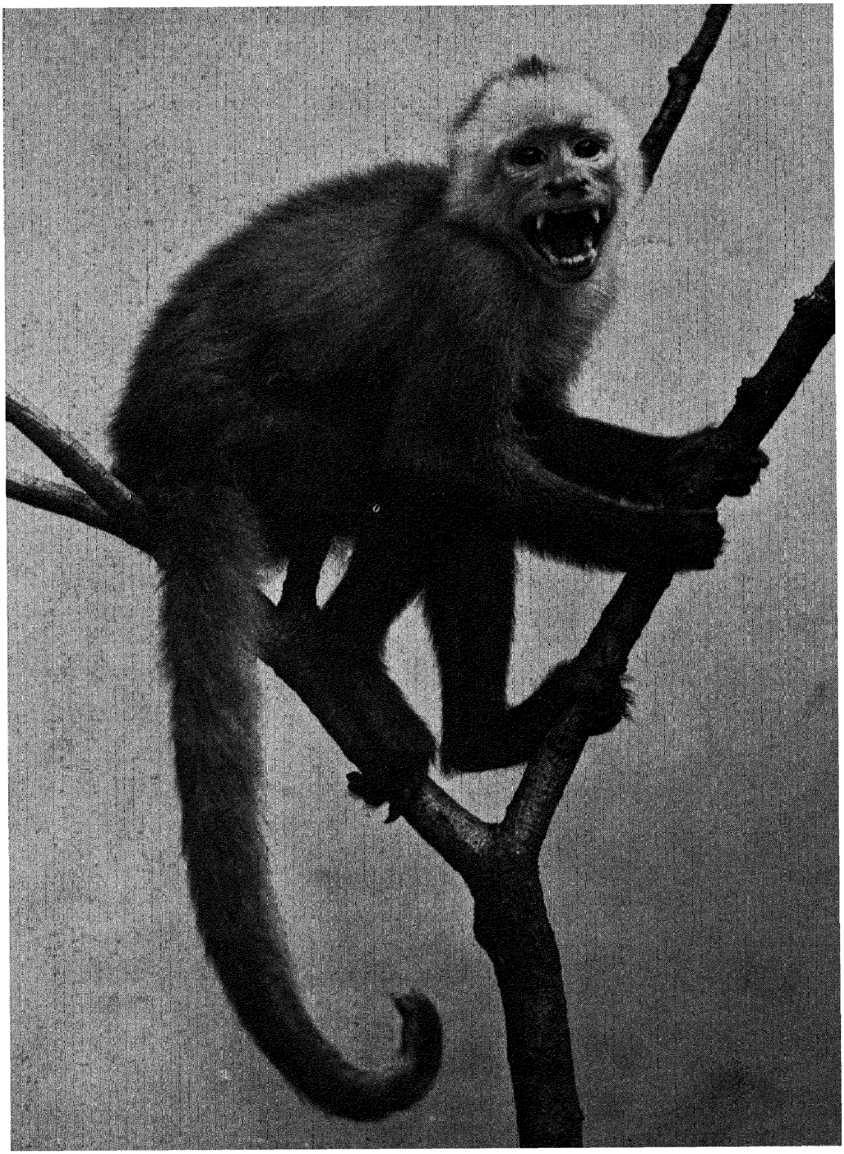


Fig. 27. White-throated Sapajou (*Cebus capucinus*). (Photo, New York Zoological Society.)

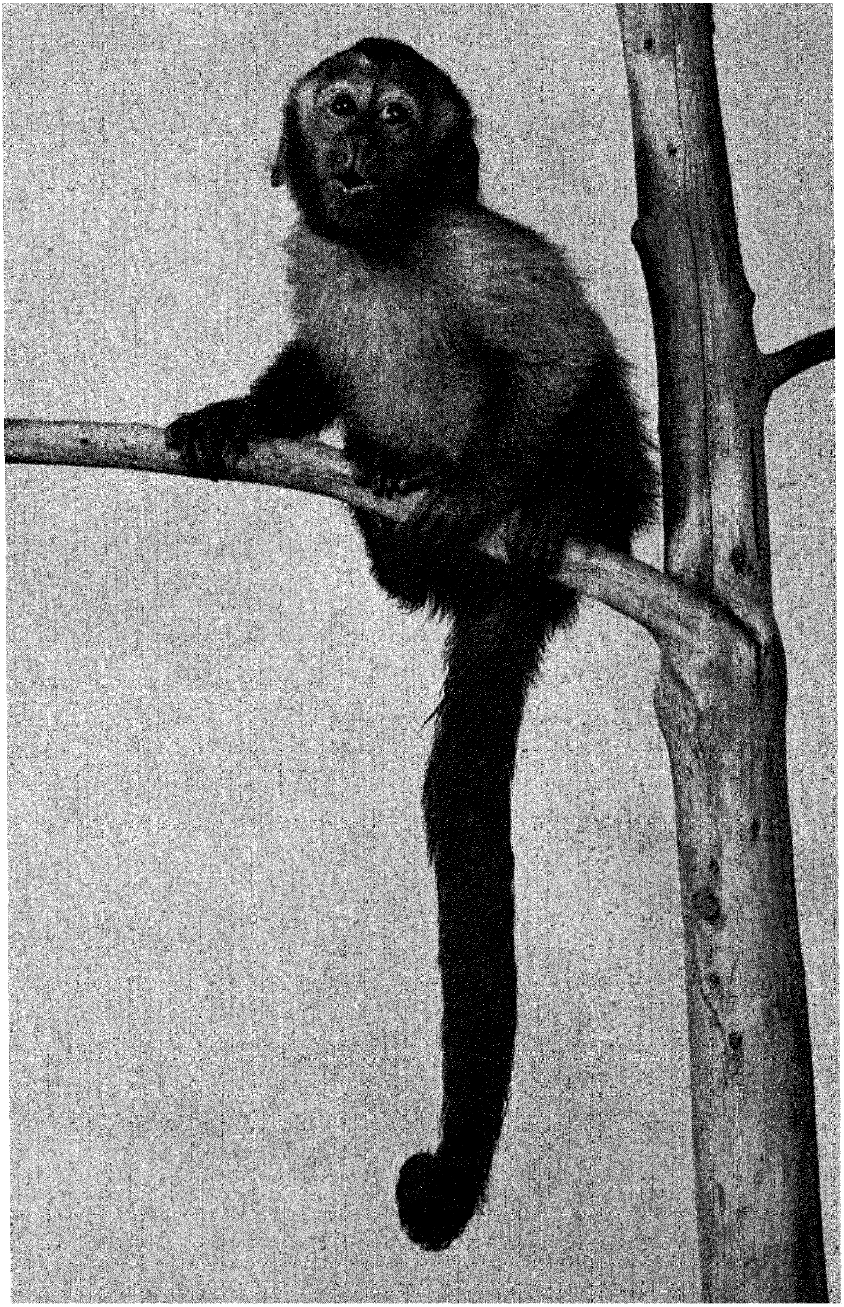


FIG. 28. Hooded Sapajou (*Cebus fatuellus*). (Photo, New York Zoological Society.)

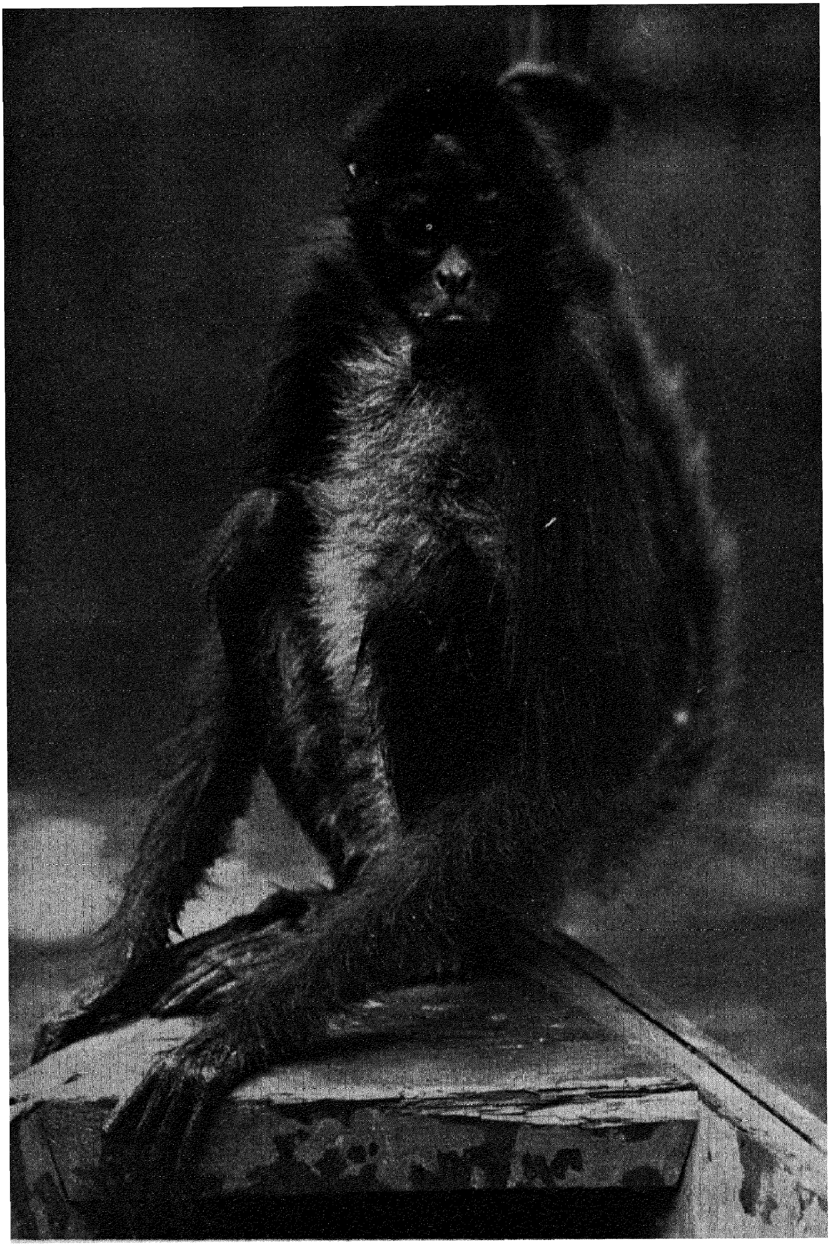


Fig. 29. Spider Monkey (*Ateles ater*). (Photo, New York Zoological Society.)

communities. Diet varies from genus to genus but is mainly frugivorous; some insects are eaten, while the howler monkeys (*Alouatta*) are mainly leaf eaters.

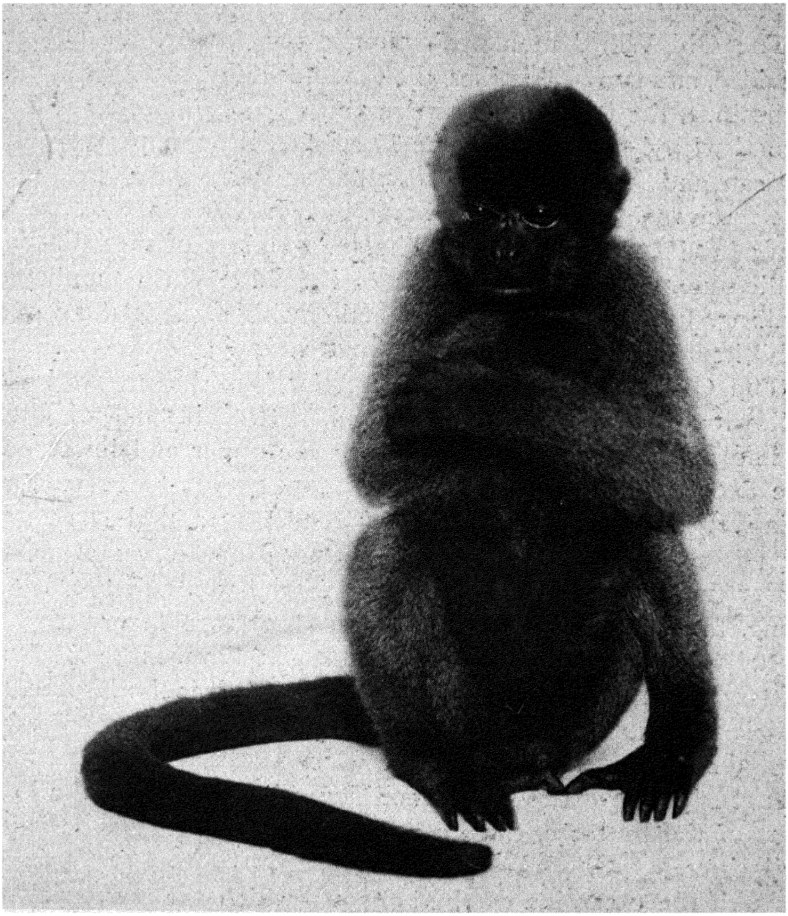


FIG. 30. Wooly Monkey, Immature (*Lagothrix humboldti*). (Photo, New York Zoological Society.)

The Cebidae are comparatively intelligent creatures, gentle, relatively unaggressive, and capable of a very wide range of facial expression.

Anthropoidea

SERIES CATARRHINI

The Old World Monkeys and Baboons

SUPERFAMILY CERCOPITHECOIDEA

The Old World monkeys comprise one family, the Cercopithecidae, and two subfamilies, the Cercopithecinae and the Semnopithecinae, the first with 8 genera and some 137 species, and the second with 4 genera and some 78 species. All the catarrhini are African and Asiatic in their distribution, with the exception of one species which, though at home in North Africa, also has the run of the rock of Gibraltar. The great variety of specializations exhibited by different members of the Old World monkeys is striking, but it is a question whether this exceeds the variety exhibited by other families of primates.

The Old World differ from the New World monkeys in the following characters: There are only two, instead of three, premolar teeth on each side both in the upper and lower jaws, the dental formula being $I\,\frac{2}{2},\ C\,\frac{1}{1},\ PM\,\frac{2}{2},\ M\,\frac{3}{3}$; the palate is relatively long, the auditory bulla is absent, and the tympanic ring is elongated to form a true external auditory meatus, the malar never articulates with the parietal bone, and the frontal bone, forming the forehead, is somewhat more depressed. The nostrils are set close together, all digits have more perfectly flattened nails, the thumb is opposable, and so is the big toe, the tail is not prehensile, the cercopitheques possess cheek pouches, and the semnopitheques, sacculated stomachs, while all species possess sitting pads of naked modified skin situated on the lower part of the buttocks, these callused pads being known as ischial callosities.

With the exception of the baboons—which are terrestrial—the Old World monkeys are arboreal in their habits, and all are completely diurnal.

Visual acuity is very highly developed, the mangabeys (*Cercocebus*), for example, having an even more highly developed retina than man.

There are seven cervical and an average of 12 thoracic, seven

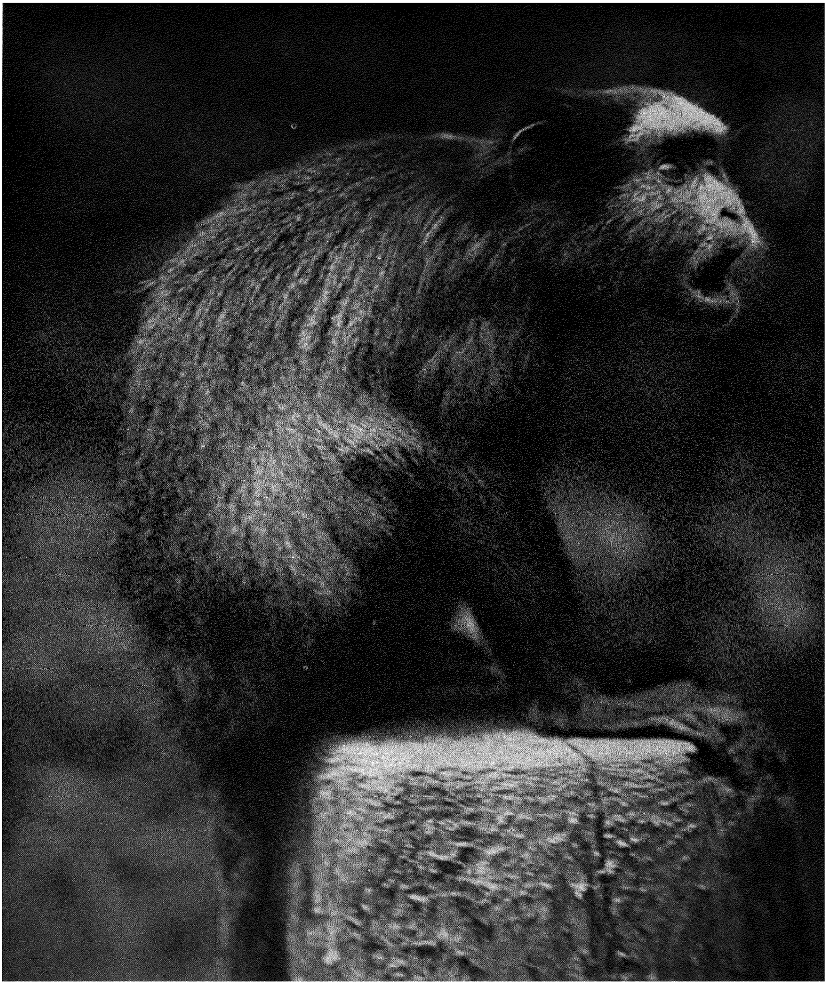


FIG. 31. Black Guenon (*Cercopithecus nigrigenis*). (Photo, New York Zoological Society.)

lumbar, three or four sacral, and from 12 to 28 caudal vertebrae.

The female experiences a regular estrous cycle, characterized by the swelling of the perineal sexual skin, in most species, and by menstruation in all. One young is born at a birth, and this clings to the hair of the mother's belly where it is carried until, in about a month, it is able to shift for itself. At a later stage, when the infant is about six months, it may be carried on the mother's back.

The Old World monkeys live in small communities. They are temperamentally aggressive creatures, and on the whole do not appear to possess as high a degree of intelligence as the New World monkeys. They are capable of a wide range of facial expression. Their diet is herbivorous and frugivorous and, in the case of the baboons especially, more or less insectivorous.

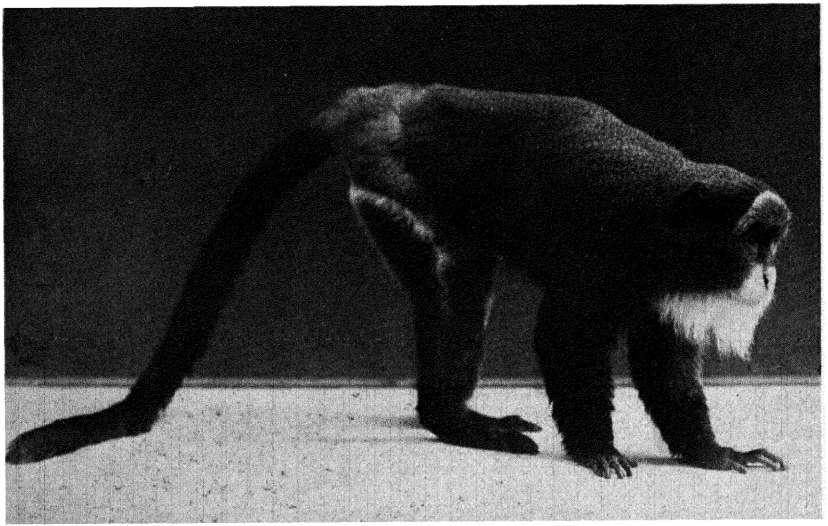


FIG. 32. De Brazza Guenon (*Cercopithecus brazzae*). (Photo, New York Zoological Society.)

Synopsis of the Old World Monkeys and Baboons

SUBORDER ANTHROPOIDEA

SERIES CATARRHINI

The Old World Monkeys and Baboons

II. SUPERFAMILY CERCOPITHECOIDEA

I. FAMILY CERCOPITHECIDAE

SUBFAMILY CERCOPITHECINAE

Genus *Cercopithecus*. The guenons (Africa)

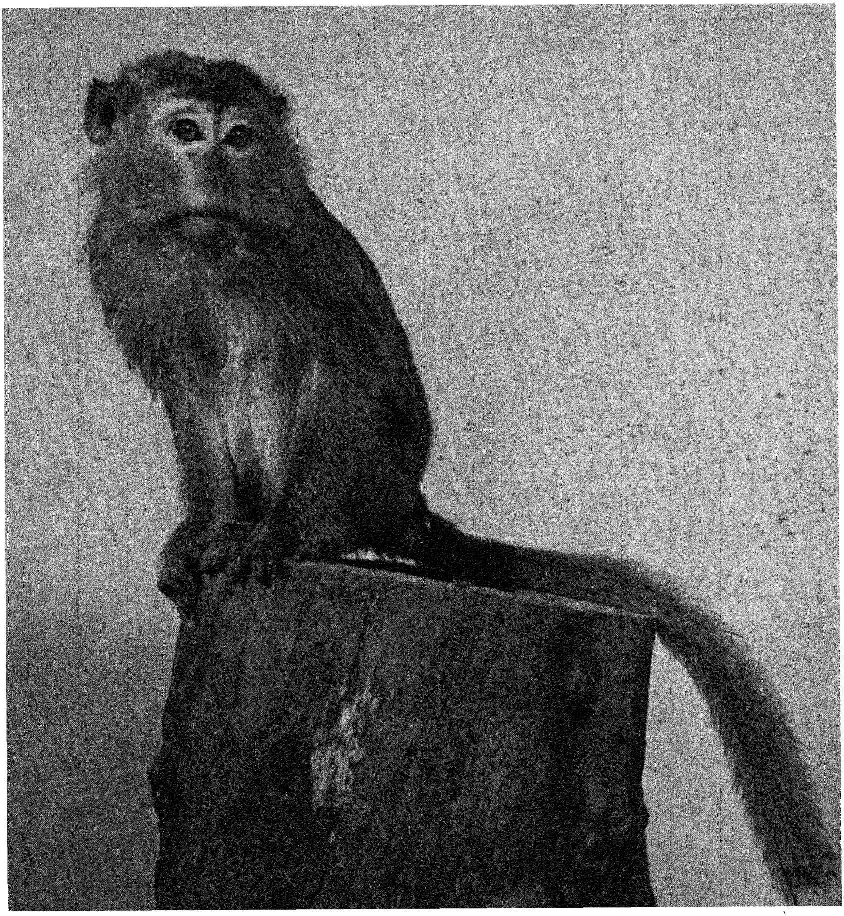


FIG. 33. Java Macaque or Java Monkey (*Macaca irus*). (Photo, New York Zoological Society.)

Genus *Erythrocebus*. The red-haired patas or hussar monkeys (Equatorial Africa)

Genus *Cercocebus*. The mangabeys (Equatorial Africa)

Genus *Macaca*. The macaque (Southern Asia, China, Japan, Philippines, East Indies, North Africa, Gibraltar)

Genus *Cynopithecus*. The Celebes or black "ape" (Celebes, Philippines)

Genus *Theropithecus*. The Gelada baboon (Southern Abyssinia)

Genus *Papio*. The typical baboon (Abyssinia, Arabia, South Africa)

FIG. 34. Barbary Ape (*Macaca sylvana*). (Photo, New York Zoological Society.)

Genus *Mandrillus.* The mandrill and drill (Senegambia to Congo)

SUBFAMILY SEMNOPITHECINAE

Genus *Semnopithecus.* The langurs (Asia)
Genus *Colobus.* The guerezas (Equatorial Africa)
Genus *Rhinopithecus.* The retroussé-nosed langurs (North-western China)
Genus *Nasalis.* The proboscis monkey (Borneo)

CERCOPITHECINAE

With the exception of the Celebes "ape" (*Cynopithecus*), which is native to Celebes, and has been introduced into Batchian and the Philippines, all the genera of cercopitheques are represented in Africa, while only one genus which occurs in Africa is represented outside that continent, namely, the macaques (*Macaca*), species of which are found in Asia and in Gibraltar.

The cercopitheques in contrast to the semnopitheques all possess cheek pouches. In these receptacles they are able to cram a great quantity of food which they are then able to masticate at leisure. The semnopitheques, on the other hand, are distinguished from the cercopitheques by the possession of sacculated stomachs, which are apparently well-adapted to the digestion of a diet consisting principally of leaves.

The guenons (*Cercopithecus*) are lightly built, long-tailed arboreal creatures of great agility, with short faces and rounded heads. The patas monkeys (*Erythrocebus*) are very similar in form to the guenons, but are more terrestrial in their habits. The mangabeys (*Cercocebus*) are arboreal, very long-tailed, slenderly built, white-lidded, monkeys; and the jaws project quite prominently. The macaques (*Macaca*) are at home in trees and in rocky regions, but like all monkeys are capable of getting along very well, whenever necessary, on the ground. They are stockily built creatures, the tail is usually rather short, and the muzzle projecting. The Celebes "ape" (*Cynopithecus*) has an extremely reduced tail, and is very baboon-like in appearance, with an elongated flattened muzzle, and a peculiar crest of hair which springs from the crown of the head. With the Gelada "baboon" (*Theropithecus*) we come to the baboons.

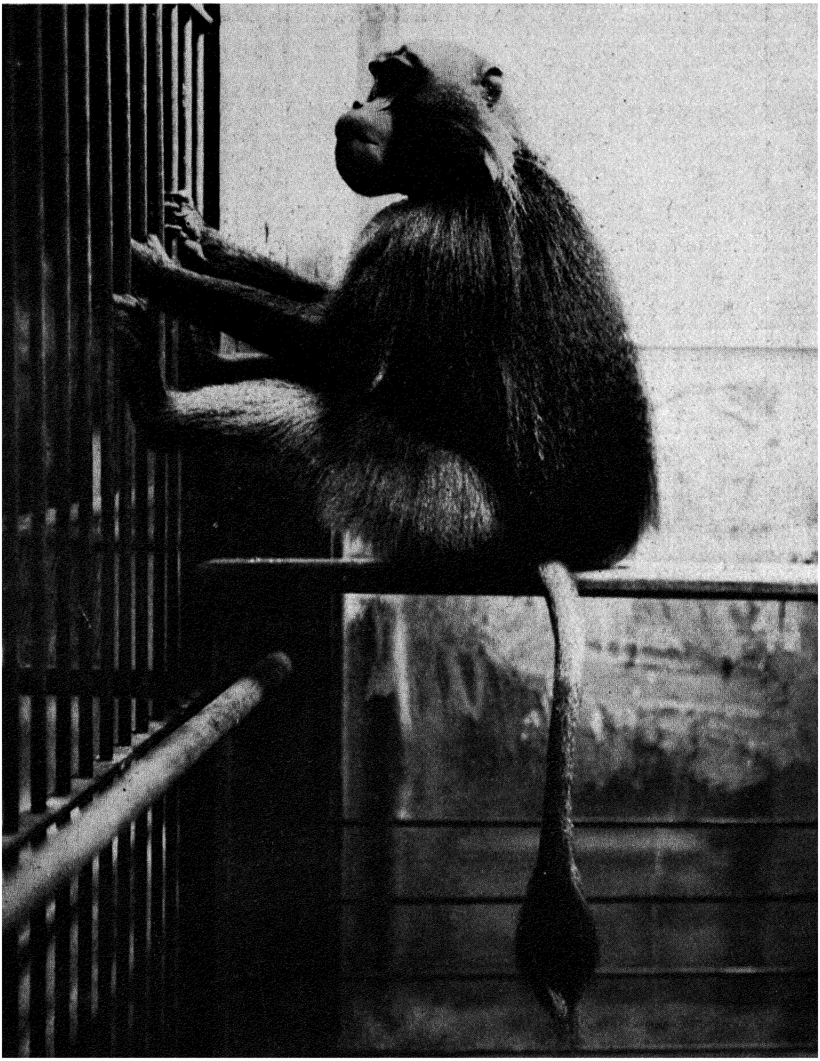


FIG. 35. Gelada Baboon (*Theropithecus gelada*). (Photo, New York Zoological Society.)

The baboons differ from all other Old World monkeys in being terrestrial in their habits rather than arboreal, and in having very elongate dog-like muzzles. Actually baboons live in rocky regions rather than on flat ground. The so-called Gelada baboon (*Theropithecus*) differs from the typical baboons (*Papio*) and the drills and mandrills (*Mandrillus*), in having the nostrils set far back instead of being situated at the most forward portion of the muzzle, and in having a deep rather than a forwardly prolonged muzzle, and in the fact that in the males the ischial callosities, the two highly callused areas situated on the lower part of the buttocks, are widely separated. The mandrill is distinguished from the drill principally by its amazing facial coloration. The top of the nose is red, the tip scarlet, the elongated muzzle ridges are bright blue with purple in the intervening furrows, the lips are grayish black. The face of the drill is entirely black without other coloration. Both have extremely short tails. In the baboons the muzzle reaches its greatest length, a condition which may be associated with their pronograde posture.

FIG. 36. Hamadryas Baboon (*Papio hamadryas*). (Photo, New York Zoological Society.)

SEMNOPITHECINAE

It has already been mentioned that this subfamily, which embraces the langurs and guerezas, differs from the cercopitheques in the possession of a sacculated stomach and in the absence of cheek pouches. The semnopitheques are also, as a whole, characterized by a long and often highly colored pelage. With the exception of the African genus of guerezas (*Colobus*), the semnopitheques are an Asiatic group. In addition to their geographic uniqueness, among the semnopitheques, the guerezas are also peculiar in that they alone among the catarrhini show the same extreme reduction of the thumb that characterizes the spider monkeys (*Ateles*) among the platyrrhini. All semnopitheques are lightly built, and all are arboreal and diurnal in their habits.

FIG. 37. Chacma Baboon (*Papio porcarius*). (Photo, New York Zoological Society.)

The true langurs (*Semnopithecus*) are slenderly built animals, with long slender tails, and short faces. The snub-nosed langurs (*Rhinopithecus*) are characterized by retroussé noses, while the proboscis monkey (*Nasalis*) is notable for the remarkable development of the nose which projects several inches beyond the face and below the level of the mouth. Interestingly enough the young proboscis monkey and the female are characterized by the possession of a retroussé nose.

The guerezas (*Colobus*) have short faces, long slender nonprehensile tails, and external thumbs reduced to a tubercle which may or may not have a rudimentary nail.

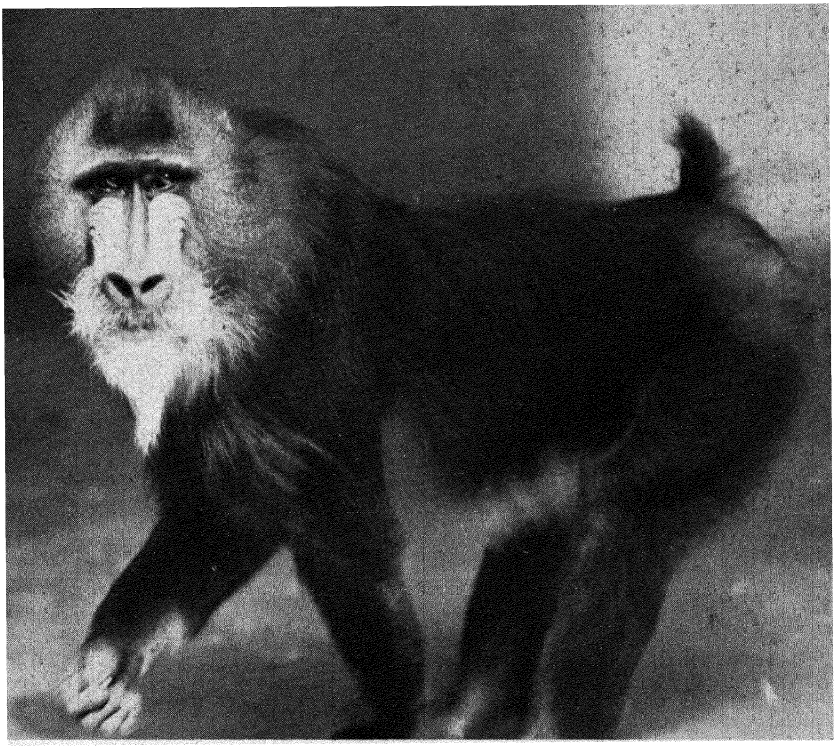


FIG. 38. Mandrill (*Mandrillus sphinx*). (Photo, New York Zoological Society.)

Anthropoidea

SERIES CATARRHINI

SUPERFAMILY HOMINOIDEA

The Apes and Man

The anthropomorphous primates seem to constitute a natural unit and are therefore placed together in the single superfamily Hominoidea. The Hominoidea consists of two families, the

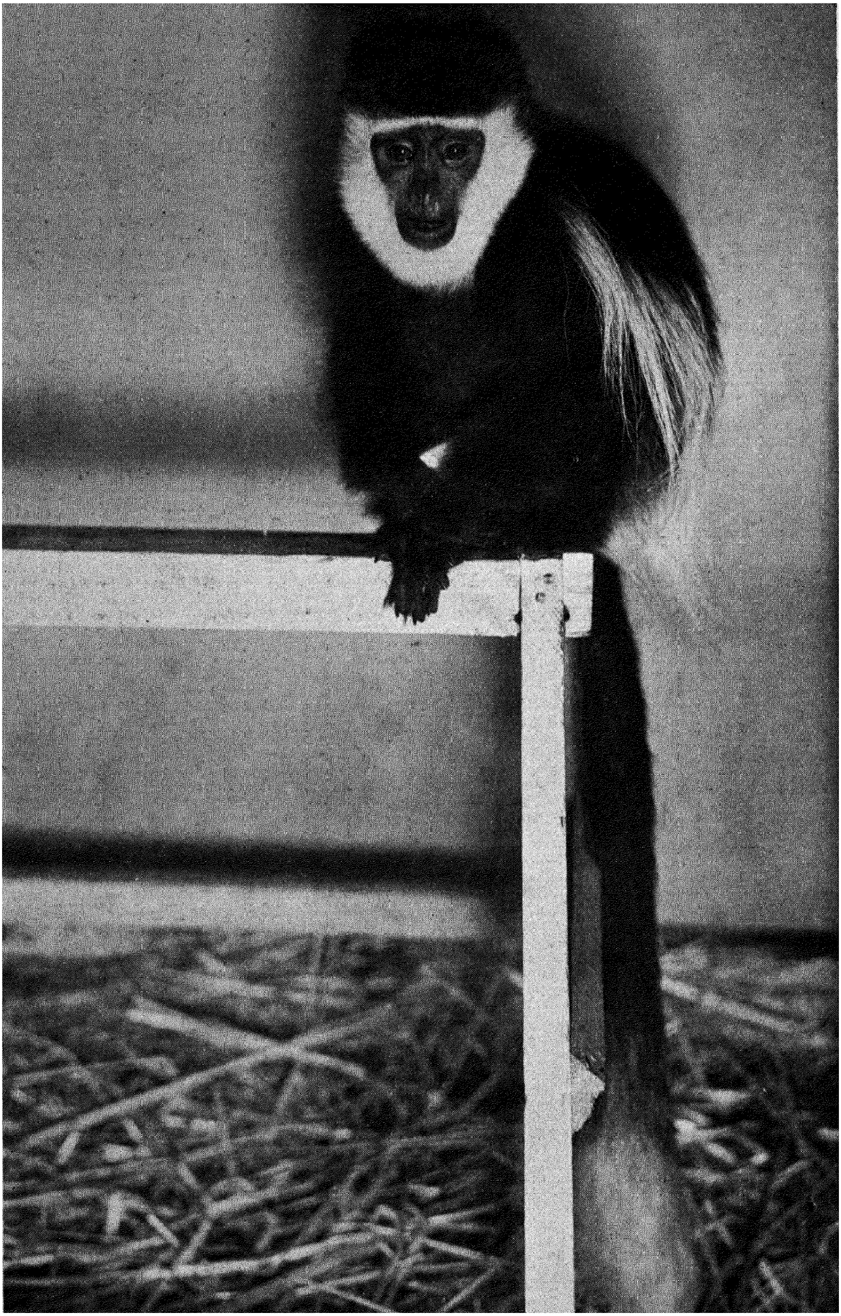


Fig. 39. Guereza Monkey (*Colobus abyssinicus*). (Photo, New York Zoological Society.)

Pongidae or anthropoid apes, and the Hominidae or men. The Pongidae consist of two subfamilies, the Ponginae with three genera comprising the three great apes, the gorilla (*Gorilla*), the chimpanzee (*Pan*), and the orang-utan (*Pongo*), each with a single species. The second subfamily, the Hylobatinae, consists of two genera, the common gibbon (*Hylobates*), and the siamang (*Symphalangus*), each with a single species. The Hominidae consists of a single genus *Homo*, and a single species *sapiens*.

The Hominoidea are distinguished from most other genera of primates by the absence of a tail, the presence of a vermiform appendix, a very large complex brain, arms which are longer than the legs (save in man), a laterally expanded pelvis, chest more or less flattened from front to back, ability to assume an erect posture, locomotion by brachiation or overarm swinging (except in man and the adult gorilla), the great apes being obliquely quadrupedal, while man is habitually bipedal. The thumb and big toe are opposable in the anthropomorphous apes, but in man the thumb alone is opposable.

Synopsis of the Apes and Man

SUBORDER ANTHROPOIDEA

SERIES CATARRHINI

Anthropomorpha

The Apes and Man

III. SUPERFAMILY HOMINOIDEA

I. FAMILY PONGIDAE

SUBFAMILY HYLOBATINAE
Genus *Hylobates*. The common gibbons (Asia)
Genus *Symphalangus*. The siamang (Sumatra)

SUBFAMILY PONGINAE
Genus *Gorilla*. The lowland and mountain gorillas (Western and Eastern Equatorial Africa)
Genus *Pan*. The chimpanzee (Western and Central Equatorial Africa)
Genus *Pongo*. The orang-utan (Borneo and Sumatra)

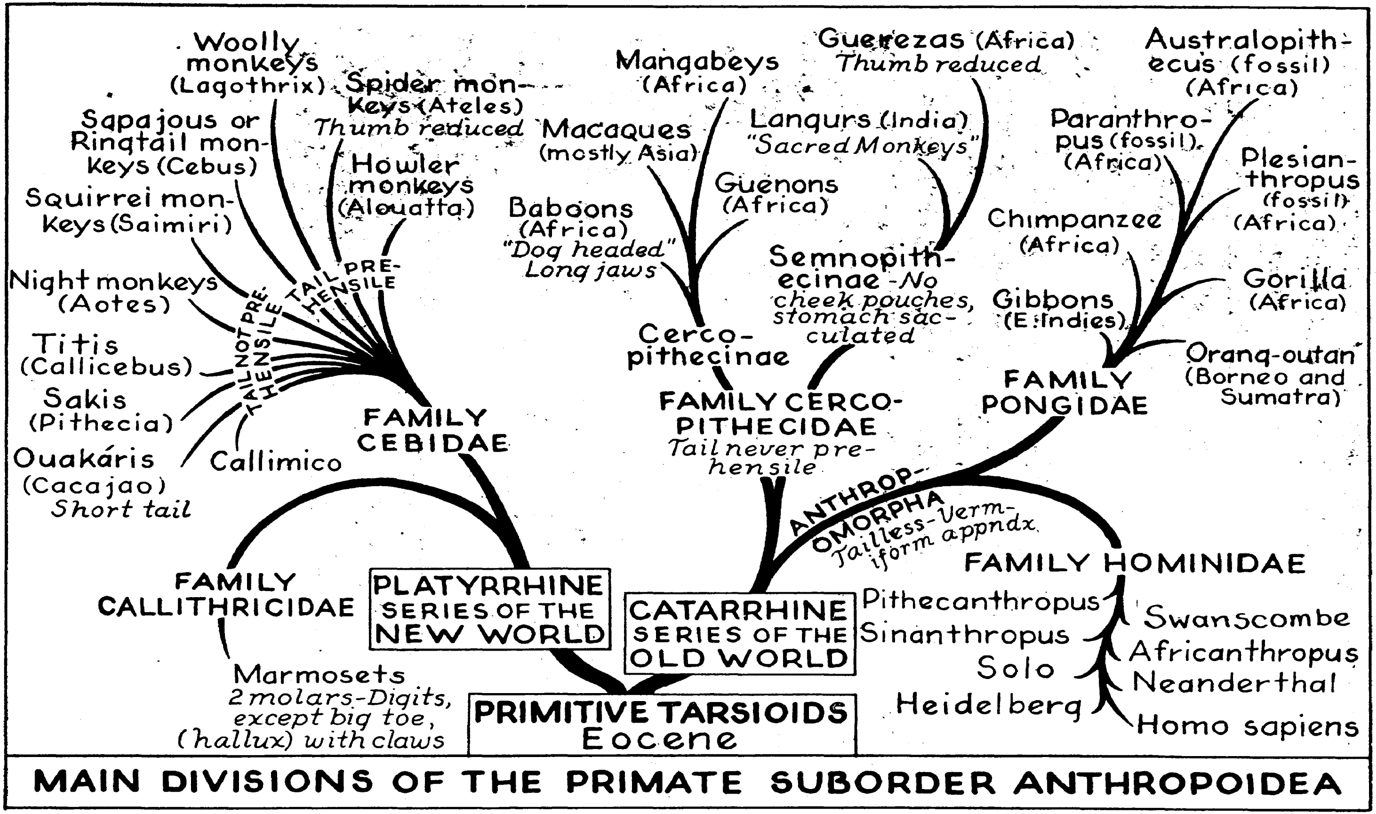


FIG. 40. Main Divisions of the Primate Suborder Anthropoidea.

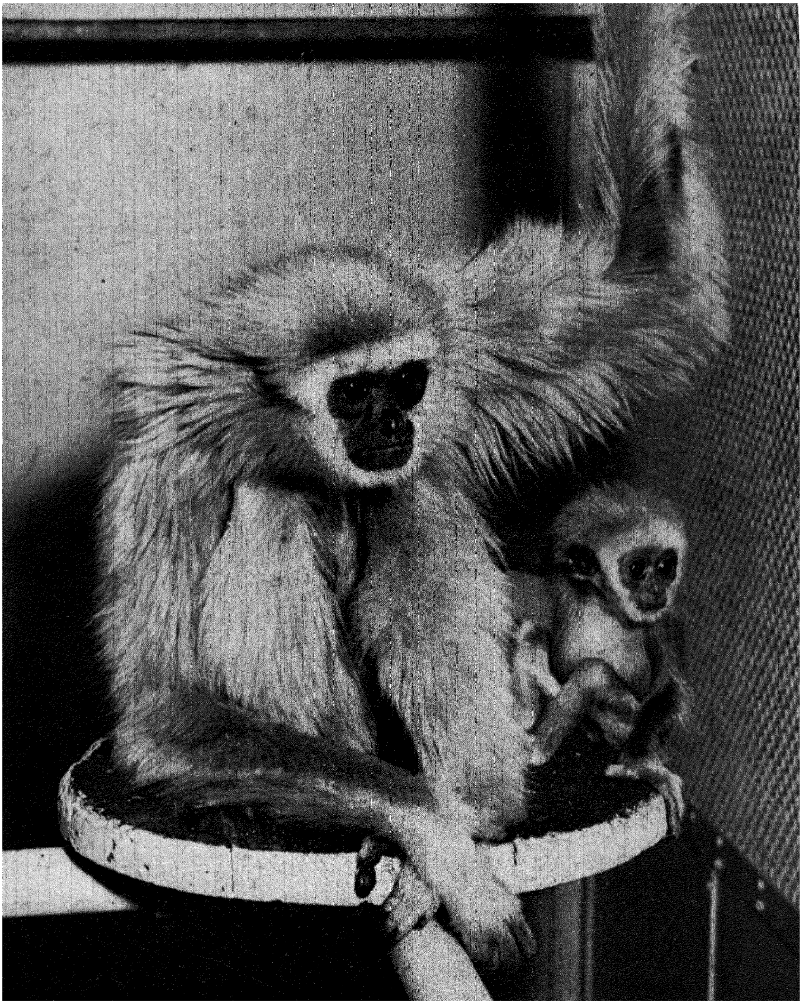


FIG. 41. White-handed Gibbon with Baby *(Hylobates lar).* (Photo. New York Zoological Society.)

II. FAMILY HOMINIDAE

Genus *Homo.* All living types of man (the habitable globe)

We may now turn to the consideration of the Hominoidea in some detail.

HYLOBATINAE

The gibbons (including the siamangs) are the smallest of the apes, being slightly under three feet in height. The Hylobatinae comprise two genera, *Hylobates*, the common gibbon, and *Symphalangus*, the siamang, each with one species. *Hylobates* is found in Assam, Burma, Siam, Indo-China, Hainan Island, the Malay Peninsula, and the British and Dutch East Indies. The siamang is found only on the island of Sumatra. Although some eight species of *Hylobates* have been described, it seems fairly evident that these are geographic races or subspecies rather than species. *Hylobates* is a genus with a single polytypic species, and *Symphalangus* a genus with a single monotypic species.

Some of the features in which the siamang differs from the common gibbon are: (1) a larger body weight (24 as against 13 pounds), and larger dimensions of nearly all bodily parts; (2) much shorter trunk and relatively broader chest; (3) shorter legs (in proportion to the trunk) and much larger arms (in proportion to the legs; (4) relatively broader hands; (5) an average cranial capacity of 124.6 c.c. as against 97.5 c.c.; (6) a longer skull; (7) the common occurrence of supernumerary molar teeth; (8) the presence of a throat pouch; (9) scantier body hair; and (10) frequent webbing between the second and third toes.

The arms are of such extraordinary length in the gibbon that when the animal stands erect its finger-tips touch the ground. The length of its upper extremities is no doubt correlated with the amazing ability of the gibbon to progress through the trees by overarm swinging. The brachiating ("arming") mode of progression has reached its highest development in the gibbons, who are the true aerial acrobats among the primates. Brachiation is the mode of progression followed by the gibbon about 90 per cent of the time, walking and jumping fills in the remaining 10 per cent of the time. On the ground the gibbon normally progresses in the upright position using his long arms as balancers.

There are seven cervical, and an average of 13 thoracic, five lumbar, five sacral, and two to three coccygeal vertebrae.

Among important features which distinguish the Hylobatinae from the Ponginae are the constant presence of ischial callosities (these are occasionally present in the Ponginae), the wide flaring of the zygomatic or malar bone on the side of the skull, and its occasional contact with the parietal, the early eruption of the teeth and their smaller size, the eruption of the canine before the second molar teeth, and the great density of the body hair.

FIG. 42. Gibbons on Monkey Island (*Hylobates lar.*) (Photo, New York Zoological Society.)

Except for the external genitalia there are no perceptible external differences observable between the male and female gibbon. In many respects the gibbons stand intermediate between the Old World monkeys and the Ponginae. They are more nearly allied to the Oriental orang-utan than to the African apes, the chimpanzee and the gorilla.

Menstruation occurs at intervals of four weeks and lasts about two or three days. There are no sexual skin changes except for some slight eversion of the vaginal orifice and changes in the turgidity and color of the labia during the cycle.

There is no definite breeding season, copulation taking place throughout the year. Pregnancy lasts about 30 weeks. One young is born at a birth, and this is devotedly nursed by the mother. From the first day the infant is able to hold on to the mother's abdominal hair, and later by encircling her waist with its long arms, while she brachiates through the trees without affording her infant any other support. The young one scarcely ever leaves its mother's protective custody until after the sixth month.

Temperamentally the gibbon is a gentle creature but very nervous and excitable and quite unpredictable. Gibbons are capable of a considerable amount of facial expression.

Gibbons live in small family groups, which are generally part of a larger territorial population.

Diet is frugivorous and insectivorous, but birds' eggs and small birds are eaten with relish.

PONGINAE

Pongo. The orang-utan is represented by a single species, *Pongo pygmaeus*, confined to the islands of Borneo and Sumatra. The orang-utan has very long arms and short legs, and reaches a height of slightly over four feet. The average weight of the male is 165 pounds, of the female but a little over 80 pounds. Orangs are almost exclusively arboreal creatures. The coarse, shaggy, body hair is reddish-brown or "bright-foxy" red. Skin color is pale yellowish-brown. Adult males usually, and adult females, sometimes, exhibit a peculiar specialization in the form of cheek pads, great lateral outgrowths on each side of the face of fat and connective tissue. With the exception of the common gibbon the apes all possess laryngeal sacs, but these reach their greatest development in the orang. These structures arise a little distance above the vocal cords and descend in the neck and chest, spreading out laterally frequently as far as the armpits, and below as far as the base of the breastbone. The function of the sac, if any, is unknown. In man the laryngeal "sac" is represented by a minute blind sinus beneath the vestibular fold just above the vocal fold. Ischial callosities occur in about five per cent of orangs. There are seven cervical, and an average of 12 thoracic, four lumbar, five sacral, and three coccygeal vertebrae.

FIG. 43. Female Orang-Utan with Young from Borneo (*Pongo pygmaeus*). (Photo, Zoological Society of Philadelphia.)

The skull is very peculiar in form, exhibiting a short rounded brain-case, and a concave hollowed-out face. This gives the facial profile a somewhat "s"-like appearance which has been termed "sinognathism." The supraorbital ridges are not confluent with one another, and thus do not form a torus above the orbits as in the other great apes. The nasal bones are markedly reduced in breadth, and often altogether fail to develop. There is no mastoid process. The adult male generally develops a bony crest, the sagittal crest, along the middle of the top of the skull. The forehead is comparatively high and rounded. The average cranial capacity of the male is 416 c.c.

The upper extremities of the orang are so long that when the animal stands erect the finger tips reach to the ankles. The lower extremities are very short, the proportion of the upper to the lower being 170 per cent. The hand is extremely long and the skeletal opposable thumb is relatively short, about 44 per cent of the total length of the hand.

The movements of the orang are very slow and deliberate, and on the ground he moves on all fours in a laborious and shaky manner.

In the female menstruation occurs regularly, and in some animals there is a definite swelling of the sexual skin during pregnancy. Pregnancy lasts 275 days, and one young is born at a birth; this is carried by the mother in a very human-like manner.

Temperamentally the orang is very placid and sluggish, and is facially the most expressionless of the apes, though he is not altogether incapable of a certain amount of facial expression.

Very little is known of the social life of the orang, but family groups consisting of a male, female and young have been observed. Little is known of the dietary habits of the orang, but they appear to be mainly frugivorous. At nightfall the orang builds himself a roofed nest of branches and twigs and leaves up in a tree, and there rests through the night.

Pan. The chimpanzee is an inhabitant of western and eastern equatorial Africa. Two species have been described, the common chimpanzee (*Pan satyrus*), and the bald-headed chimpanzee (*Pan calvus*), but these are clearly geographic races or subspecies. A pygmy chimpanzee has recently been described as a third species, *Pan paniscus*, but it is an open question whether this is not more properly to be regarded as a third subspecies very closely related to *Pan satyrus*.

There are seven cervical, and an average of 13 thoracic, four lumbar, six sacral, and three coccygeal vertebrae.

The average weight of the male is 110 pounds, and of the female 88 pounds. The average height of the male is five feet and of the female four feet. The chimpanzees are expert climbers and brachiators, but spend much time on the ground where they walk in an obliquely quadrupedal position on the flat of their feet, supporting themselves on the middle joints of their bent fingers. The coarse, straight, body hair is black, but brown, reddish-brown, gray, and white hairs may be found more or less sparsely distributed over the body. Some chimpanzees are entirely white-skinned, others are as completely black-skinned, some are brown-skinned, still others have a mottle-brown face and a white body skin. Young animals may be white-skinned and then turn black

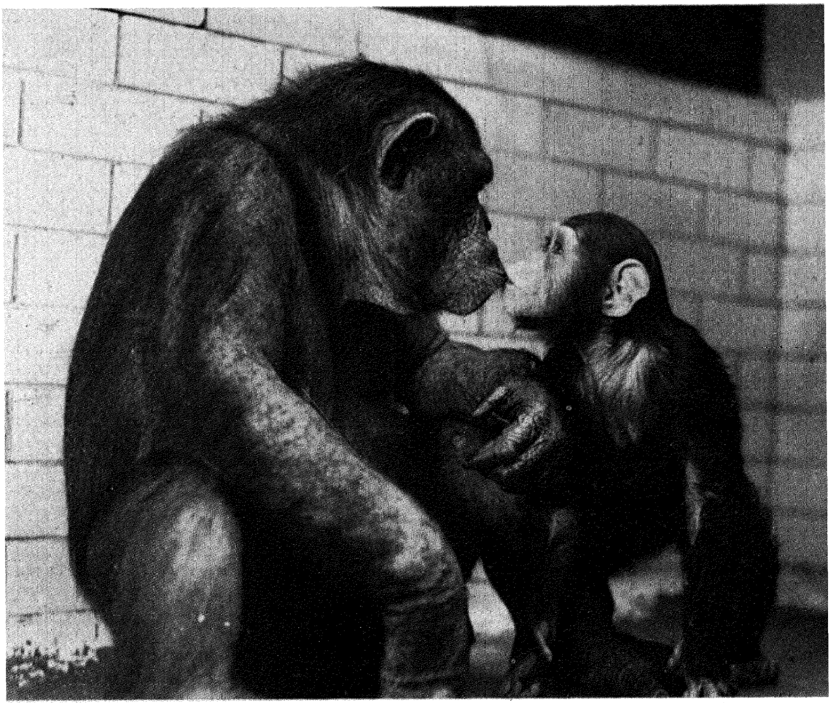


FIG. 44. Chimpanzee Mother and Young One (*Pan satyrus*). (Photo, Zoological Society of London.)

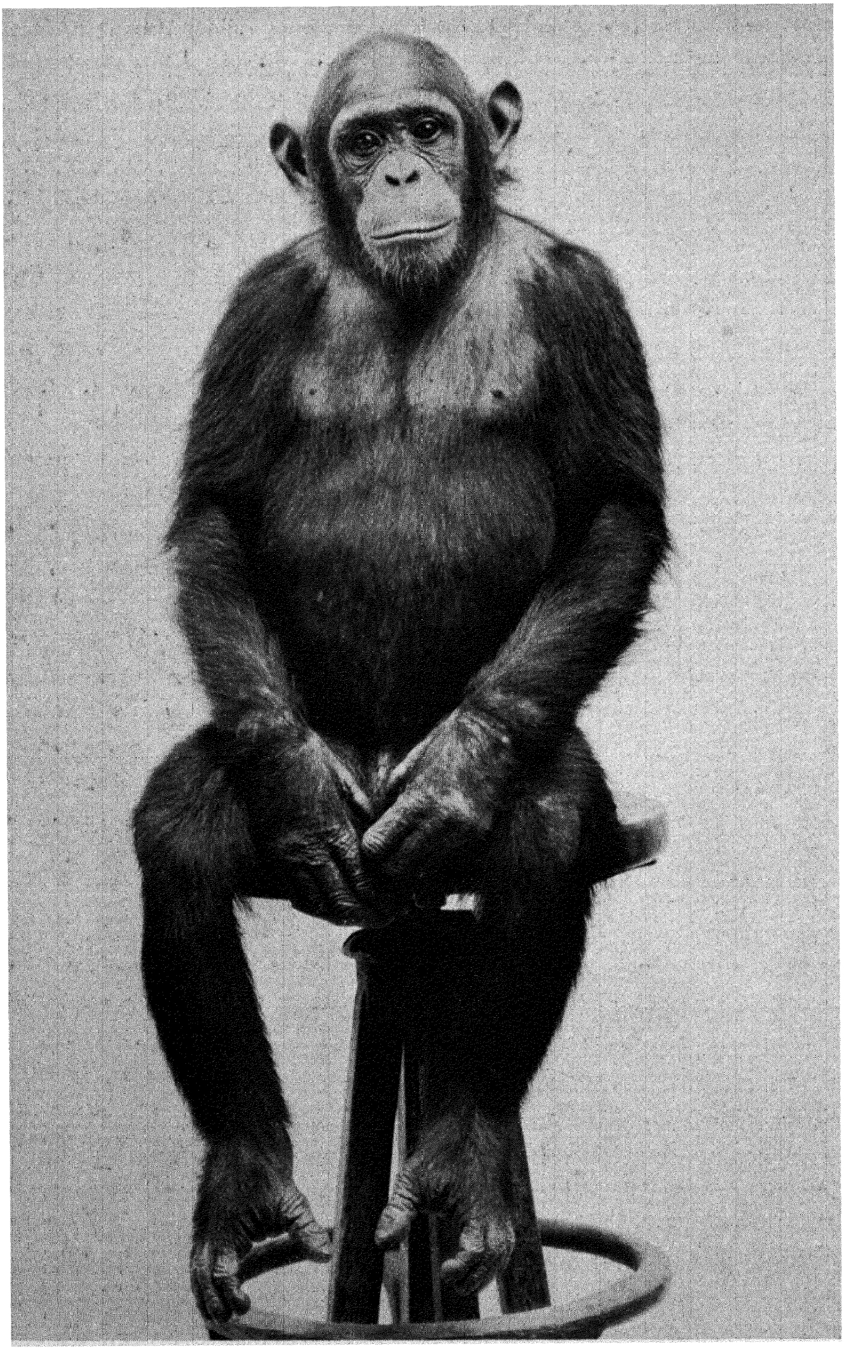


Fig. 45. Chimpanzee (*Pan satyrus*). (Photo, New York Zoological Society.)

with age. Chimpanzees kept indoors for an appreciable time may become very markedly depigmented, but regain their pigmentation in a short time when exposed to sunlight. Ischial callosities occur in about 38 per cent of animals.

The skull has a very low vault, well developed arched supraorbital ridges, a somewhat lesser projection of the jaws than the orang, and a cranial capacity, in the male, of about 400 c.c. A sagittal crest is usually absent, and there is no mastoid process. The root and bridge of the nose are depressed, and the nasal bones are relatively short and flat. The lips are extremely mobile. The upper extremities are long, the tips of the fingers reaching to the level of the knee-joint. The hand is narrow and the fingers long. The thumb is opposable, comparatively short, and its skeletal length is about 47 per cent of the total length of the hand.

In the female the first menstruation, the menarche, occurs at an average age of eight years and seven months. The female experiences regular menstrual cycles with considerable swelling of the sexual skin, the whole estrous cycle lasting about 36 days, one week longer than in the human female. The average duration of pregnancy is 235 days, about 31 days less than in man. One young is born at a birth, and is suckled by the mother in a very humanlike manner. There is continuous maternal safeguarding and surveillance of the activities and welfare of the infant. The young one is carried in the abdominal position for between three to six months, when it may then be changed to the mother's arm or leg, or allowed to ride upon the mother's back.

Not very much is known of the social life of chimpanzees or whether such a social unit as a paternal family exists among them, but scientific observation in the wild indicates that they live in small bands or groups numbering, on the average, about nine individuals in summer, and somewhat more in the rainy season. The strongest male appears to be leader of the band. The chimpanzee builds himself a nest of leaves in the trees on a foundation of skilfully interwined branches, in which he rests for the night, but he has no permanent home, being a perfect nomad, wandering about during the day as his appetites and desires lead him. Diet is mainly frugivorous.

Chimpanzees are peaceful animals. They are capable of a wide range of facial expression.

Yerkes estimates that the life-span of the chimpanzee may be about 30 years.

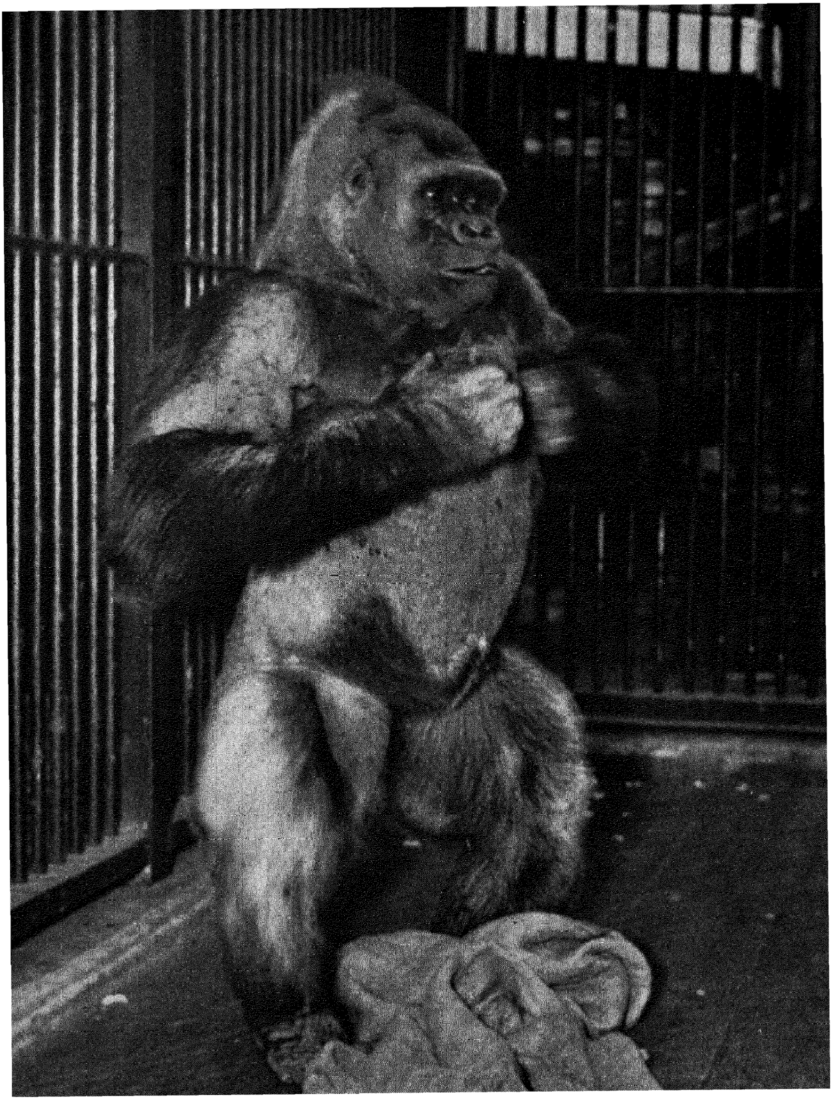


FIG. 46. Male Gorilla (believed to be *Gorilla gorilla beringei,* the mountain gorilla.) (Photo, Zoological Society of Philadelphia.)

Gorilla. The habitat of the gorilla is east central and western equatorial Africa. There is only one genus, *Gorilla,* and two subspecies are recognized, the East African lowland or coastal gorilla, *Gorilla gorilla gorilla,* and the West African highland or mountain gorilla, *Gorilla gorilla beringei.* The western or lowland gorilla dwells in the densely forested region of the Cameroons and the Gaboon. Here, in a moist, damp, environment, the rainy season lasts for eight months. The eastern or mountain gorilla inhabits a narrow mountainous region of the eastern Congo west of Lake Edward and Lake Kivu, extending south to the northern tip of Lake Tanganyika, an area some 250 miles long by 60 miles wide. This region is also densely forested, and the mountain gorilla is found at altitudes from 7,500 to 12,000 feet. The distance separating the habitats of the lowland and mountain gorillas is about 600 miles. Hence, the two races are geographically though almost certainly not reproductively isolated from each other.

The differences between the lowland and mountain gorilla are many, but it takes an expert to detect them. The mountain differs from the lowland gorilla in having somewhat shorter arms, broader and short hands, usually webbed toes, narrower hips, greater length of trunk, narrower width between the eyes, greater length of neck, generally narrower skull, longer palate, thicker pelage, and in a good many other characters. It will be perceived that these are simply minor qualitative differences.

The gorilla is the largest or rather bulkiest of all the primates. The average height of the gorilla is about five feet six inches, but larger males may be a foot taller than this. Because the erect animal keeps his knees bent he usually appears somewhat shorter than he actually is. The gorilla is enormously robust with an average chest girth (below the nipples) of 56 inches, and an average weight of 450 pounds. Weights up to 670 pounds have been recorded. The number of vertebrae is the same as in the chimpanzee, seven cervical, and an average of 13 thoracic, four lumbar, six sacral, and three coccygeal. Skin color is usually black, but the writer has seen one young gorilla with a white body skin under its thick black coat of hair; in later life this may, however, have turned black.

The gorilla is the only one of the anthropoids that exhibits a slight elevation of the nasal bones, an elevation which is highest at the median ridge where the two bones fuse at an early age. Both root and bridge of nose are flat. The free margins of the nasal bones extend well below the level of the infraorbital margins. The lower portion of the nose is broader than that to be found in any other primate. The nasal wings are very thick, enclosing "V"-shaped nostrils separated by a thin septum, and pass below into the upper lip. The lips are very thin, with scarcely any exposure of mucous membrane such as gives the lip in man its characteristic appearance. The ears are small and set close to the head. Because of the presence of massive, chisel-like incisors and huge tusk-like canine teeth in the male, the upper and lower jaws are very wide in front, making the mouth-slit of great width. The female is a smaller and much less specialized animal than the male gorilla. Her canine teeth are much smaller, and in her skeletal characters she is somewhat less rugged than the male. The skull of the adult male is generally easily distinguished from that of the female by the presence of a prominent sagittal crest of bone which runs down the middle of the vault, and which is much larger than anything of the kind achieved by the male orang. To this crest are attached the temporal muscles which move the massive lower jaw. The crest is not seen in the living animal principally because the temporal muscles fill in the areas on each side of the crest, and because of the presence of a "crown pad" of connective tissue which lies above these.

Above the orbits stretches a very strongly developed bar of bone, which is internally hollowed out to form enormous frontal sinuses. Behind the bar is a depression, and from this depression the frontal bone hardly manages to raise itself into the semblance of a forehead. Externally the skull is long, but internally the cranial cavity itself is actually relatively broad, so that in the case of the gorilla we are dealing with a dolichocranial or long external skull and a brachycranial or broad internal skull. The average cranial capacity of the male is 550 c.c. and of the female 460 c.c. There is no concavity to the facial profile of the gorilla, but the face projects obliquely downwards and forwards in an almost straight line. A moderately well developed mastoid process is present. Owing to the peculiar configuration of the back of the head and the powerfully developed neck muscles there is no obvious demarcation between the back of the head and the trunk. Laryngeal sacs are present, but are not quite as well developed as in the orang.

Thumb and great toe are opposable. The gorilla spends most of his time on the ground where he progresses by walking more or less on the flat of the soles of his feet, and resting his weight anteriorly on the middle joints of his fingers. The gorilla is able to stand erectly and even to take a few steps in that position, but his normal gait is obliquely quadrupedal. Since his forelimbs are considerably longer than his hindlimbs, and the latter are habitually bent at the knees, the posture thus produced is one which is best described as obliquely quadrupedal. The term "semi-erect" does not accurately describe either the posture or the habitual mode of progression of the gorilla.

The gorilla is a slow moving creature, and on the ground is easily overtaken by man. Gorillas are not entirely terrestrial in their habits, for the smaller ones occasionally climb trees, in which they progress by brachiation and by walking erectly while grasping the branches above them with their hands. At the approach of night the gorilla builds himself a comfortable nest which he uses once only, and abandons in the morning. The lowland gorilla builds nests sometimes in trees but mostly on the ground. The mountain gorilla usually builds his nest on the ground under large trees, and sometimes—interestingly enough—under ledges of rocks, but quite frequently also in trees. Diet is principally herbivorous.

The gorilla lives in small bands of from three to 10 or more families. These generally separate during the day but return before nightfall to make their nests together. Gorillas are nomadic in their habits, rarely staying longer than a month in the same locality, principally, it is supposed, because of the exhaustion of the food supply. The gorilla is a peaceable animal, and will never attack a man unless badly frightened or threatened.

Very little is known of the reproductive life of the gorilla. What is known is that the gorilla experiences a definite estrous cycle much like that of the human female, with menstruation every 39 days, no sexual skin, and slight swelling of the labia majora prior to menstruation. Duration of pregnancy is probably about the same as in man. One young is born at a birth, and this generally clings to the mother's chest or abdomen, and is frequently carried on her arm. When the infant grows older, it rides on the mother's back.

In contrast to the chimpanzee, which may be described as a somewhat manic type temperamentally, the gorilla, in captivity at any rate, may be described as a distinctly quiet type. The latter is much less given to emotional expression of any sort than the former, and the gorilla's range of facial expression seems to be less than that of the chimpanzee.

Homo. All the living forms of man belong to the single genus *Homo,* and the single species *sapiens.* Although man is unquestionably a member of the giant anthropomorphous primates, he differs in so many respects from them as to justify his inclusion in a separate family, the Hominidae.

The following are some of the many features distinguishing man from the living anthropoid apes:

1. Fully erect posture
2. Bipedal locomotion
3. Legs much longer than arms
4. Greater average relative length of lower limbs
5. Shortest average relative length of upper limbs
6. Longest thumb in relation to hand length
7. Earliest disappearance of independent *os centrale*
8. Straighter fingers and palm
9. Shortest relative length of toes, excepting big toe
10. Non-opposable great toe, set in line with other toes
11. Foot arched transversely and longitudinally
12. Lowest shoulders
13. Lowest placed nipples
14. Least increase in average stoutness of trunk
15. Highest average total number of vertebrae
16. Highest average number of thoracolumbar and coccygeal vertebrae (except gibbons)

17. Relatively longest cervical and lumbar regions of spine
18. Relatively greatest distance between thorax and pelvis
19. Relatively much shorter pelvis
20. Much greater curvature of iliac blades
21. Iliac fossae of pelvis face one another
22. Presence of a true inguinal ligament
23. Absence of penis bone
24. Absence of ischial callosities
25. Shortest height of face
26. Relatively greater distance between eyes
27. Absence of highly developed laryngeal air sacs
28. Great reduction of the projection of the jaws
29. Great reduction in size of canine teeth
30. Equality of sexes with regard to size of canine teeth
31. Much later completion of eruption of permanent dentition
32. Extremely early fusion of facial maxilla with premaxilla
33. Absence of premaxillary bone from anterior aspect of face
34. Late closure of bregmatic fontanelle
35. Late closure of metopic suture
36. Rarity and lateness of fusion of nasal bones
37. Absence of a diastema in the upper jaw for the reception of the tip of the lower canine tooth
38. Prominent bony nose with elongated fleshy tip
39. Median furrow or philtrum of the upper lip
40. Outward rolled mucous membrane forming lips
41. A well marked chin
42. Absence of a simian mandibular shelf
43. Great reduction in density of hair (except on scalp)
44. Absence of tactile hairs
45. Occurrence of wavy and curly hair
46. Brain more than twice as large
47. Greatest weight at birth in relation to body weight in adult life
48. Most retarded skeletal maturation at birth
49. Longer growth period and slower rate of development
50. Longer life span

There are numerous other morphological and particularly physiological characters in which man differs from the anthropoids, and an even larger number in which both man and the anthropoids differ from the Cercopithecidae or non-anthropomorphous catarrhines. Huxley's classic judgment of 1863 that the structural differences which separate man from the great apes are not so great as those which separate the great apes from the monkeys, has been fully confirmed by subsequent investigation. So, too, has his judgment that "the structural differences between Man and the Man-like apes certainly justify our regarding him as constituting a family apart from them."

With respect to more qualitative features man differs from all non-human primates in the following traits or potentialities:

1. Relative freedom from constraint of biologically predetermined behavioral responses.
2. The potentialities for the development of a complex intelligence. Educability.
3. The capacity for complex symbolic thought.
4. Speech as an expression of symbolic thought.
5. The development of a complex way of life or culture.

It is in the possession of these five potentialities, and in their active realization and transmission, from generation to generation, that man qualitatively differs so very significantly from all other primates. It is the development of these potentialities which alone enables him to become a human being. It is probable that these peculiarly human traits are significantly associated with some of the unique features of man's anatomical structure. The size and complexity of the brain, the erect bipedal posture, and the complete freeing of the hands, are factors which are almost certainly significantly associated with man's social development, and there are doubtless others.

FOR FURTHER READING, CONSULT:

BINGHAM, H. C.: *Gorillas in a Native Habitat.* Washington, D.C., Carnegie Inst., 1932.

A study of the social life and habits of the mountain gorilla (*Gorilla gorilla beringei*) in Parc National Albert, Belgian Congo, Africa.

BOULENGER, E. G.: *Apes and Monkeys.* London, Harrap, 1936.

A popular well illustrated account.

CARPENTER, C. R.: A field study of the behavior and social relations of howling monkeys. *Comparative Psychol. Monogr., 10:* Serial no. 48; 1934.

A study of the social life and habits of the howler monkey (*Alouatta palliata*) on Barro Colorado Island, Panama Canal Zone.

———: A field study in Siam of the behavior and social relations of the gibbon (*Hylobates lar*). *Comparative Psychol. Monogr., 16:* serial no. 84; 1940.

An invaluable study.

FYLEMAN, R.: *Monkeys.* New York, Nelson, 1936.

Intended for younger people this is a delightful book, thoroughly sound, extremely well written, and short; it may be read with advantage by all classes of readers.

HOOTON, A. E.: *Man's Poor Relations.* New York, Doubleday Doran, 1942.

One of the best available accounts of the living primates.

JONES, F. WOOD: *Man's Place Among the Mammals.* New York, Longmans, Green, 1929.

An excellent book on the primates, brilliantly written, though not always sound where factual details are brought into the discussion of controversial matters.

NISSEN, H. W.: A field study of the chimpanzee. *Comparative Psychol. Monogr. 8:* serial no. 36, 1931.

Observations of chimpanzee behavior and environment in Western French Guinea.

SCHENCK, E. T. and MCMASTERS: J. H. *Procedure in Taxonomy.* Stanford University Press, 1936.

A very useful presentation of the formal rules of taxonomy and zoological nomenclature.

SCHULTZ, A. H.: Characters common to higher primates and characters specific for man. *The Quart. Rev. Biol., 11:*259-283, 425-455, 1936.

An authoritative analysis of the comparative anatomy of apes and man.

———: Ontogenetic specialization of man. *Arch. der Julius Klaus-Stiftung* (Zurich), *24:*197-216, 1950.

A valuable study of the differences characterizing man at different stages of his development in comparison with other primates.

———: The physical distinctions of man. *Proc. Amer. Phil. Soc., 94:*428-449, 1950.

An important and original study of the physical distinctions of man as compared with other primates.

SIMPSON, G. G.: The principles of classification and a classification of mammals. *Bull. Am. Museum Natur. Hist., 85:* 1945, pp. xvi + 350.

A masterly work. Authoritatively and delightfully written, it should be obligatory reading for all students and others desiring a working knowledge of the principles of taxonomy. The author's classification of the primates is the best thus far offered, being for the first time adopted in the present volume.

SONNTAG, C. F.: *The Morphology and Evolution of the Apes and Man.* London, Bale, 1924.

Intended to serve as an introduction to anthropology, this worthy volume, illustrated somewhat primitively, gives very complete information on the anatomy and relationships of the primates with especial reference to the apes and man.

YERKES, R. M. and A. W.: *The Great Apes.* New Haven, Yale University Press, 1934.

The best and most readable account of the anthropoid apes extant.

ZUCKERMAN, S.: *The Social Life of Monkeys and Apes.* New York, Harcourt, Brace, 1932.

The standard work on the subject. Based mostly on original observations, readably and interestingly written.

———: *Functional Affinities of Man, Monkeys, and Apes.* New York, Harcourt, Brace, 1933.

An important and very readable study of the bearings of physiology and behavior on the taxonomy and phylogeny of the primates.

Chapter III

THE ORIGIN AND EVOLUTION OF THE PRIMATES

THE first known primates appeared on this earth some sixty-five million years ago, in the Middle Paleocene. In Fig. 47 will be found a systematic classification of the geologic eras, periods, and epochs, and an estimate of their duration in time, together with some of the representative forms of life which flourished therein. It is a useful thing to memorize such a time-scale, for it serves to give one a firmer grasp upon the succession of the forms of life in time than could otherwise be obtained.

During the last two decades Gidley, Jepsen, Simpson, and others, have described numerous fossil primate teeth and jaws from the Middle and Upper Paleocene of Montana and other parts of North America. Before Gidley's original discovery at Fort Union, Montana, only one doubtfully recognized primate, *Plesiadapis,* was known from the (Upper) Paleocene. Today four distinct families are recognized from the Paleocene, the Anaptomorphidae, the Apatemyidae, the Carpolestidae, and the Plesiadapidae. Several genera and a good number of species are distinguished in each of these families. The more important genera may be listed here.

FAMILY ANAPTOMORPHIDAE

Genus *Palenochtha*	Middle Paleocene of North America
Genus *Palaechthon*	
Genus *Paromomys*	
Genus *Plesiolestes*	

FAMILY APATEMYIDAE

Genus *Jepsenella*	Middle	Paleocene of North America
Genus *Labidolemur*	Upper	

FAMILY CARPOLESTIDAE

Genus *Elphidotarsius*	Middle	Paleocene of North America
Genus *Carpolestes*	Upper	
Genus *Carpodaptes*	Upper	

FAMILY PLESIADAPIDAE

Genus *Pronothedectes*	Middle Paleocene of North America
Genus *Plesiadapis*	Upper Paleocene of North America and Europe
Genus *Chiromyoides*	Upper Paleocene of France

The available remains of fossil Paleocene primates do not permit of any definite conclusions concerning the relationships of these forms to later Eocene primates. Broadly speaking the apatemyids and plesiadapids appear to be related to the primitive lemurs, while the carpolestids were possibly of proto-tarsioid origin, but do not appear to have been ancestral to any other group, whereas the carpolestids have clear genetic affinities with the tarsioids. *Palenochtha,* the most generalized type, may well be ancestral to the tarsioids. *Paromomys* might well be ancestral to the European tarsioid genus *Necrolemur,* while *Plesiolestes* (from Northern Wyoming) may represent a slightly modified and progressive descendent of *Palaechthon. Chiromyoides* from the Upper Paleocene of France is closely related to the ancestral stock of the "aye-aye."

Whatever the relationships may prove to be it is, in any event, clear that in the Paleocene there were already in existence several primate phyletic lines, but evidently less distinctly differentiated than those of the Lower Eocene.

The fossil teeth, jaws, and other skeletal remains of the earliest Eocene primates already display many well differentiated characters, indicating a past history extending over a very long period of time. These differences are so marked and significant that they render it necessary to recognize the existence, even at that remote period, of two separate infraorders, namely, the Lemuriformes and the Tarsiiformes. Both in size and proportions the Eocene lemuroids strongly resemble the existing lemuriform or Malagasy lemurs which inhabit Madagascar and the neighboring Comoro Islands. The latter may therefore be regarded as "living fossils," with the tree-shrews the surviving primitives among the primates. The fossil lemuroids are represented by a widespread family, the Adapidae, which may be divided into two subfamilies, the Adapinae and the

Era	Period	Epoch	Millions of Years Since the Beginning of Each Epoch	Forms of Life
Cenozoic The Age of Mammals	Quaternary	Recent	1/40	Man, the slave and master.
		Pleistocene	1	*Pithecanthropus, Sinanthropus, Swanscombe, Homo sapiens.*
	Tertiary	Pliocene	12	First men probably appeared during the latter part of this epoch, at present known only from eoliths.
		Miocene	28	Appearance of true anthropoid apes. *Dryopithecus, Sivapithecus, Proconsul.*
		Oligocene	39	Primitive anthropoid apes appear such as *Propliopithecus*
		Eocene	58	Spread of modern mammals.
		Paleocene	75	Appearance of insectivorous preprimates and earliest primates, primitive lemuroids and tarsioids.
Mesozoic The Age of Reptiles	Secondary	Cretaceous	135	Rise of archaic mammals and birds. Extinction of dinosaurs, pterodactyls, and toothed birds. Insectivores.
		Jurassic	165	Spread of primitive mammals and pterodactyls, rise of toothed birds.
		Triassic	205	Rise of dinosaurs, pterodactyls and primitive mammals.
Paleozoic The Age of Ancient Life		Permian	230	Spread of amphibians and insects. Extinction of trilobites.
		Carboniferous	255	Primitive reptiles, insects, spiders. Great forests of ferns and mosses.
		Devonian	325	Rise of fishes and amphibians. Spreading of forests.
		Silurian	360	Rise of ostracoderms, sea-scorpions (Eurypterids). First Land plants.
		Ordovician	425	First primitive fishes, the ostracoderms.
		Cambrian	505	Still no land-life known, trilobites, mollusks, brachiopods.
Proterozoic			925	Sponges, protozoons, diatoms, and protophyta, and other commencing complex forms of life developed during this era.
Archeozoic			1,500	Probably simple unicellular sea-dwelling forms.

Fig. 47. Geological Time-Scale of the Appearance of Various Representative Forms of Life

The estimated number of millions of years in the fourth column for the Tertiary period is based on a combination of paleontological data, with specific reference to the evolution of the horse from *Eohippus* to *Equus*, and the evidence of geology and radioactivity. The figures for the preceding periods are largely based on the uranium transformation method. When uranium and lead occur together in a fragment of rock otherwise free from these elements it may generally be safely assumed that the lead represents "decomposed" or transformed uranium. It is known that 1,000,000 grams of uranium yields 1/7600 grams of lead a year. Hence the age of such rocks can be determined from the proportions of these elements which they contain, thus:

$$\text{Age of rock} = \frac{\text{Weight of Lead}}{\text{Weight of Uranium}} \times 7600 \text{ million years}$$

Notharctinae; the former being confined to Europe with three distinct genera, *Adapis, Anchomomys* and *Pronycticebus,* with several species; the latter, the Notharctinae, comprising the genera *Notharctus, Pelycodus of* North America, and *Protoadapis* of France. Because both tarsioids and lemuroids occur there at earlier horizons than elsewhere in the world the probability is high that North America was the birthplace of the primates.

Some 20 or more genera of fossil tarsioids have been described nearly three-fourths of which occur in America, and the remainder in Europe.

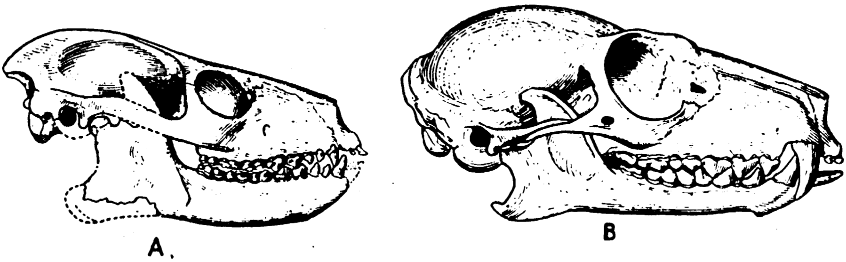


FIG. 48. A, Skull of the Eocene Lemur, *Notharctus.* B, Skull of Modern Lemur. (Redrawn after W. K. Gregory.)

The early lemuroids differ from the early tarsioids in having, on the whole, retained a greater number of primitive characters, e.g., more dependence upon smell and less upon sight, less peculiar specializations in the skeleton for leaping from branch to branch, and a less developed brain. The tarsioids, on the other hand, display many of those morphological changes which made the subsequent development of man possible. The Prosimii were, as almost all primates continue to be, tree dwellers.

But from what group of animals were the Prosimii themselves derived? We have already seen that the evidence indicates that they were derived from an Upper Cretaceous group of insectivores which very closely resembled the existing tree-shrews of the family Tupaiidae (Fig. 49).

The adoption of the habit of living in the trees by some of those early shrews put a premium upon those characters which would best enable these creatures to pursue an arboreal existence. A terrestrial existence demands of the four-footed animal that in its search for a living it keep its nose, as it were, to the ground. The forefront, and greater part, of the primitive vertebrate brain was a smell-brain, a receptor for odors from the external world, and this fact determined the patterns of development of the brain of the earliest mammals. When, however, such a mammal takes to the trees, a nervous receptor-organ such as the brain which is dominantly olfactory, must undergo certain readjustments if the species is to make the proper adaptations and survive. In the trees the sense of smell is not as important as the sense of vision. With all four feet flat on the ground it is easy to smell out edible objects and pick them up with one's jaws. But up in the trees the problem is entirely different. It is necessary to see one's food rather than to smell it out, and when it has been seen it must often be caught on the wing by a jump to another branch and held by the forelimbs, while the supporting branch must be grasped by the hindlimbs at the same time. Insects must be caught in flight, grubs and worms picked out of the bark with finger and nail after they have been smelled or the visual signs of their presence detected. Delicate adjustments in equilibrium and in motor coördination, in the sense of hearing, in the sense of touch, and, indeed, in all the faculties of discrimination, are necessary.

FIG. 49. The Tree-shrew (*Tupaia ferruginea*).

Thus it came about that for orientation in space and for recognition of objects in that space the sense of vision was developed by arboreal mammals into a much finer mechanism than ever before.

In the course of several millions of years the accumulation of variations favoring animals pursuing an arboreal life resulted in the various Prosimii.

It is the development in the importance of the sense of vision which led to the birth of the primates, and it was arboreal life which provided the conditions favoring such a development. The fossil Prosimii show highly specialized divergent changes in the structures subserving the senses of smell and vision, both in the skeleton and the soft tissues as they may be interpreted from the latter, and by comparing the fossil forms with their living descendants. From the lateral position which they occupy in earlier forms the eyes now tend to assume a more frontal position, although it is only in the Lorisidae and in *Tarsius* that this position is actually achieved among prosimians. The cone cells of the retina practically entirely disappear in most forms, leaving the rod cells only. This latter specialization is associated with the nocturnal habits of the Prosimii, for they have poor vision in daylight and excellent vision at night. They spend the daylight hours in sleep and are most active at night. How this habit came into existence we do not know, though it would be easy enough to suggest that it was probably of some adaptive value.

In the Tarsiiformes the visual areas of the brain are somewhat more complex and relatively larger than in the Lemuriformes, and there is every reason to believe that this was equally true in the early tarsioids. In the latter the eyes underwent an enormous increase in size, resulting in the development of the largest eyes, in proportion to the size of the head, to be found in any mammal. This is well seen in the surviving species of the Tarsiiformes, *Tarsius spectrum*. In the tarsioids vision became the dominant sense, definitely usurping the position once occupied by smell as the principal guide to the animal, thus surpassing the lemurs in whose life olfaction still plays a dominant rôle.

The gradual development of the sense of vision constitutes probably the most important single factor in the evolution of the primates. It vastly extended the "space of recognition."

It has already been pointed out that the freeing of the forelimbs for the handling of objects promotes the development of the hand and the specialization of each of the digits to perform those remarkably fine and complex adjustive movements of which the human hand is perhaps the most perfect example. Not only does the opposability of the thumb to the other digits of the hand become possible, but the ground work is fully laid for the development of the erect posture—a possibility not to be fully realized until the appearance of the first men in the Pleistocene.

The nocturnal mode of life of the Prosimii demands considerable auditory acuity, and here again, as between both groups, the sense of hearing is more highly developed in the tarsiers than in the lemurs, and was presumably so in their Eocene ancestors.

Thus, it may be perceived that because the Eocene primates learned to rely primarily on vision rather than on the sense of smell for the exploration, recognition, and apperception of their environment, there commenced a progressive development of all their senses, with the exception of that of smell which was destined to undergo a very thorough retrogression. The most important result of this revolutionary change was to produce a corresponding development of those centers of the brain which could integrate the disparate sensory stimuli into a "unity of apperception." Those centers are situated in what is termed the neopallium of the endbrain. Simulataneously a considerable involution occurred of that part of the endbrain which subserves the sense of smell, the so-called "rhinencephalon."

The neopallium contains the largest part of the "cortex" or external "gray matter" (pallium) of the brain into which lead tracts from all the non-olfactory senses. Particular areas of the neopallium receive particular kinds of stimuli. Between these cortical areas there are numerous and very intricate connections which render possible the coordination of different kinds of stimuli. There are, moreover, areas in the cortex which send out fibers relaying "motor" impulses to the lower centers of the brain and spinal cord. But that is not all, the cortex contains association areas capable not only of association but of memory. Where there is a consciousness or sense of the past, there is concern about the future. The neopallium becomes not only a regulating and coordinating organ but also a computing machine for the prediction of future events and thus for the choice of goals to be actively achieved. As it grows and develops, it more and more frees the organism from automatic and instinctive controls and determinants of behavior, and permits the development of reflection upon the basis of past experience, and conduct, adapted to meet the ends which the organism consciously seeks.

The neopallium has attained its greatest growth and highest development in man, and it is because of the special properties or potentialities of his neopallium that man is able to develop that humanity of which he is capable.

Though the brains of creatures which lived many millions of years ago are not preserved, we can, from the fossil skulls and the forms very like these animals which survive today, reconstruct something of the history of the brain. We have seen how enlightening this can be for the understanding of our own history. The progressive enlargement of the neopallium and the reduction of the olfactory areas of the brain is graphically illustrated in Fig. 50, in which diagrams of the brain from insectivore to man are shown.

Eocene lemuroids did not give rise to monkeys and apes. They simply transmitted their essential lemuroid character to their lemuriform descendants, displayed to this day in the existing families and genera.

The tarsioids most probably originated from a group of insectivores similar to that which gave rise to the lemurs, but unlike the unproductive lemuroids, the tarsioids seem to have provided the material out of which all other later primates developed. A study of the living tarsiers reveals them as epitomizing in themselves, along with peculiar specializations of the teeth, skull and ankle bones, many of the potentialities for the development of all those characters which all the members of the Anthropoidea exhibit. One eminent student of the primates, Professor Wood Jones, believes that the evidence suggests that not the manlike apes but the tarsiers are man's closest living relations. The consensus of scientific opinion is, however, against this view. It is probable that some of the predecessors of the tarsiers stand basically in the line of development of all the monkeys, apes, and men, but the relationship is extremely distant. Most of the early

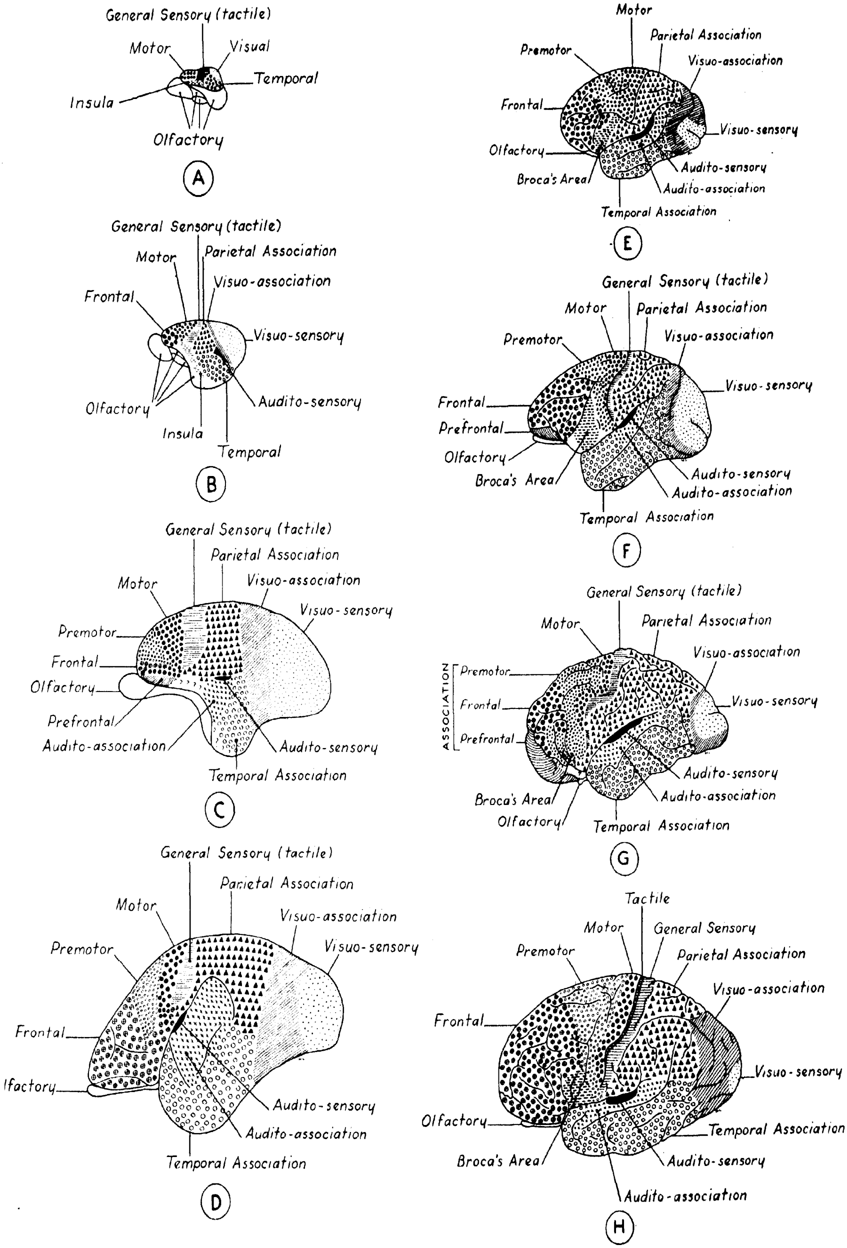


FIG. 50. A comparison of the brains of eight different types of primates. A) Jumping Shrew (*Macroscelides*), B) Tree-Shrew (*Tupaia minor*), C) Tarsier (*Tarsius spectrum*), D) Marmoset (*Callithrix jacchus*), E) Spider Monkey (*Ateles vellerosus*), F) Rhesus monkey (*Macacus rhesus*), G) Gorilla (*Gorilla gorilla gorilla*), H) Man (*Homo sapiens*). The brain sizes are not in scale.

tarsioids constitute highly specialized side-branches, but there were almost certainly in existence a group of Upper Paleocene tarsioids which were ancestral to the monkeys and apes of later geologic times, and these in turn to their existing descendants.

The geological record of the primates in the Oligocene is very poor, but we do know that by the beginning of that epoch the primates of North America had retreated before the advance of the cooler weather to Central and South America, where the existing New World monkeys, the platyrrhini, were evolved. Remains of several New World monkeys from the Lower Miocene are known from South America, chief among these being *Homunculus* from Santa Cruz in Patagonia.

It is most probable that at the same time another group of American Eocene primates migrated across one of the landbridges then existing between Asia and America, such as the Bering Straits, and by this route to the Eastern Hemisphere, to give rise to the Old World monkeys and apes, the catarrhini. Unfortunately the fossil record for the platyrrhini is very bare, and apart from the New World such fossil remains are quite unknown. It is in the Upper Miocene of Europe, and of the Siwalik deposits in India, that the chief representative fossil forms of the Old World monkeys are to be found.

It appears, then, that the Old World, as well as the New World, monkeys evolved in the Oligocene. Simultaneously in the Old World the stock leading to the Anthropomorpha was undergoing development.

In the Lower Oligocene of the Fayum oasis, southwest of Cairo in Egypt, the well-preserved lower jaw of an animal which is undoubtedly the most primitive known member of the catarrhini has been discovered. This has been named *Parapithecus*. Phylogenetically *Parapithecus* is conceived to stand in a position intermediate between the Eocene tarsioids and the higher apes. In this animal the premolar teeth were reduced from three to two in number, yielding for the first time the number of teeth characteristic of the catarrhine series, namely $I\frac{2}{2}$, $C\frac{1}{1}$, $PM\frac{2}{2}$, $M\frac{3}{3}$.

The ancestral placental mammalian dental formula was $I\frac{3}{3}$, C $\frac{1}{1}$, PM $\frac{4}{4}$, M $\frac{3}{3}$. This reduction in the number of premolars in *Parapithecus*, from PM $\frac{4}{4}$ of the ancestral placental mammalian dental formula, suggests that already at this early period the muzzle and jaws were undergoing shortening, a trend which has reached its culmination in the reduction of these parts of the face in man. In the Eocene lemurs, the Notharctinae, the fourth premolar is still retained, while the modern lemurs are characterized by three premolars.

Parapithecus was not much larger than the modern tarsier, having actually been about the size of a big squirrel. The broad rear of the jaw suggests an expanded brain and a short face. Indeed, many morphologists believe that *Parapithecus* constitutes a possible ancestor for the apes and man.

From the same deposits has been recovered the lower jaw of an animal which is remarkably anthropoid in its characters, namely *Propliopithecus*. The latter is smaller and much more primitive than the Lower Miocene *Prohylobates*, a primitive gibbon from the Burdigalian deposits at Moghara on the northern edge of the Libyan desert, and the Upper Miocene and Lower Pliocene *Pliopithecus* of Gascony which in turn closely resembles the modern gibbons.

Propliopithecus, judging from the structure of its jaw and teeth, constitutes an even better ancestor for the apes and man than does *Parapithecus*. *Prohylobates* is by some authorities believed to belong in the same genus with *Pliopithecus*. *Prohylobates* seems to be somewhat more primitive, but however this may be, both are so gibbon-like that they may be classed with the gibbons in the family Hylobatidae. Both are, therefore, off the main line of development leading to the great apes and man; such types gave rise to the gibbons, whereas a type such as *Parapithecus* possibly gave rise to *Propliopithecus*, from which in turn stemmed the various Miocene Anthropomorpha which led on the one hand to the existing apes and on the other to man. All these inferences are, of course, based upon the fact that, in the parts preserved, the characters are such as we would expect to find in an ancestral type.

Portions of the mandibles and teeth of two fossil apes, *Xeno-*

pithecus and *Limnopithecus,* from the Lower Miocene of Kenya Colony, East Africa, are of animals somewhat more than twice the height of *Propliopithecus* (which was probably not more than a foot in height), and which with *Prohylobates* and *Pliopithecus* may well represent contemporary stages in divergent lines of development from the *Propliopithecus* stock.

Among these Miocene genera of fossil Anthropomorpha one of the most important is represented by *Proconsul* from the Lower Miocene of Kenya Colony, East Africa. Parts of the skeletons of a number of individuals are known, among these a remarkably well preserved skull. Three species have been identified. *Proconsul africanus* is represented by several individuals, the best preserved yielding a fairly complete skull, the first such ever found for any Miocene ape. This discovery, as well as most others of these Miocene apes, we owe to the labors of Dr. and Mrs. L. S. B. Leakey. An earlier find had yielded a portion of the right maxilla with upper teeth of the same species. The interesting thing about the skull, discovered in 1947, is its rather cercopithecoid appearance. The skull is that of an adult, and it is intermediate in size between that of a gibbon and a chimpanzee. The skull is delicately constructed, there is no supraorbital torus, the nasal bones are relatively broad, the incisive region of the upper jaw is narrow, and the nasal aperture is constricted, as in the cercopithecoid monkeys, at its lower extremity. The form of the intracranial cavity and the convolutional impressions on the inner aspect of the frontal and parietal bones make it clear that the sulcal pattern of the brain must have conformed closely to the cercopithecoid brain. The mandibular condyles, as in man, are somewhat outwardly rotated; the mandibular symphysis (the junction in the midline of the two sides of the jaw) is short; there is a reduction in the size, and an increase in the breadth index, of the premolars and first molar; a simian shelf, the transverse plate of bone at the back of the lower part of the mandibular symphysis in the modern apes, is absent; the length of the premolar and molar teeth is reduced; there is a forward convergence of the tooth rows, unlike the paralleling or even divergence in the modern apes; the canine teeth are strongly developed, and the anterior lower premolars have a sectorial form.

Proconsul major is represented by the right side of a mandible with the second premolar and all the molar teeth. Discovered by the Leakeys in 1947, the body of this mandible is massively constructed, and evidently belonged to an animal closely approximating the gorilla in size.

Proconsul nyanzae, described in 1943 by MacInnes, was discovered by Leakey on Rusinga Island. This is represented by an

FIG. 51. *Proconsul africanus.* (Photo, courtesy Dr. L. S. B. Leakey.)

almost complete mandible of an adult with only the right canine and four incisor teeth missing. Removed from the same deposits but not found in direct association with any of the *Proconsul* remains were two thigh bones, a humerus, part of a clavicle (all found in association), and the foot bones, the talus and calcaneus, of a single individual. In their dimensions these bones resemble those of the chimpanzee, but in many of the details of their structure these bones more closely resemble the cercopithecoid limb bones than they do those of the modern great apes. From the structure of their limb bones it would appear that the *Pronconsul* group was not adapted to an arboreal brachiating mode of life. On the contrary; they seem to have been constructed on a quadrupedal plan like the cercopithecoid monkeys.

Clearly the Lower Miocene apes were extremely primitive. The form of their limbs was of a sufficiently generalized character to have allowed the evolutionary development of the locomotor specializations of the Pongidae on the one hand and those peculiar to the Hominidae on the other.

Evidently the derivation of man from a stock which had not passed through an arboreal stage of evolutionary development is quite compatible with the view that that stock was of anthropoid type.

From the generalized Lower Oligocene tarsioid *Parapithecus* probably sprung the tarsiers, the New and Old World monkeys, and the anthropoid *Propliopithecus*. From *Propliopithecus* the lines leading to the later anthropoids and to man very likely took their origin. The divergent evolution of the anthropoid and hominid lines may therefore be said to have commenced in the Upper Oligocene, about 30,000,000 years ago. According to this theory an early anthropoid stage in the evolution of man is postulated, with later anthropoid types tending in the human direction.

Some authorities interpret the facts to indicate that man never passed through an anthropoid stage of development but originated from either a tarsioid or generalized catarrhine monkey either in the Eocene or early Oligocene. Still others hold the view that the separation of the anthropoid and human lines occurred in the Upper Miocene, some ten to fifteen million years ago. These authorities believe that the two genera of Middle and Upper Miocene apes, *Dryopithecus* of Europe and *Sivapithecus* of Asia, possess the characters to be expected in the common ancestors of the higher apes and man. These two genera had an extremely wide range in the eastern hemisphere from Spain in the west to India in the east, south to East Africa, and even to South Africa. At present more than a dozen nominal species of *Dryopithecus* are known, and about half that number of species of *Sivapithecus*. Most of these fossil apes are known from portions of their upper and lower jaws and associated teeth alone, and these parts indicate that these creatures were fairly unspecialized apes. Gregory and Hellman cite many dental characters suggesting that *Sivapithecus* may be more closely related to the orang than to man, while *Dryopithecus,* the European member of the group may be nearer to the chimpanzee-gorilla-man division.

Since these extinct apes are, for the most part, known only from their jaws and teeth, and only occasionally from other parts of the skeleton, conclusions regarding their phylogenetic relationships have had to be drawn from detailed studies principally of the teeth. For such studies the scientific world is principally indebted to the fundamental work of Professors W. K. Gregory and Milo Hellman of the American Museum of Natural History. Such studies yield valuable indications respecting such relationships, but they are at best only indications. Each of the 32 teeth in the adult dental series, as well as each of the 20 teeth in the deciduous or milk dentition, has, as it were, its own character. Each cusp, each fissure between the cusps, and each ledge and surface, has its special significance. Studied in the light of the significance of each of these many dental characters the probable relationships of these fossil apes to one another, and of these in turn to the later apes and to the family of man, the Hominidae, are cogently suggested.

We see not so much a gradual evolution towards the hominid type of jaws and teeth, as the development of a great many variant forms. Some have manlike anterior and apelike posterior teeth or *vice versa,* still others have such specialized canine teeth that, because of their resemblance to those of the chimpanzee and gorilla, we are led to believe that some such types must have been ancestral to the modern African apes. On the other hand, in certain members of the *Dryopithecus-Sivapithecus* stock, such as *Dryopithecus rhenanus* and *Sivapithecus sivalensis,* the dentition has retained many primitive features, and is of such a nature that it would take but a few slight modifications to produce the characteristic dentition of man. Nevertheless, even these forms exhibit specialization of the canine and first premolar teeth which render improbable their being in the direct line of man's ancestry.

Dryopithecus, for example, has sectorial premolars, while the older *Propliopithecus,* like later *Homo,* has bicuspid premolars. For some authorities this difference is alone sufficient to exclude *Dryopithecus* from the ancestry of man.

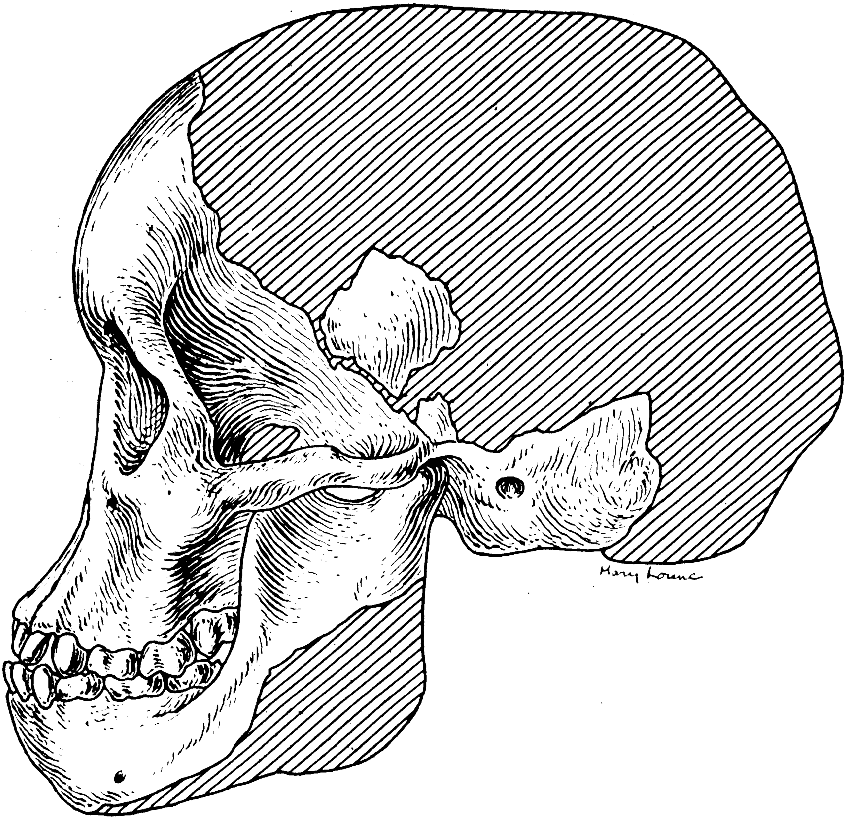


FIG. 52. *Australopithecus africanus* (right side reversed).

The common ancestor of man and the great apes must have been a relatively unspecialized small ape, and precisely such an ancestor is supplied by the Lower Oligocene *Propliopithecus.*

The mistaken notion is occasionally encountered that scientists believe man to be descended from one or another of the living great apes. Such a view is quite contrary to what scientists in fact believe. In *The Descent of Man* (1871) Darwin took special pains to emphasize this point, saying "We must not fall into the error of supposing that the early progenitor of the whole Simian stock, including man, was identical with, or even closely resembled, any existing ape or monkey." The accumulating evidence since Darwin's day indicates ever more clearly that man and the living great apes are collateral, and not lineal, descendants from the same stock.

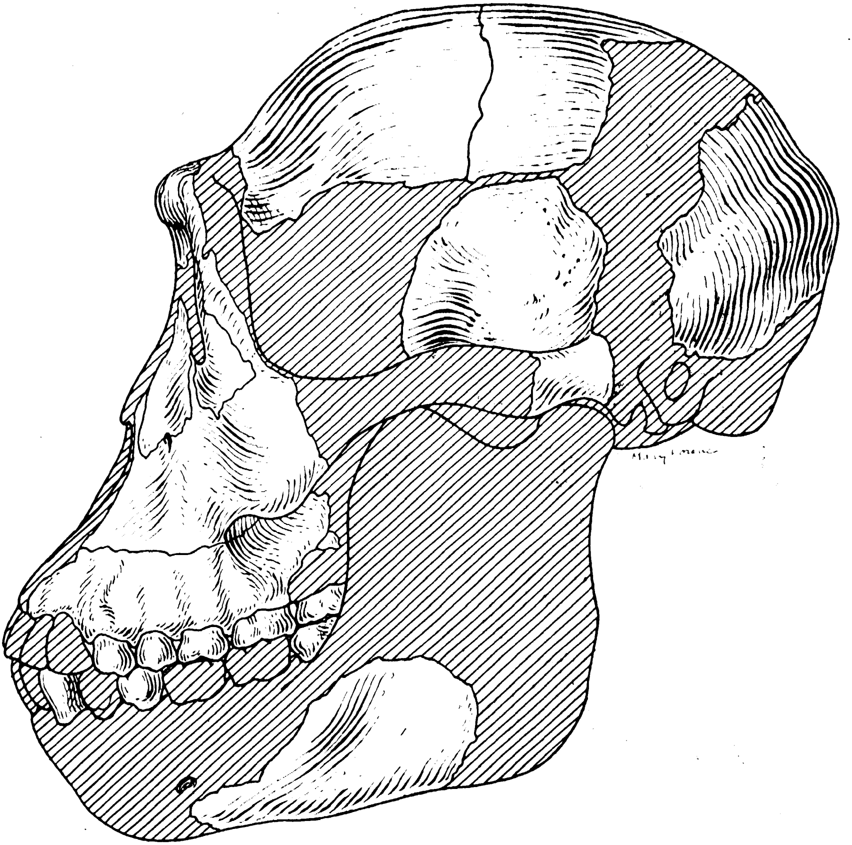


FIG. 53. *Plesianthropus transvaalensis* (reconstruction using parts of the right and left sides). (Based on the reconstruction by Gregory and Hellman (1945).)

Since their divergence from the common ancestral stock they have pursued their evolutionary paths quite independently of one another.

It is most fortunate that in the last quarter of a century knowledge has become available of a stock which had already almost passed over into the Hominidae; this is represented by the subfamily of australopithecine apes of South Africa.

In the Pleistocene of South Africa there have been found the fossil remains of several manlike apes, *Australopithecus africanus, Australopithecus prometheus, Plesianthropus transvaalensis, Paranthropus robustus, Paranthropus crassidens,* and *Telanthropus capensis.* These are extremely important finds, for they represent a stage in evolution at which an ape is seen virtually merging into man.

The juvenile skull of *Australopithecus* was blasted out of a quarry at Taungs in Bechuanaland in 1924. The age of the formation from which it came is believed by Broom to belong to the Middle Pliocene or the lower part of the Upper Pliocene. The evidence, however, does not support an age older than the Lower Pleistocene. The almost complete skull with the milk teeth and first permanent molars in an excellent state of preservation is equivalent in age to a modern child of six years. The teeth are remarkably manlike though their size exceeds that of man. The premaxilla is well developed, as in anthropoids, and there is a typical anthropoid premaxillary diastema, the space in the upper jaw between the lateral incisor and canine teeth, measuring some 4.2 mm. Cranial capacity is 500 c.c., with estimated cranial capacity for the adult of 600 cc. (Fig. 52).

Plesianthropus was blasted out of a cave at Sterkfontein in the Transvaal in 1936 from a deposit of Middle Pleistocene age. At that time the remains of at least four and possibly seven individuals were recovered. These include the nearly complete skull without mandible of a young male, the almost perfect right maxilla of a female, the crushed and fragmentary skull of an old male, and part of the mandible of a young male. Teeth were well represented, and the manlike postcranial bones were represented by the lower end (with part of the shaft) of a femur, part of a digital bone, and one wrist bone (capitate). On the facial portion of the skull the remains of the premaxillary suture are visible, and also a small premaxillary diastema between the lateral incisor and canine. The canine teeth, judging from the preserved lower left one, are well developed and project beyond the level of the remaining teeth, but more closely resemble the human than

FIG. 53A. Skull of *Plesianthropus transvaalensis.* Found 18 April 1947. (Courtesy, Dr. R. Broom and Mr. J. T. Robinson.)

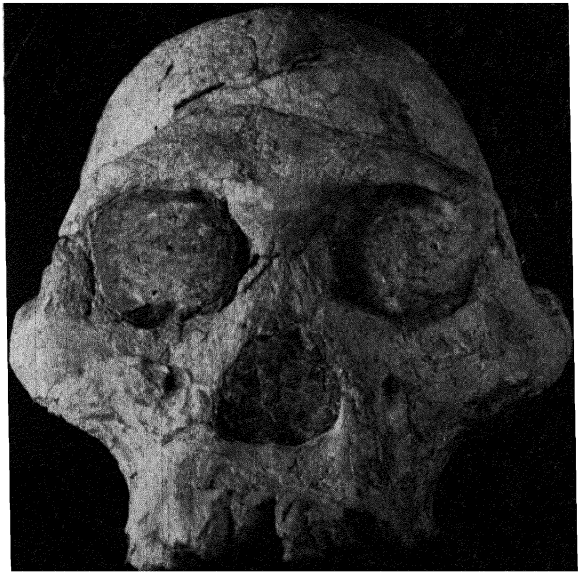


FIG. 53B. Frontal view of skull of *Plesianthropus transvaalensis.* (Courtesy, Dr. R. Broom and Mr. J. T. Robinson.)

they do the anthropoid type. The third permanent molar had fully erupted and showed signs of wear, while the coronal and sagittal sutures were still completely patent, thus suggesting a growth period comparable to that of man. The cranial capacity is 560 c.c. (Fig. 53).

FIG. 53C. Inner side of right pelvic arch of *Plesianthropus transvaalensis.* A small part of the ilium has been gnawed off. The pubis and part of the ischium have been broken and displaced. Found 1st August 1947.

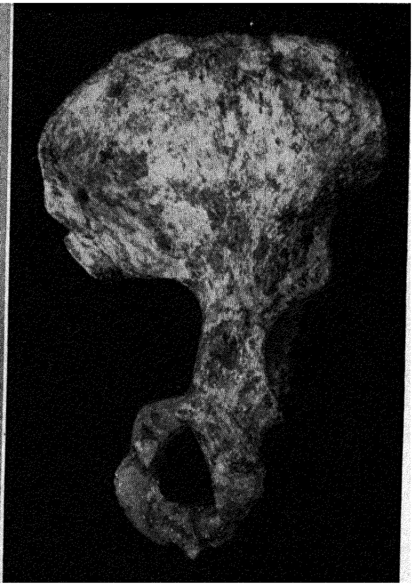


FIG. 53D. Outer side of right pubic arch of *Plesianthropus transvaalensis.* Photographs of pelvis as found. (Photos, courtesy of Dr. R. Broom and Mr. J. T. Robinson.)

In April 1947, within a few feet of the 1936 discovery, Broom found part of the upper jaw of a young male, the upper jaw of a child of about three years, the upper canine of a male of about 30 years, the lower molar of a female of about 40 years, the complete skull, without mandible and teeth, of an elderly female, and later the manlike pelvis and upper half of a femur. All are assigned by Broom to *Plesianthropus.* The milk teeth of the child, according to Broom, are practically identical with those of the Bushman child (Figs. 53A to D).

Paranthropus robustus was found at Kromdraai, two miles east of Sterkfontein, in 1938 in a Middle Pleistocene deposit. Two individuals are represented, the greater part of the skull of an adult male together with the lower end of a right humerus, a portion of the right ulna, a left metacarpal with two phalangeal bones, two toe bones, and a talus. The remains of the second individual are represented by a much weathered mandible of a three or four year old child with the milk teeth in almost perfect condition. The mandible was found some four feet from the adult specimen. As is usual in adult anthropoids the premaxilla is united with the maxilla, and it is quite evident that the premaxilla was of the

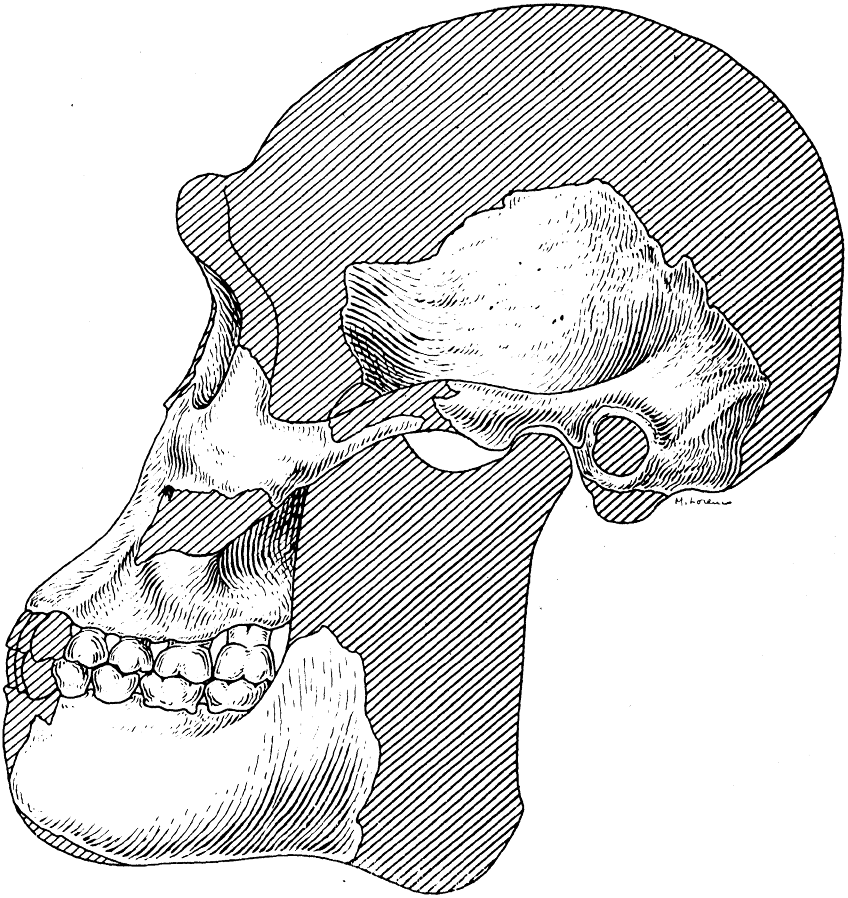


Fig. 54. *Paranthropus robustus*. (Redrawn after Broom.)

anthropoid type, with a premaxillary diastema of about 3.0 mm. In man the premaxilla is completely overgrown on the face save in a small number of infants in which the apical portion of the premaxilla is partially visible; a diastema (with the exception of *Pithecanthropus robustus*, see p. 137) is normally never present in man. The cranial capacity of *Paranthropus robustus* is 650 c. c.

The evidence provided by the limb bones of *Plesianthropus* and *Paranthropus* indicates that they habitually walked erectly or nearly erectly and that their hands were of the hominid type, being in no way adapted for the middle-knuckle obliquely quadrupedal manner of progression characteristic of the great apes. The pelvic bones of *Australopithecus* and *Plesianthropus* prove that the erect or nearly erect posture was habitual to the australopithecines. The small brain of these australopithecines, scarcely larger than that of the gorilla or chimpanzee, associated with manlike limb bones makes it quite clear that in the stage of evolution represented by these australopithecines the erect posture had already been attained when the brain was still of ape-like proportions. At this stage, too, the teeth were already distinctly manlike. It has been argued that these facts support the inferences which have been drawn from the evidence of comparative anatomy that many of the characters of the living anthropoid apes, such as the tusk-like canines and the large incisors accompanied by the mandibular simian shelf, the exaggerated development of the supraorbital torus, the powerful brachiating arms, and certain features of the hindlimbs, are to be regarded as aberrant specializations, and not as primitive features to be sought for in the ancestors of man.

It is, indeed, highly probable that these characters were absent in the immediate prehuman stock which gave rise to man, and it is agreed by almost all authorities, that the living anthropoids exhibit highly specialized characters which were developed *after* their divergence from that much earlier stock from which they originated together with the line which led to man. A distinction must be recognized between the remote anthropoid stock from which the *line* originated which led to man, and the anthropoid stock from which he immediately originated. Whether the former was a brachiating type remains to be determined, the latter was almost certainly not.

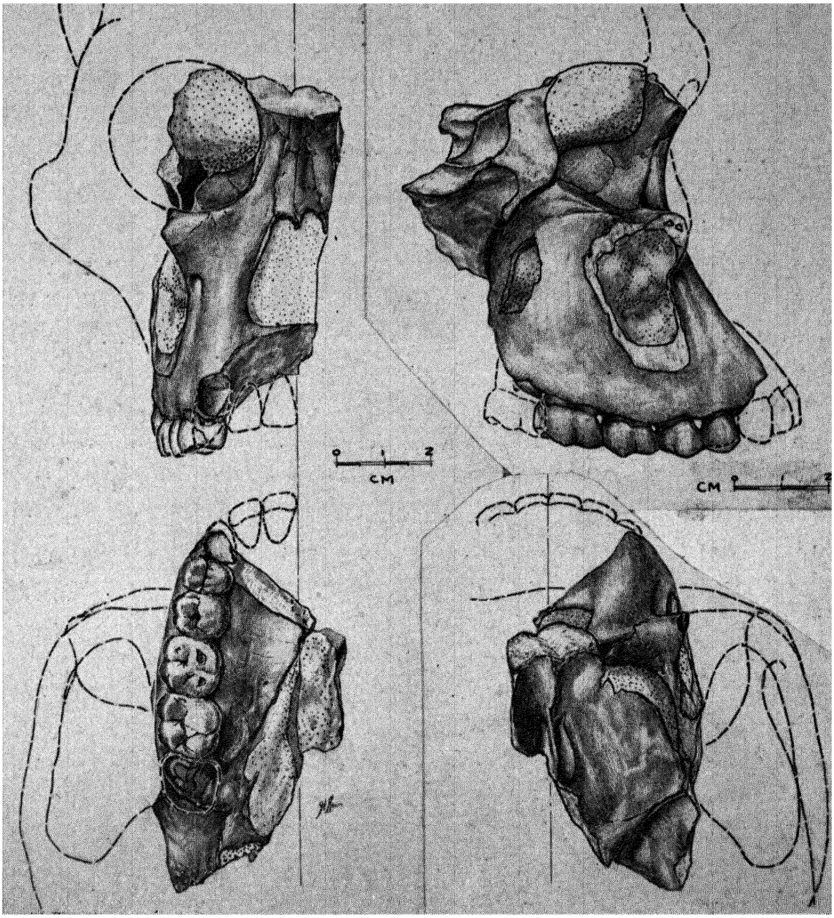


FIG. 55. *Australopithecus prometheus.* The cranio-facial fragment in four views. Anterior (upper left), lateral (upper right), palatal (lower left), from above (lower right). (From Dart. Courtesy *Am. J. Phys. Anthrop.*)

The attainment of hominid or human status is associated with the following three attributes: (1) the erect bipedal posture; (2) virtually complete emancipation of the hands; and (3) speech. The australopithecines had attained the first two; they virtually appear to have achieved the third.

In September 1947, a calvarial fragment of another australopithecid was found in a deserted limeworks dump on the farm Makapansgat some 13 miles northeast of Potieterarust in the Central Transvaal, about 200 miles to the northeast of the Taungs-Plesianthropus district of the Southern Transvaal, South Africa. The fragment consists of the major portion of the occipital bone, including most of the right margin of the foramen magnum and the posterior third of each of the parietal bones. It has been identified as having come from the basal gray fossiliferous stratum of the Cave of Hearths. This, together with the associated mammalian fauna, indicates a late Villafranchian or early Pleistocene age.

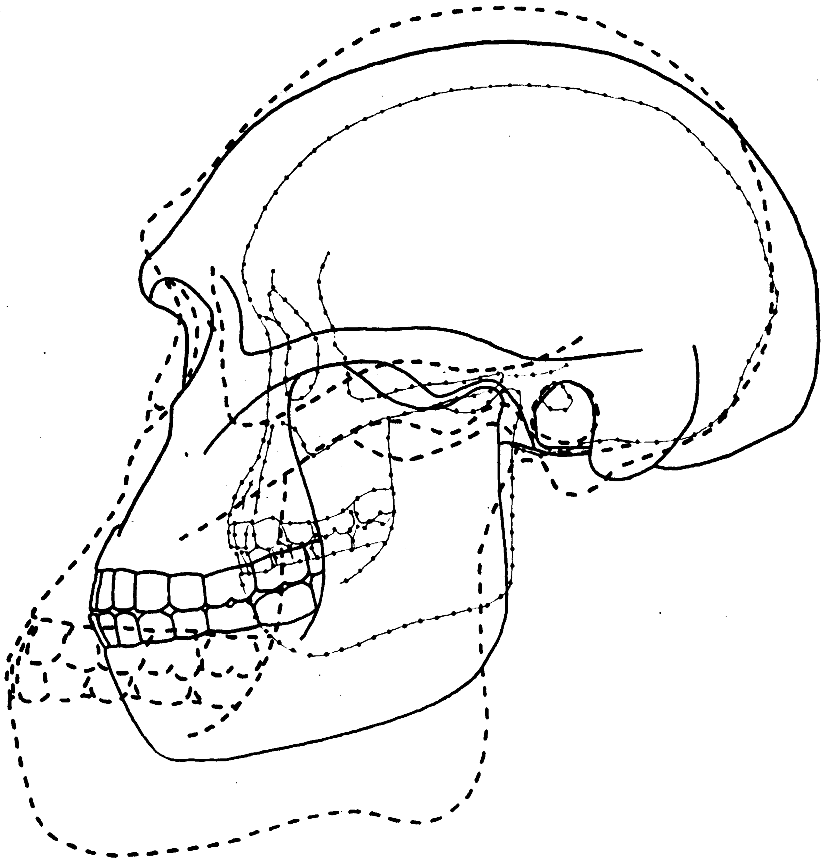


FIG. 56. Craniograms of *Australopithecus africanus* (infant) —·—·—·—·—, *Australopithecus prometheus* ♀———, and *Paranthropus robustus* ♂------. One half normal size. (From Dart. Courtesy *Am. J. Phys. Anthrop.*)

The bones are those of a mature adult and are extremely thick, varying between 6.0 and 13.0 mm., the base of the occiput is very broad, there is a moderately developed occipital torus, a transverse occipital suture is present, the external occipital protuberance is inferiorly situated in relation to the point which marks the most distant one from the front of the skull (the opisthocranion), the cerebral surface of the occipital bone is 5030 mm.^{2} as compared with 864 mm.^{2} in the chimpanzee. All these features are claimed by Dart to distinguish this fragment as human, and he has assigned it to a new species of the australopithecine group, namely, *Australopithecus prometheus.*

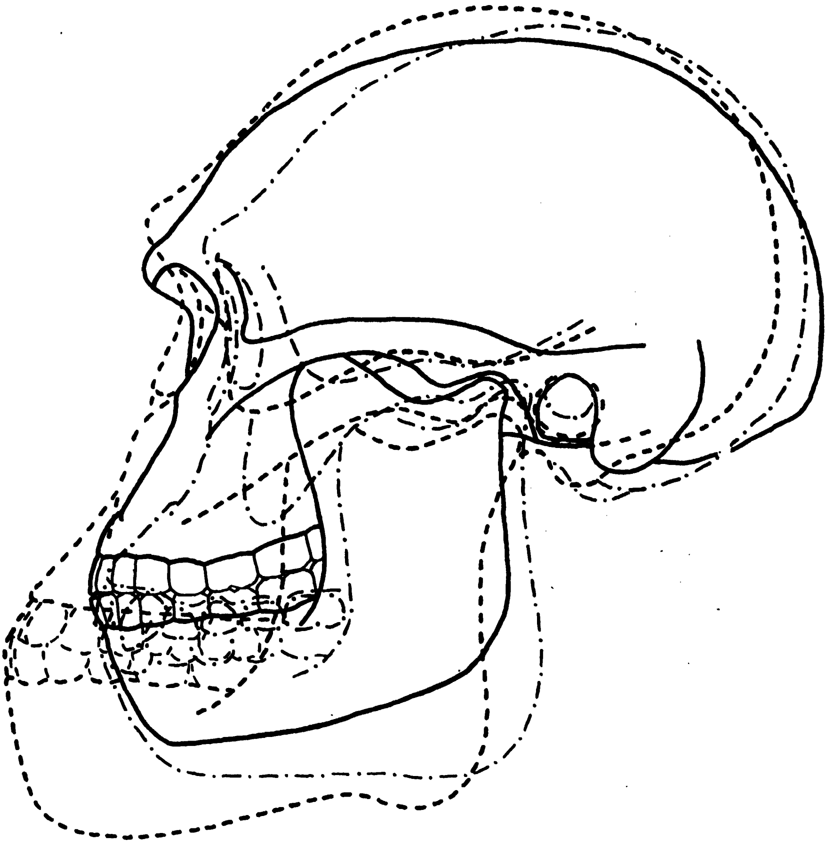


FIG. 57. Craniograms of *Australopithecus prometheus* ———, *Plesianthropus transvaalensis* ♂ —·—·—·—, and *Paranthropus robustus* ♂ – – – – –. One half natural size. (From Dart. Courtesy *Am. J. Phys. Anthrop.*)

Australopithecus prometheus was a small animal, but its cranial capacity was not less than 650 c.c.

Dart makes the startling claim that the evidence indicates *Australopithecus prometheus* was a big game hunter, who not only used bone implements, but was also acquainted with fire. Numerous smashed skulls and split bones of almost every type of big game characteristic of the eastern riverine savannah testify, Dart believes, to the hunting skill and manual dexterity of this species. That the prometheans used fire Dart believes is suggested by the chemical and microscopic analysis of glassy and ashy materials and charred bones excavated from the basal gray bone breccia.

In July 1948, some 20 feet from the site in which the occiput was found, there was discovered the almost perfect body of the mandible and dentition of an approximately 12 year old adolescent *Australopithecus prometheus.* The jaw is chinless, and a simian shelf is not present. The form and crown patterns of the teeth are even more humanlike than those hitherto described in any previous australopithecine.

In November 1948 Broom discovered a massive fossil manlike mandible in the deposits on the Swartkrans farm, about a mile from the main Sterkfontein quarry. Two perfectly preserved upper incisors and an upper canine were also found some 10 feet from the site of the mandible. Broom believes these teeth to belong to another individual of the same species. These teeth, according to Broom, are almost typically human, though a little larger than most human teeth. The teeth in the mandible are relatively large.

Broom believes that the Swartkrans find is related neither to *Australopithecus* nor to *Plesianthropus,* but is allied to *Paranthropus.* On the basis of its distinctive characters Broom has assigned the remains of this giant ape-man of Swartkrans to a new species of the genus *Paranthropus,* namely, *Paranthropus crassidens.*

During 1949 and 1950 Broom and Robinson discovered many more remains at Swartkrans of *Paranthropus crassidens.* Many skulls are now available, two almost complete, three perfect lower jaws, and two complete but somewhat crushed skulls of children of about seven years of age. Imperfect skulls of half a dozen other individuals and some 300 teeth, the well preserved right half of a pelvis, and various other bones of the skeleton have been recovered.

The incisor and canine teeth are typically human in form and size, the premolar and molar teeth, however, while human in form are much larger than in modern man. The lower jaw in some of the female specimens has quite a distinct human chin. The massive lower jaw is associated with a well-developed sagittal crest, to which the temporal muscles which move the lower jaw are attached. This sagittal crest on top of the skull is similar to that which is seen in the male gorilla. The orbits are overhung by a confluent supraorbital torus, and the large, flat face terminates in a prognathous upper jaw, upon which the premaxilla is quite as evident as it is in any of the apes. A premaxillary diastema is, however, not present. This is an extremely interesting fact, for it indicates that in the evolution of man the canine tooth first underwent reduction, that this was later followed by reduction of the premaxillary diastema, and that the overgrowth of the facial portion of the premaxilla by the maxilla occured with the reduction of prognathism. That this represents the probable course of events is borne out by the fact that in *Pithecanthropus robustus* the canine is reduced, but the premaxillary diastema remains well developed in the male, as presumably does the facial portion of the premaxilla. The inference from this would be that prognathism was more marked in *Pithecanthropus robustus* than in *Pithecanthropus erectus* in whom the canine teeth and the premaxillary diastema were reduced.

Broom estimates the cranial capacity of *Paranthropus crassidens* to be well over 900 cc., in the males possibly as high as 1050 cc., thus falling within the range of man.

The whole right side of the pelvis of *Paranthropus crassidens* has been recovered. This is entirely manlike, except for the form of the ischium which is more like that of an ape. From the form of the pelvis as a whole it may be concluded that *Paranthropus crassidens* habitually walked more or less erectly.

We have, then, in *Paranthropus crassidens* a being with a brain as large as that of some men, a lower jaw with a manlike chin in several instances, manlike teeth in both jaws, and a manlike pelvis, but with a skull retaining many apelike features such as the sagittal crest, the supraorbital torus, the facial premaxilla, and an apelike nose. Is it ape, man, or man-ape? Whatever we decide to call it *Paranthropus crassidens* represents a form very like that from which man himself must have originated.

In the summer of 1949 Robinson and Broom discovered at Swartkran's the crushed complete skull of a young male of about 7 years of age, the almost perfect lower jaw of a huge male together with the lower part of the face, and the upper jaw and palate with the premolar-molar teeth *in situ,* all referred to *Paranthropus crassidens.*

That large manlike forms lived in South Africa during the Pleistocene, and probably earlier, need not surprise us. We know such forms from Java, namely, *Meganthropus* and *Gigantopithecus.* Africa was almost certain to supply them. We may expect to hear of the discovery of others in due time.

What do these "giant" forms mean? Do they mean that man must have passed through a stage of gigantism during the course of his evolution? There is no evidence that the line of man ever passed through such a stage. On the contrary, the evidence indicates that throughout his history man's stature has never exceeded, nor fallen below, the range of variation for stature which characterizes the human species at the present day. The occurrence of "giant" manlike forms in any geographic group of animals may be explained as probably due to the fixation of mutations either through the action of natural selection or genetic drift or the complementary action of both.

In the cave at Swartkrans which yield the jaws and skulls of the huge ape-man *Paranthropus crassidens,* on 29 April 1949 Mr. J. T. Robinson found the lower jaw of a new type of man. This has been named *Telanthropus capensis.* The jaw is nearly perfect except for the loss of most of the left condyle and the whole of the right. A very small part of the lower symphyseal region is lost. The general appearance is not unlike that of the Heidelberg jaw, according to Robinson and Broom. The ramus is broad but short, and so is the cranio-caudal extent of the body. The height of the jaw from base to condyle is 55.0 mm. There is no simian shelf, and the mylohyoid groove runs up to the mandibular foramen, as in human skulls. The teeth are slightly larger than human. The third molar is the largest of the series, unlike man. The incisors and canines, so far as can be judged from the sockets, are human in form. In *Plesianthropus transvaalensis* the three molars measure in the male about 43.0 mm; in *Paranthropus robustus* about 45.0 mm. In *Paranthropus crassidens* about 51.0 mm, while in *Telanthropus capensis* they measure 38.4 mm. In the South African native the molars measure 35.0 mm.

Robinson and Broom regard *Telanthropus capensis* as possibly allied to Heidelberg man, and as intermediate between ape-man and true man.

In June 1949 Dart published a description of the craniofacial fragment of an adult, probably female, Australopithecine skull from the Makapansgat Limeworks dump. By ingenious casting it was possible to restore this fragment sufficiently well to obtain a good idea of the form of the face, palate, and teeth, as shown in Fig. 55. The fragment probably belonged to the same individual whose occiput formed the holotype of *Australopithecus prometheus.* The maxillary premolars and the first and second molars were preserved *in situ.* The craniograms shown in Figs. 56 and 57 indicate how closely *Australopithecus prometheus* resembles *Australopithecus africanus.*

In the same month, June 1949, Dart announced the discovery, at Makapansgat, of an almost complete left ilium and the major portion of a right ischium of an australopithecine adolescent, which may have belonged to the same adolescent individual whose mandible was found in the same dump of breccia, and which was referred to *Australopithecus prometheus.* As may be seen from the dioptographic drawings shown in Fig. 58 the pelvic bones of this australopithecine are strikingly manlike, closely resembling those of the living Bushman and differing markedly from the anthropoid chimpanzee pelvis. The pelvis of *Australopithecus prometheus* is more manlike than that of *Plesianthropus* discovered at Sterkfontein, some 200 miles southward in the Transvaal. Dart points out that the external iliac surface is anteriorly and medially rotated in *Australopithecus prometheus,* a fact which shows that the gluteal muscles necessary for the maintenance of the erect posture were disposed on the lateral aspect of pelvis and thigh

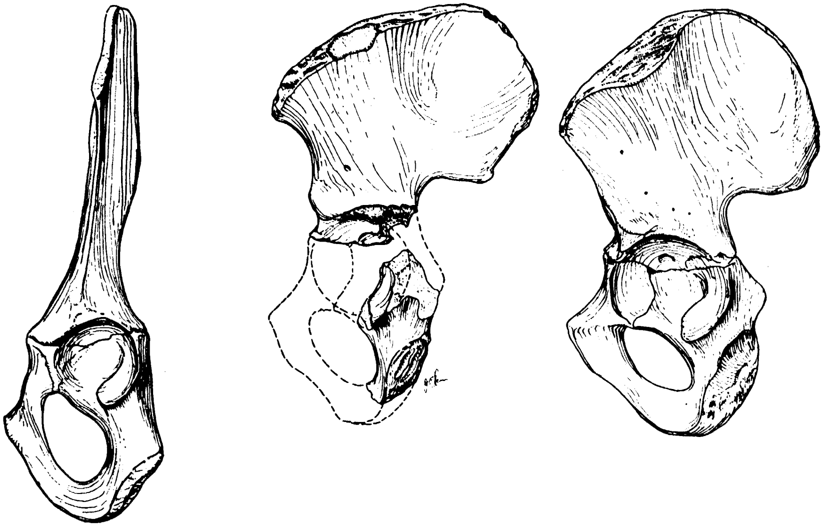


FIG. 58. Left lateral views of innominate bones in chimpanzee (left), *Australopithecus prometheus* (center) and Bushman (right). Male adolescents taken from dioptographic tracings of the assembled pelvis. (From Dart. Courtesy *Am. J. Phys. Anthrop.*)

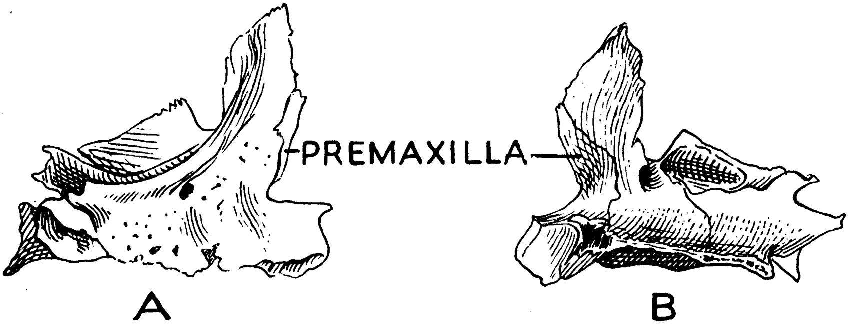


FIG. 59. Upper jaw of a newborn male (Negro) showing A, a portion of the premaxilla upon the facial aspect of the skull, and B, the whole of the ascending process of the premaxilla within the nasal fossa.

essentially as in man. The indications are, therefore, that *Australopithecus* was capable of standing and walking erectly in approximately human fashion.

In June 1950 Broom and Robinson announced yet another discovery in the main deposit of the cave at Swartkrans, the very same deposit from which the remains of at least 10 individuals of *Paranthropus crassidens* have thus far been recovered. The discovery represents a considerable portion of the right side of a lower jaw with the first and second much-worn molars *in situ*. Broom and Robinson believe the jaw to be the relict of an early man, and they are certain that it is contemporaneous with *Paranthropus crassidens,* though manifestly differing from that form both in size and in other characters. The new jaw does not differ very much in size from that of *Telanthropus capensis,* and the discoverers are uncertain as to whether it may belong to the latter species or not. There is no simian shelf, and the front of the symphysis was probably rounded. The jaw is rather deep towards the front of the body, but is not more massive than in most modern jaws. The first molar measures about 12.3 mm. in length, and the second 12.9 mm. in length and 12.3 mm. in greatest breadth.

In the Australopithecines it seems fairly evident that we are dealing with a single genus represented by several polytypic species.

Gregory and Hellman believe that the australopithecine group were derived from the *Dryopithecus-Sivapithecus* stock of the late Tertiary, and that they represent the conservative cousins of the contemporary human branch. On the other hand, Weidenreich, Broom and Schepers believe that the australopithecines separated from the typical anthropoids at a pre-dryopithecid stage probably as early as the Lower Oligocene and that the earliest hominids, possibly the pithecanthropoids, arose from a form very near to *Australopithecus* in the Pliocene.

It has already been mentioned that the size of the teeth in the australopithecines is somewhat larger than are the teeth of any known form of man, with the exception of *Meganthropus palaeojavanicus* and *Gigantopithecus blacki* (see p. 133), otherwise they are remarkably manlike in character. This difference in size is regarded by von Koenigswald as significant, for the larger teeth of the australopithecines, according to him, must be regarded as a specialization which precludes these forms from being ancestral to man; the size of the teeth in relation to the size of the brain indicating an animal too large to be an ancestor of man.

The fact, however, is that during the process of evolution teeth do undergo a reduction in size, and as for bodily size Broom has estimated that the australopithecines were small animals weighing between 80 and 100 pounds.

It is quite possible that the australopithecines pursued a parallel evolution with early men since Lower Pliocene times, and may even have originated from a common Pliocene ancestor. In the latter case they would best be regarded as a side branch stemming from the main line which led to man.

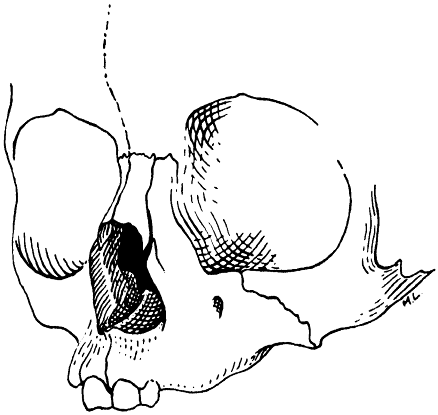


FIG. 60. Cranio-facial aspect of the skull of a white infant aged about 11 months showing the apical portion of the premaxilla separated from the maxilla. Within the nasal cavity the premaxilla and its suture (indicated here by a white line) are clearly visible in their entirety.

Wood Jones has recently (1947) argued that since the premaxilla is of anthropoid type in the australopithecines man could not have originated from such a stock. This argument is of doubtful cogency, for only the very slightest genetic changes would be required to transform the australopithecine into the hominid type of upper jaw. In the evolutionary series immediately leading to man it would appear that so far as the upper jaw is concerned there was first, a reduction in the size of the canine teeth (e.g., *Australopithecus*), followed second, by overgrowth of the premaxilla by the maxilla with retention of the premaxillary diastema (*Pithe-*

canthropus robustus), and third, complete reduction of the premaxillary diastema (*Pithecanthropus erectus* or *Sinanthropus*).

It is probable that the hominid type of upper jaw has been derived from an anthropoid type of upper jaw in which the premaxilla was suturally separated upon the face from the maxilla. When in early fetal life the fusion of premaxilla with maxilla has been retarded the relationship between these bones are seen to be exactly as in the anthropoids, and differing substantially from the condition seen in other primates, at least, as far as the form of the suture separating the two bones is concerned (see Fig. 59). Furthermore, portions of the premaxilla may occasionally be seen on the facial aspect of human crania as late as the fifth year (Fig. 60).

Among the widely dispersed and variegated Tertiary apes it is quite impossible to point with any certainty to any one form and say: This is the animal which, without any intermediate stages of development, gave rise to the earliest men.

In the present state of our knowledge one can only point to the australopithecines and say, that while no one of them may have been directly ancestral to man, a type very like them must have been; which is to say that the manlike apes from South Africa are man's nearest present known relatives, and that there may have been one or more stages of development between a form like them and the appearance of the first man. There cannot have been, however, more than a few such intermediate stages for the australopithecines have themselves almost made the passage into the family of man, the Hominidae, to the rise of which we shall give our attention in the next chapter.

Darwin's conclusion, in *The Descent of Man* (1871), that mankind originated from an early unspecialized anthropoid ape has to-day been so strengthened by the investigations of innumerable workers that it has come to be generally, though by no means universally, accepted by scientists.

The facts show that man and the anthropoid apes constitute a natural group, the superfamily Hominoidea, characterized by the common possession of hundreds of known diagnostic characters which separate them as a group from the remainder of the primates.

CHRONOLOGICAL-CULTURAL TABLE OF THE DIVISIONS OF PREHISTORY AND OF THE HISTORIC PERIOD

	Age	Alpine and Scandinavian glacial oscillations with corresponding changes of sea level and climate	Approximate dates	Principal Culture Stages of Europe, Egypt, and the Near East			Human Types
				Northwestern Continental Europe	West Central Europe	Egypt and the Near East	
	Power Tools		A.D. 1900	Rise of the Age of Power Tools			
	Old New STEEL		A.D. 1850	Steel Age Develops			
			A.D. 1700	Steel (carbonised iron)			
Late	IRON	Present conditions of Mya Period in Baltic Area	A.D. 1000				
			A.D. 500	Viking Age			
Middle				Roman Period of Iron Age			
			0	Iron Age Introduced	Historic Times		
Early		Final land rise in Baltic area or Late Tapes Period	500 B.C.		Iron Age Introduced		
			1000 B.C.	Bronze Age Introduced		Iron Age Begins	
	BRONZE		1500 B.C.	Traces of Copper	Bronze Age Introduced		
			2000 B.C.	Late Neolithic with thick poll axe	Copper Age Introduced	Bronze Age Begins	
	COPPER		2500 B.C.			Alloys in use	
Late	NEO-LITHIC		3000 B.C. 3500 B.C.	Middle Neolithic with thin poll axe	Late Neolithic	History Begins	
Middle		Sea rising, Ragunda retreat, with Littorina Sea (Early Tapes Period) preceded by late Ancylus Lake	4000 B.C. 4500 B.C.	Early Neolithic: Shell mound or Campignian industry Ertebølle industries	Middle Neolithic or Robenhausian industry	Use of Iron Begins	
Early			5000 B.C.	Norse industry with petroglyphs	Early Neolithic or Campignian and Asturian industries	Use of Copper Begins	
	MESO-LITHIC		5500 B.C.			Amratian industry	
			6000 B.C.	Maglemose industry		Badarian industry	
		Ragunda pause with Ancylus Lake	6500 B.C. 7800 B.C.	Lyngby industry	Azilian, Tardenoisian, and Capsian industries	Tasian industry	

FIG. 61

UPPER	PALEOLITHIC	Fini-Glacial pause with Baltic ice-lake	8500 B.C.		Late Magdalenian		Chancelade
		Fini-Glacial pause with Baltic ice-lake	13,500 B.C.		Early Magdalenian and Capsian industries	Probable beginning of Neolithic culture in Nile Valley floor silts	Předmost *Baker's Hole* Rhodesian Cro-Magnon
		Gothi-Glacial retreat with Baltic ice-lake			Solutrean industry. Late Aurignacian industry		
		Gothi-Glacial pause with Baltic ice-lake	18,500 B.C.		Early Aurignacian or Châtelperronian and Capsian industries	Sebilian industry of Nile valley terrace silts	Châtelperron Grimaldi, Cro-Magnon Africanthropus, Solo
MIDDLE		Würm or Aachen and Dani-Glacial retreats with Frankfort and Pomeranian pause. Flandrian terrace	50,000 B.C.		Final Mousterian of the caves	Late Mousterian of the 10 ft. Nile terrace	Boskop
		Würm and Brandenburg or Dani-Glacial advances. **4th glacial**			Mousterian of the caves		Florisbad, Skhūl, Gibraltar II, Piltdown, *Wadjak*, *Keilor*
		Riss retreat with Monastirian terrace. **3rd Interglacial.** Hot summer	75,000 B.C. 150,000 B.C.		Contemporary Acheulian, Early Mousterian, Tayacian, Micoquian, Levalloisian, and Clactonian industries from Somme terrace, etc.	Early Mousterian of the 30 ft. Nile terrace	*London* Tabūn, Neanderthal, Ehringsdorf Fontéchevade
LOWER		Riss and Polonian Advances. **3rd Glacial**	250,000 B.C.		Derived implements		*Bury St. Edmunds* Swanscombe *Gigantopithecus*
		Mindel retreat with Tyrrhenian terrace. **2nd Interglacial**	450,000 B.C.		Acheulian and contemporary Abbevillian and Clactonian industries from 2nd Somme terrace. Clacton-on-Sea, Mesvin, etc.	Acheulian industry of the 50 ft. Nile terrace	*Steinheim* Heidelberg Sinanthropus Pithecanthropus erectus
		Mindel advance. **2nd Glacial**	550,000 B.C.		Derived implements		Pithecanthropus robustus
		Günz retreat with Milazzian terrace. **1st Interglacial**	600,000 B.C.		Proto-Abbevillian industry from below the Cromer forest beds and 3rd Somme terrace	Abbevillian and Early Abbevillian industries of the 100 ft. Nile terrace	Pithecanthropus (Modjokerto) *Meganthropus* *Kanam*
	ARCHEOLITHIC	Günz Advance. **1st Glacial** PLEISTOCENE	1,000,000 yrs.		Pre-Abbevillian or Ipswichian flake industry of East Anglian Crag formations	?	
		PLIOCENE Donau with Sicilian terrace			Pre-Abbevillian or Ipswichian flake industry of subcrag formations		
				Eolithic stage?	Eolithic stage?	Eolithic stage?	

In using this table it should be understood that the approximate dates assigned to the different "Ages" refers only in a general way to the areas mentioned. As the table indicates these "Ages" were not everywhere contemporaneous. The different "Ages" do not afford a measure of time, for they varied in different parts of the world both in the time of their appearance and in their duration, while some of the cultural stages they embrace never appeared at all, but were completely skipped in the progress from one cultural stage to another. These ages are therefore to be regarded as *cultural or technological* rather than as chronological periods. It is extremely important to grasp this fact. There was no world-wide evolution from one stage to another, each stage represents an industrial revolution in the manufacture of tools which occurred in different places at different times, nor did the several stages begin and end simultaneously all over the world. Thus, to give a simple example, the Early Iron Age began in Asia Minor about 1200 B.C., in Italy about 1000 B.C., in central Europe about 900 B.C., in China about 700 B.C., in southern England about 600 B.C., in Japan about A.D., 200, and in Fiji about 1872. Compare this table with Fig. 111 p. 214, and note the difference in dating. In the last column names in *italics* refer to types which are uncertainly dated.

FOR FURTHER READING, CONSULT:

Broom, R. and Schepers, G. W. H.: *The South African Fossil Ape-Men, the Australopithecinae.* Pretoria, Transvaal Museum Memoir No. 2, 1946.
The official account of the australopithecines.

———: *Commemorative Volume.* Cape Town, Special Publication of the Roy. Soc. South Africa, 1948.
Contains a series of excellent papers on South African anthropology, and Broom's ideas and contributions.

———:The genera and species of the South African fossil ape-men. *Am. J. Phy. Anthropol.,* n.s. *8*:1-13, 1950.
A generic analysis.

———: *Finding the Missing Link.* London, Watts, 1950.
Broom's personal very lively account of the discovery of the South African ape-man.

———, Robinson, J. T., and Schepers, G. W. H.: *Sterkfontein Ape-Man Plesianthropus.* Pretoria, Transvaal Museum Memoir No. 4, 1950.
A first-hand account of the remains of *Plesianthropus.*

——— and Robinson, J. T.: One of the earliest types of man. *South African J. Sc.,* 47:55-57, 1950.
A short account and restoration of *Paranthropus crassidens.*

——— and Robinson, J. T.: Notes on the pelves of the fossil ape-men. *Am. J. Phys. Anthropol.,* n.s. *8*:489-494, 1950.
A description of the right pelvis of *Paranthropus crassidens* with a discussion of the pelves of the other australopithecinae.

Clark, W. E. Le Gros: *Early Forerunners of Man.* Baltimore, Wood, 1934.
A morphological study of the evolutionary origin of the primates.

———: *History of the Primates: An Introduction to the Study of Fossil Man.* London, British Museum (Natural History), 1949.
A most excellent and readable introduction.

———: New palaeontological evidence bearing on the evolution of the Hominoidea. *J. Geol. Soc.,* (London), *105*:225-264, 1949.
A brilliant account and discussion of *Proconsul* and the australopithecines.

——— and L. S. B. Leakey: The Miocene Hominoidea of East Africa. *Fossil Mammals of Africa,* No. 1, British Museum (Natural History), 1951.
A thorough description of the East African primates discovered by Leakey, *Proconsul, Sivapithecus,* and *Limnopithecus.*

Darwin, C.: *The Descent of Man.* London, 1871 and later editions.
The classic work on the probable manner of origin and evolution of man.

Elliot, D. G.: *A Review of the Primates,* 3 vols., New York, American Museum of Natural History, 1913.
A monumental, much used, but not entirely reliable, work on the characters and classification of the primates. To be used with caution.

Forbes, H. O.: *Monkeys,* 2 vols. London, Shaw, 1894.
On the characters and classification of the primates, in many ways more attractive and reliable than Elliot's work, though lacking the latter's invaluable plates of crania.

Gregory, W. K.: Studies on the evolution of the primates. *Bull. Am. Museum Natur. Hist., 35*:239-355, 1916.

A classic work on the evolution of the primates, abundantly illustrated.

——— and Hellman, M.: The dentition of the extinct South African Man-Ape *Australopithecus (Plesianthropus) Transvaalensis* Broom. A comparative and phylogenetic study. *Ann. Transvaal Museum, 19*:339-373, 1939.

A study of the dentition and phylogenetic relationships of the australopithecines.

———: *The Origin and Evolution of the Human Dentition.* Baltimore, Williams & Wilkins, 1922.

The best book on the subject, containing far more general material than the title suggests.

———: *Man's Place Among the Anthropoids.* New York, Oxford, 1934.

A good account and discussion of the morphological relationships of the anthropoid apes, fossil and living, to man. Valuable also as an example of the manner in which controversial points are handled. The theories and claims particularly criticized are those of Wood Jones.

———: The bearing of the Australopithecinae upon the problem of man's place in nature. *Am. J. Phys. Anthropol., 7*:485-512, 1949.

A most important study.

Hooton, E. A.: *Up From the Ape,* revised edition. New York, Macmillan, 1946.

An amusingly written account of man's evolutionary and morphological relationships to the primates.

———: *Man's Poor Relations.* New York, Doubleday, Doran, 1943.

A sound popular account of the lemurs, tarsiers, monkeys, and apes.

Hopwood, A. T.: Miocene primates from Kenya. *J. Linnaean Soc., London* (Zoology), *37*:437-464, 1933.

A description of the first find of *Proconsul africanus* and other primates found at Koru in East Africa.

Jones, F. Wood: *Man's Place Among the Mammals.* New York, Longman's, 1929.

A brilliant and original work in which an attempt is made to sustain the hypothesis that man is derived from a tarsioid stock. Discusses the primates fully but not always accurately. For a critical examination of Wood Jones' theories and claims, see M. F. Ashley Montagu's "The Tarsian Hypothesis and the descent of man," *J. Roy. Anthropol. Inst., 60*:335-362, 1930.

Koenigswald, G. H. R. Von: *The South African Man-Apes and Pithecanthropus.* Washington, D.C., Carnegie Inst., 1942, publication, 530, pp. 205-222.

An important study.

MacInnes, D. G.: Notes on the East African Miocene Primates. *J. East African and Uganda Natur. Hist. Soc., 17*:141-181, 1943.

A description of the four specimens of *Proconsul africanus* and other fossil primates found in East Africa. An invaluable study.

Romer, A. S.: *Man and the Vertebrates,* 3rd edition. Chicago, Univ., Chicago Press, 1941.

A most excellent and attractively written book on the origin and evolution of the vertebrates, including the primates, abundantly illustrated.

Ruch, T. C.: *Bibliographia Primatologica*. Springfield, Illinois, Thomas, 1941.

The best and most exhaustive classified bibliography on studies of every kind relating to the primates.

Smith, G. Elliot: *The Evolution of Man,* (2nd edition). New York, Oxford, 1927.

A good general introduction to the morphological aspects of physical anthropology, containing a very clear account of man's primate ancestors.

Straus, Jr., W. L.: The riddle of man's ancestry. *Quart. Rev. Biol., 24*:200-223, 1949.

A most interesting criticism of the "anthropoid-ape" theory of man's origin. The author cites some of the evidence which suggests man's derivation from unspecialized, monkey-like quadrupeds.

Yerkes, R. M. and A. W.: *The Great Apes*. New Haven, Yale, 1934.

The best, and most readable, all-round account of the anthropoid apes. The history of our knowledge of these creatures, their external characters, behavior, and intelligence, is here interestingly recounted. The illustrations are numerous and illuminating.

Wilder, H. H.: *The Pedigree of the Human Race*. New York, Holt, 1926.

The great value of this book lies in the efficient manner in which the mammalian and primate relationships of man are stated and discussed, with a minimum of discursiveness. In details Wilder is not always sound but in general he is reliable enough for the reader to derive great benefit from his book.

Zuckerman, S.: *Functional Affinities of Man, Monkeys and Apes*. New York, Harcourt, 1933.

A study of the bearings of physiology and behavior on the origin, relationships, and the classification of the lemurs, monkeys, apes, and man.

Chapter IV

THE ORIGIN AND EVOLUTION OF MAN

IF THE theory is sound that man originated from an anthropoid stock, it would follow as a necessary inference that the earliest men ought more closely to resemble such a stock than do the later evolved types. And this, at least in the earliest types, is precisely what we find.

The question may well be asked: If such early men so much resembled apes, how is it possible to determine at what point an animal ceases to be an ape and becomes a man? This is always a good question to ask, and it is an important one. Let us try to answer it.

Whether the skeletal remains of an animal represent those of an ape or of a man is a matter which is determined in much the same way as we determine the status of any living animal, namely, by its resemblance to other known forms. If it is unique, then we ask the obvious question: Does it more closely resemble the one group, say the ape, or the other, say man? Or does it, perhaps, resemble them both equally? Is it then, an intermediate type?

These are the kinds of questions that the physical anthropologist or paleoanthropologist asks, and the answer he returns depends primarily upon the weighing of the results of his analysis of the structural characters of a given specimen. It is not necessarily the number of the resemblances involved which matters, though this is important, so much as the quality of those resemblances. Thus, for example, ape-like canine teeth and the absence of a chin are characters found together only among the apes. When one or both of these characters is found in any mandible the suggestion is that we are dealing with an ape, but when in the same skull we find a cranial capacity very substantially exceeding that of an ape and falling within the range of that of man, such a single fact would alone qualitatively outweigh any quantity of ape-like characters. Such an aggregation of characters has actually occurred in more than one example of fossil man. Usually the form of the vault of the head and of the jaws, and the size and form of the teeth are alone sufficient to make the differentiation between ape and man clear.

Apes do not habitually walk erectly. When, therefore, we find evidences of the habitual assumption of the erect posture, we have a pretty definite indication of the attainment of hominid or near-hominid status.

In the following pages a description is given of the most significant fossil forms of man. Insofar as it is possible to do so this will be followed by a discussion of their general relationships. Before proceeding further, however, a few words are necessary on the subject of the nomenclature used with respect to fossil man. In its present form this nomenclature is most misleading.

When the first fossil manlike remains were discovered the differences presented by these from any other known form of man led students to place them in distinct genera. Thus, Java man was named *Pithecanthropus erectus,* Piltdown man was distinguished as *Eoanthropus dawsoni,* and continuing this trend Peking man was distinguished as *Sinanthropus pekinensis* even though this form clearly represents no more than a geographic race of *Pithecanthropus.* As more and more fossil remains were discovered the gaps between the already known fossil types were narrowed, and the earlier known types at once lost the appearance of extremes. The tendency was now to regard most types of fossil man as representing different species. Today it is slowly beginning to be recognized among anthropologists that with the possible exception of the recently discovered fossil giant ape-men, *Meganthropus* and *Gigantopithecus,* all fossil and living forms of man probably belong to the same polytypic species, the different types representing geographic or temporal races or subspecies. If and when this viewpoint becomes generally accepted an entire revision will become necessary of the names which fossil men have hitherto been given. Such a revision can be satisfactorily achieved only by an international commission. Man is a zoological species and the taxonomic rules of nomenclature should be applied to him just as they are to any other animal.

If all forms of man, fossil and living, belong to a single species, then the generic and specific names which have priority are the names originally bestowed by Linnaeus upon man, *Homo sapiens.* The distinctive types of man, fossil and living, would then be distinguished as subspecies or races of *Homo sapiens.* Without the common agreement of a commission of experts on the names which should be substituted for those now in use it would perhaps be confusing to attempt any change at this time. However, without the necessary cautions it is misleading to continue to use the old names, for these names have a way of distorting the facts and of forcing thought concerning the evolution of man in a direction which does not correspond with the facts. Names which correspond more closely to the facts, and which lead one to think more accurately are to be preferred. As Julian Huxley has pointed out, the basic theoretical aim of taxonomy is the accurate description of organic diversification in nature. With these cautions, then, we may proceed.

The order of the descriptions followed in these pages is morphological. That is to say, each type is described in the order, roughly, of its decreasing physical resemblance to some imagined anthropoid ancestral type. Such an order of description has the effect of producing a linear view of the relationship of these types to one another against which the reader must be cautioned. The reason for preserving the morphological order of description here is that it does effectively serve to convey some idea of the kind of changes which occurred during the evolution of the various types of man. The important point to remember is that many of these changes probably occurred at the same time level, that is, horizontally and *not* vertically, in geographically separated groups of the species, and hence that many of these forms were contemporary potentially or actually interbreeding groups.

We have already seen in the discussion of the non-human primates (pp. 27-28) that most groups of such primates which have been described as species are probably nothing but geographic races of a single polytypic species. The evidence clearly shows that the same holds true for man. It will be recalled that a species was defined as a group of actually or potentially interbreeding natural populations, which is reproductively isolated from other such groups. The actual or potentially interbreeding populations may be recognized as subspecies or geographic races, the subspecies or races being defined as populations which differ from one another in the incidence of one or more genes. Such populations comprise a single polytypic species, that is to say, a species is made up of a number of populations, each of which is a more or less self-contained breeding unit, which differs from other such breeding units in the incidence of certain genes.

All forms of fossil and living man fall within the limits of this conception of a species.

Morphologically the variation presented by the Hominidae is of the continuous kind; there are very few striking discontinuities or gaps between one group and another, and this is true even when early types such as the Java men are compared with modern man. As Dobzhansky and Weidenreich have independently pointed out, the available evidence indicates that no more than a single hominid species has existed at any time level during the Pleistocene. Whatever races existed within the species either interbred or were capable of doing so.

These views mirror the biological facts, and are supported by modern genetics and the findings of the new systematics. We shall return to their discussion a little later in this chapter.

As we shall see, types very like modern man almost certainly lived contemporaneously with pithecanthropoid types; and it is now quite clear that such types lived prior to the advent of Neanderthal types and subsequently absorbed them.

Several further methodological considerations are in order here. Since the orthogenetic or straight-line conception of the evolution of man from a "primitive" to a more "advanced" stage of man was a basic tenet of most anthropologists' faith, up to very recent times, it was considered that the earliest types of men must have been morphologically "primitive" (nearer to the ancestral form), while the later types were less so, becoming morphologically more "advanced" as time progressed (further removed from the ancestral form). It was in this way that morphological evolution and Time became associated, according to the formula: the more "primitive" the form the earlier in time, the more "advanced" in form the later in time.

Since it was believed that the original ancestral stock of the earliest men was an anthropoid group not unlike an "unspecialized" group of chimpanzees or gorillas, it followed that the forms of man most closely resembling the postulated ancestor would be more "primitive" than those forms of man which showed more resemblance to modern man,—modern man being conceived to be the latest product of the primate evolutionary process. This seemed to be a reasonable enough theory. It was, however, based on several assumptions, and reasonable as they seemed, there is now very good reason to believe that those assumptions were unsound.

The first of these assumptions was a covert one which was for the most part unconsciously injected into the conception of man's descent from an "unspecialized" anthropoid. The theory of man's descent from an "unspecialized" anthropoid seems to be sound enough, but what is unsound is the meaning which that idea seems to have had for many students. That meaning seems unavoidably to creep into their thinking, and that is the habit of thinking of the ancestral stock of man as resembling a chimpanzee or gorilla. This habit of thought is evident in the practice of those innumerable studies which are undertaken in order to point out the likenesses and differences between these apes and man. A consequence of this habit of thought is that any manlike form which in some of its characters strongly resembles these apes is regarded as clearly more primitive than any form which shows fewer resemblances to them. The image of a living ape or even its skeleton makes much more of an impression upon the mind than the scrambled mess of fragments of a hundred fossil jaws and teeth. But in fact we have good reason to believe that the existing great apes are highly divergent and specialized forms which in many respects probably bear considerably less resemblance to the common stock from which they and man originated than does modern man! Hence, it is suggested that it is a mistake to evaluate the degree of primitiveness or advancement of a character by reference to the standard of an animal resembling the living great apes. The great apes have almost certainly departed very much more considerably from that common ancestral stock than has modern man. It would, almost, be more in keeping with the evidence today to utilize modern man as a standard by which to measure the primitiveness or development not only of any other form of man, but even of the anthropoid apes!

Contemporary man possesses a large number of morphological and functional traits of a highly unspecialized, rather primitive, creature. As we shall see, in subsequent pages of this book, taken altogether the evidence today very strongly suggests that contemporary man represents the persisting form of an early unspecialized type, whereas other forms of man, such as the Pithecanthropoids and Neanderthaloids, represent specializations away from a type closely resembling contemporary man.

The second erroneous assumption was to equate "primitiveness" with morphologically "brutal" traits, and "advancement" with morphologically gracile traits. The third erroneous assumption has already been touched upon, namely, the equation of "primitiveness" in the brutal sense with early appearance in time, and the equation of "advancement" in the sense of the less brutal, more gracile form with later development in time.

Unfortunately, some of the terms we shall have to use in this book enshrine some of these errors of thought. For example, the term "neanthropic" refers to "new or recent man," meaning what it suggests, namely; that the latest type of man is the newest type of man. This, it has already been suggested, there is good reason to believe, is untrue. Yet the term (coined by Sir Arthur Keith in 1925) is now widely used to refer to the modern type of man. It will do no harm if we realize what is the matter with it, particularly if it is strictly used—as we intend—throughout this book, to refer to *the morphological type of man persisting into the contemporary period, wherever, and in relation to whatever time, he is found upon this earth.*

The term "paleoanthropic man" ("old or ancient man") was used in connection with the phase of man which was believed immediately to have preceded the appearance of neanthropic man, namely, Neanderthal man. The idea behind the original coinage of the term is unsound. We shall, however, retain the term in the sense of *a morphological type of prehistoric man, ranging from Pithecanthropus to Neanderthal* man, which has become extinct.

The sense in which these terms have been used by other students may be exemplified in the practice of Weidenreich and of Kroeber.

The Pithecanthropine types are called Archanthropinae by Weidenreich, and Protoanthropic types by Kroeber. The Neanderthaloids, Solo, Heidelberg, Rhodesian, and Mount Carmel men, are called Paleoanthropinae by Weidenreich, and Paleoanthropic types by Kroeber. The Neanthropinae are, according to Weidenreich's usage, recognized as presenting two phases: the Upper Paleolithic phase, and modern man. In Kroeber's usage the term Neanthropic refers to the men of the Upper Paleolithic, who " differed from us only as a subspecies or race."

If these terms are to be used at all it might be wiser to restrict the term "Protoanthropic" man to such forms as the Australopithecines, and to *Gigantopithecus* and *Meganthropus.*

Since neither the term paleoanthropic nor neanthropic should carry temporal implications, one may speak of late or early paleoanthropic types, and similarly of early or late neanthropic types. In general, it may be said that early neanthropic man closely resembles contemporary man in every way except for the characteristic possession of somewhat thicker cranial bones. Examples, are Kanam (of which the anterior part of the mandible is alone known (Fig. 108), Swanscombe, and Fontéchevade II man. The development of thinner cranial bones appears to have occurred during the Upper Pleistocene.

It is important to remember that the greater part of man's evolutionary development falls within the Ice Age or Pleistocene, a period from which the earth has only just emerged. During the Pleistocene ice-caps were formed at varying intervals in the polar and temperate regions of the earth with appreciable effects upon the climate everywhere. The intervals between the periods of glaciation were characterized by climates very different from those of the present day. Pleistocene man was forced to adapt himself to these climatic changes, but since they occurred at a very gradual rate the processes of his cultural adjustment were correspondingly extended over considerable periods of time.

.Let us now proceed with the description of the more important types of fossil man.

Meganthropus palaeojavanicus. In the year 1941 Dr. G. H. R. von Koenigswald, a Dutch geologist, discovered the fragments of two lower jaws in the Lower Pleistocene beds of Sangiran in Central Java. These probably belonged to the earliest form of man known. The jaw is considerably larger in size, and particularly in thickness, than the jawbone of any hitherto known form of man.

For this reason, and with reference to the region in which it was found it has been named *Meganthropus palaeojavanicus.* Weidenreich, comparing this jaw fragment with the same parts in the great apes, estimates that *Meganthropus* reached the size, stoutness and strength of a big gorilla. The only other known hominid jaw which approaches this in size, is the Swartkrans jaw discovered by Broom at Sterkfontein in South Africa in November 1948 (see p. 114).

Gigantopithecus blacki. Between the years 1934 and 1939 von Koenigswald found, in the drawers of Hong Kong Chinese apothecary shops, three man-like molar teeth. These consisted of right and left lower third molars belonging to different individuals, and an upper molar most probably belonging to a third individual. The size of the teeth is enormous. The volume of the crown of the lower third molar is about six times larger than the average crown of the equivalent tooth of modern man, it is almost twice as large as the corresponding tooth of the gorilla, and about one-third larger than that of *Meganthropus.* Dr. von Koenigswald considered that the first retrieved lower molar was that of a giant anthropoid, and so he named the creature to which it belonged *Gigantopithecus* (and in honor of Davidson Black who discovered the first tooth of *Sinanthropus* under similar conditions) *blacki.* When Dr. von Koenigswald showed this tooth to the author of this book in the spring of 1937 there was no doubt in the latter's mind that its crown pattern was distinctively human and not anthropoid. This view has been fully confirmed by Weidenreich's study of all three teeth. These are the teeth of an early giant form of extinct man. As Weidenreich suggests, this extinct form of man should properly be called *Gigantanthropus.* Since, however, it is contrary to the rules of nomenclature to change a name once given, on the grounds of unsuitability, the earlier name must stand. Broom, it may be mentioned here, is of the opinion that *Gigantopithecus* actually represents a giant australopithecine. The Swartkrans jaw lends some support to this view.

The age of *Gigantopithecus* is probably lower Middle Pleistocene.

It is possible that there is a genetic relationship between *Meganthropus* and *Gigantopithecus,* and that either one or both stand in ancestral relationship to the other Sino-Malayan hominids, namely, the Javanese *Pithecanthropus* group and the Chinese *Sinanthropus* group. But upon these points very little further can be said until additional evidence becomes available.

The existence of such giant forms of early man as *Meganthropus* and *Gigantopithecus* may serve to explain the thickness especially of the cranial bones in subsequent forms of early man—the persistence of an inherited tendency rather than the development of a novel feature. All the evidence certainly points in such a direction. From this it would appear to follow fairly clearly that in the evolution of man there has been a progressive tendency toward reduction in massiveness or, to put it positively, toward the development of a greater gracility in all features of the skeleton.

Pithecanthropus erectus*, Skulls *I, II,* and *III. When the remains of the first so-called "ape-man" were found at Trinil, in Central Java, in 1890-97, the problem of its status at once arose. The find consisted of a skull vault, a fragment of the lower jaw, three teeth, and a complete left thigh bone. Each of these remains were discovered at different times, and at varying distances from one another. The fragment of jaw was found at Kedung Brubus, 22 miles from Trinil, the skull and the femur were found within fifty feet of each other. The three teeth were found at different times near the site of the discovery of the skull-cap. For these reasons there was some doubt whether all these parts belonged to a single individual. The probabilities were that they belonged to more than one individual of the same species. Today there is some question whether the teeth did not belong to an extinct orang-utan. All the remains were discovered in an horizon which is now generally agreed to be of Middle Pleistocene age, a fact which would endow the creature or creatures to which they belonged with an antiquity of something like half a million years. From the rather apelike vault of the skull, Dr. Eugene Dubois, the discoverer of the remains, was able to determine that the animal to which it belonged had a cranial capacity of between 900 and 1,000 cubic centimeters; later this was re-calculated at somewhat more than 1,000 c.c. At the present time the most generally accepted estimate is 940 c.c.

The cranial capacity of the anthropoid apes varies between a range of 290 to 650 c.c., the gorilla possessing the largest brain, with an average of 550 c.c. Mean cranial capacities for modern men vary between 1,200 c.c.,—with an average of about 1,350 c.c.—to 1,500 c.c. in its lowest range a brain volume of 900 c.c. occasionally occurs in contemporary man. Clearly, then, in the matter of cranial capacity, the Trinil skull falls within the range of human brain volume. It may be recalled here, by way of comparison, that the estimated adult cranial capacity of the Taungs ape, *Australopithecus transvaalensis,* is about 600 c.c., while the cranial capacity of *Paranthropus crassidens* has been estimated at 850 to 1,100 cc.

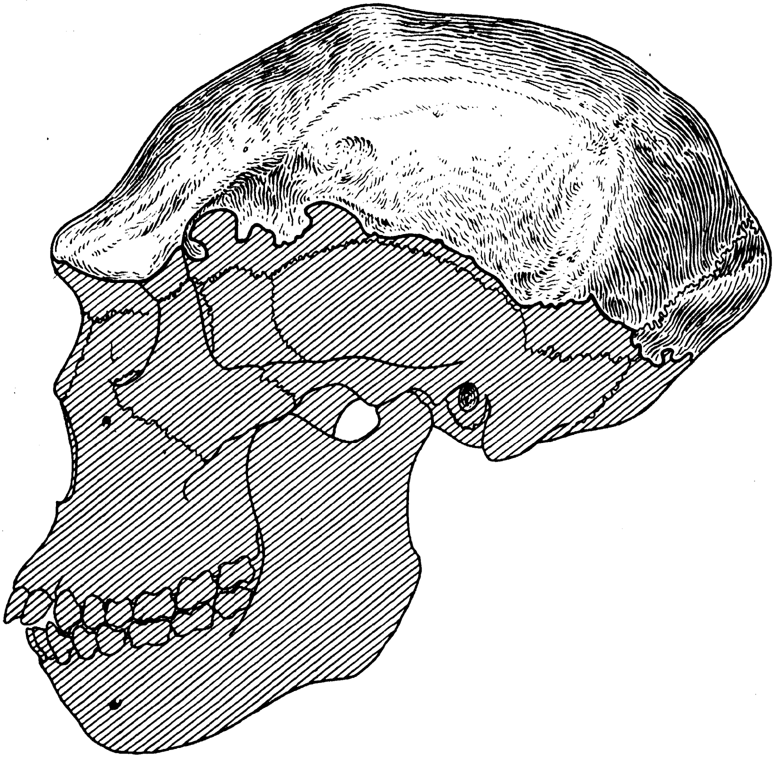


FIG. 62. A reconstruction of the skull of *Pithecanthropus erectus I.*

Brain volume then, puts *Pithecanthropus erectus* among the Hominidae rather than among the apes. An endocranial cast, that is, a cast of the interior of the cranium, reveals the presence of an interesting bulge of the inferior or third frontal convolution. This region of the brain is, in man, believed to be associated with the faculty of speech. It is quite impossible to say, but it may be that *Pithecanthropus* may have used some form of language.

The character of the femur or thigh bone is entirely manlike and proves that its owner habitually walked erectly, hence the specific name *erectus* was added to the generic name *Pithecanthropus,* which means "ape-man." From the femur the height of *Pithecanthropus* has been calculated to have been about five feet eight inches and his weight about 150 pounds. In point-of-fact there is some doubt whether the femur is not that of a modern type of fossil man, a doubt, however, which has been considerably reduced by the surprisingly manlike limb bones of the australopithecine apes.

Pithecanthropus erectus II was discovered early in 1937 by Dr. G. H. R. von Koenigswald at Sangiran in Central Java. This represents an adult specimen in which only the facial bones and lower jaw are missing (see Fig. 63). The resemblance between this and the skull discovered by Dubois in 1891 is very striking, except that the cranial capacity in this second skull was only 775 c.c., the smallest cranial capacity thus far recorded in any hominid. From the same district there had been recovered, in 1936, the fragment of a lower jaw with four teeth, undoubtedly of *Pithecanthropus,* and in 1938 the fragment of the skull of a juvenile *Pithecanthropus,* now known as Skull III. The fragment of the lower jaw, with three molars increasing in size from the first to the third, unlike the usual sequence in man, and one premolar *in situ,* is massive, and a chin is not developed. All are Middle Pleistocene.

Pithecanthropus robustus. Skull IV. By far the most important find was made by Dr. von Koenigswald in a Lower Pleistocene bed in the Sangiran district in January 1939. This consisted of the posterior three-quarters of the brain-case including the base, and the upper jaw with the teeth *in situ* with the exception of the incisors and the second and third molars of the left side. The teeth are essentially hominid in form. The canine tooth projects somewhat beyond the level of the other teeth and is larger than that of any recent or fossil hominid. As is the case in all hominids the breadth of the molars exceeds their length. What is unique for any hominid form, is the presence of a bony diastema or space, the premaxillary diastema or simian gap, measuring 6.2 mm. on the left and 5.0 mm. on the right side, separating the canine from the lateral incisor tooth. In a later find of what is believed to be a portion of the upper jaw of the female of this type a similar, though reduced, premaxillary diastema is present.

The canine tooth of *Pithecanthropus robustus* is, in fact, very small compared with that of the anthropoids, but not smaller than the same tooth in *Sinanthropus,* thus suggesting the presence of a similar small canine in the lower jaw. There is no precanine diastema in the lower jaw corresponding to the premaxillary diastema of the upper jaw. The presence of the premaxillary diastema in the upper jaw, which in the anthropoids affords room for the upper part of the large lower canine, suggests that in the evolution of man the canine tooth underwent reduction first, and that it took another separate evolutionary change to bring about the reduction of the diastema, and thus to produce a further shortening of the jaws.

The upper jaw in *Pithecanthropus robustus* is wider and longer and projects farther beyond the face than in any other known form of man. The palate exhibits certain unique features, such as the complete absence of a median torus or ridges and furrows of any kind, and the presence of posterior palatine hillocks. The bones are more massive than in any other known form of *Pithecanthropus,* and while the skull is longer than that of any of these forms it is actually appreciably lower, the length being 158 mm. as compared with 135 mm. in Skull II, while the corresponding heights are 102 mm. in the former and 105 mm. in the latter. The basal breadth of the skull exceeds the greatest parietal breadth very much more markedly than in any other known hominid skull; the shape of the skull as seen from behind or in a coronal section is distinctly triangular. A unique keel-like elevation or sagittal crest runs over the top of the skull in the mid-line from top to back, and there is an enormous bulging of the occipital torus. All these are features unique to Skull IV, and in recognition of its difference from other forms of *Pithecanthropus* it has been named *Pithecanthropus robustus.*

Homo Modjokertensis. In 1936 one of Dr. von Koenigswald's native collectors found a fossil human skull in a Lower Pleistocene

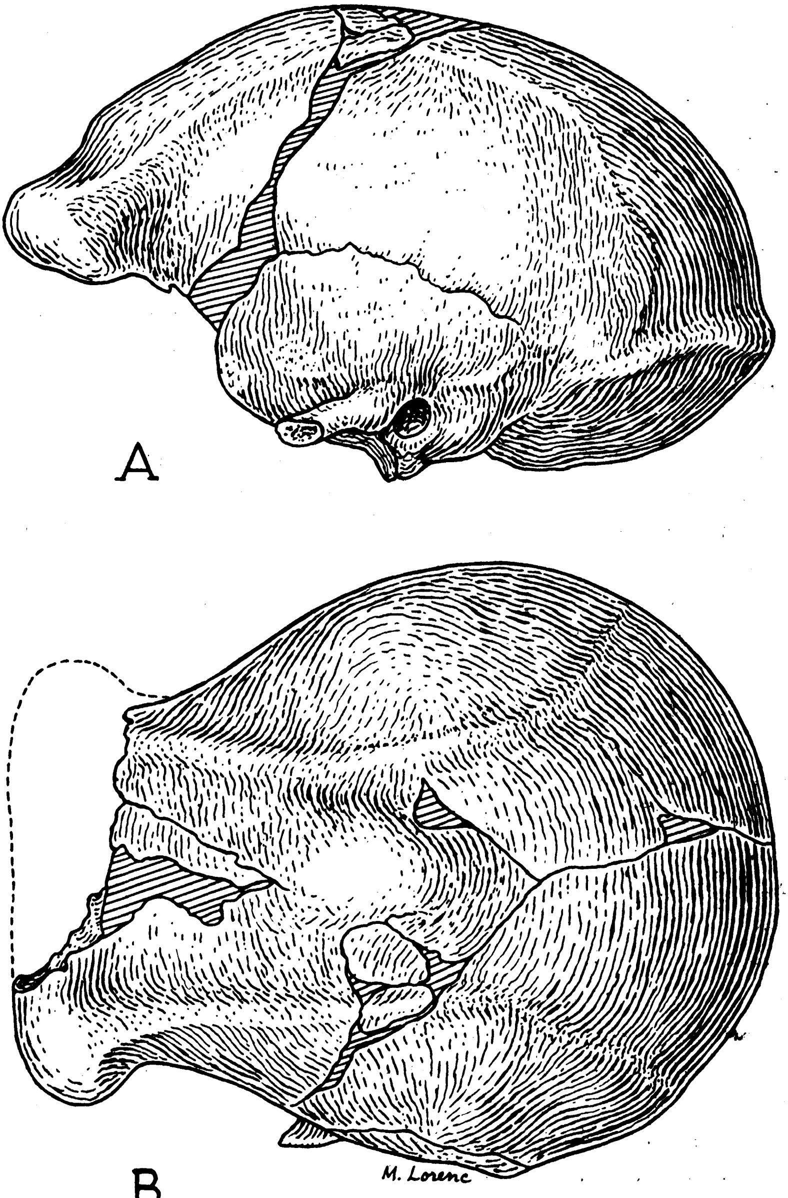


FIG. 63. A, lateral, B, vertical views of the cranium of *Pithecanthropus erectus II* (after von Koenigswald). (Courtesy, Carnegie Institution of Washington.)

bed in the Djetis zone near Modjokerto, west of Soerabaja in east Java. The skull, with facial parts and teeth missing, proved to be that of a child of about three years of age. The incipient temporal narrowness, the depressed parietal, the peculiar form of the occiput, the low frontal region and the well marked supraorbital torus, all bespeak a primitive type. The skull of this child of Lower Pleistocene age is almost certainly a member of the Pithecanthropoid group. It is very likely a juvenile member of the *robustus* type.

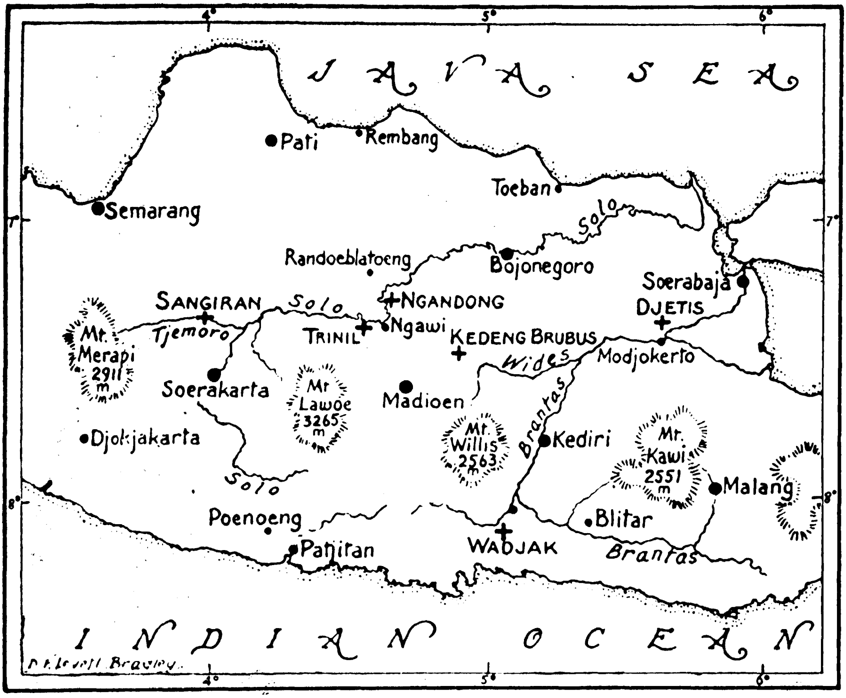


FIG. 64. Map of central and East Java, showing the chain of volcanoes and the valley of the Bengawan (Solo) River, with the sites of the human finds marked by a cross. (From Weidenreich. Courtesy, University of Chicago Press.)

It should be noted that the *robustus* skulls were discovered in a Lower Pleistocene horizon older than the Trinil beds from which *Pithecanthropus erectus* was recovered.

Homo Soloensis. In 1931 in the region of the Solo river near

Ngandong, in Central Java, a fossil human skull of Upper Pleistocene age was discovered which led to the subsequent finding of portions of ten others. Faces and teeth were missing, but the characters of the remainder of the skulls showed an extraordinarily thick-skulled primitive type having the clearest immediate affinities with *Pithecanthropus* and Modjokerto man on the one hand, and Rhodesian and Neanderthal man (see pp. 149 and 155) on the other. There is, however, not the slightest doubt that Solo man, with an average cranial capacity of 1,100 c.c. (range 1,035-1,225 c.c.) represents a Neanderthaloid advanced member of the Pithecanthropus group.

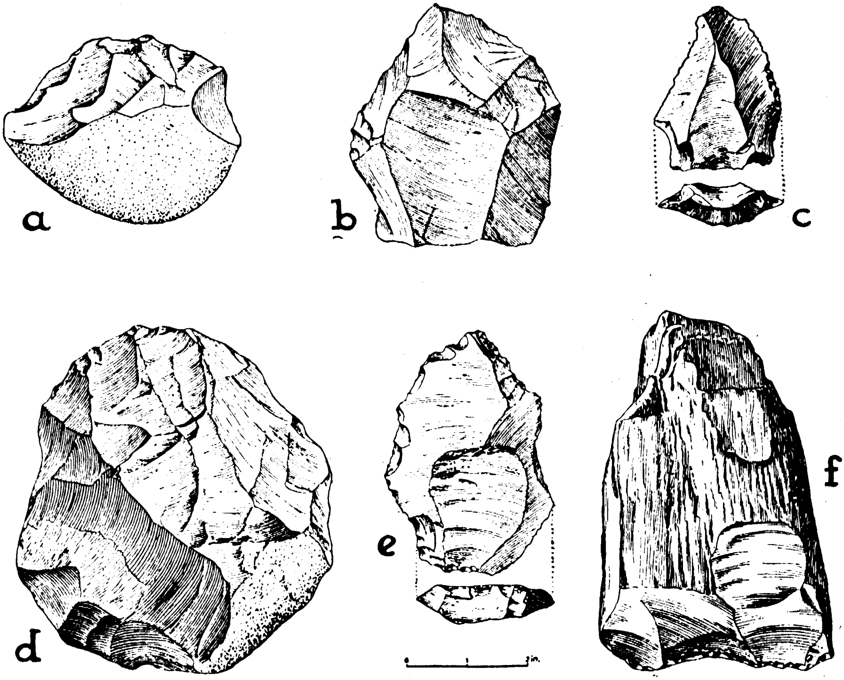


Fig. 65. Artifacts of Soan culture group. *a*. Pebble chopper-tool, and b, flake tool, probably of quartzite, Early Soan, N.W. India. After De Terra and Paterson. *c*. Late Choukoutien flake-tool of chert (resembling Mousterian point), Choukoutien, China. After Pei. *d*. Chopper-tool, and *e*, flake-tool of silicified tuff, Patjitanian, Java. After Movius. *f*. Chopper-tool (hand-adze) of fossil wood, Anyathian, Upper Burma. After Movius. (From Oakley, *Man The Tool-Maker*. Courtesy, British Museum [Natural History].)

In association with Solo man were found several beautifully worked bone implements, an axe made of deer antlers, a barbed spearhead, and a number of crude stone tools. Culturally, then, Solo man appears to have been a fairly advanced type, belonging in the upper reaches of the Paleolithic or Old Stone Age.

In the Trinil level of Central Java primitive stone implements have been discovered which may have been used by Pithecanthropoid forms. These consist of flakes, points, scrapers, and cores made of different silicified rocks (quartz, lydian stone, etc.)

On the south coast of Central Java near Patjitan similar implements have been found including a variety of chopping tools.

All these artifacts correspond to those which have been discovered in almost every part of the world, though they belong to an entirely different tradition, and in Java they are of particular interest because they strongly suggest that physical and cultural evolution was proceeding there contemporaneously with, and to some extent independently of, similar stages of evolution occurring elsewhere in the world. *Sinanthropus* or Peking man and his culture represent such contemporary stages.

Sinanthropus pekinensis. Discovered at Chou k'ou tien near Peking in China in 1929, "China Man" or *Sinanthropus* is now known from the remains of some forty individuals found in the same caves in subsequent years. Like *Pithecanthropus erectus* Peking man is of Middle Pleistocene age, and morphologically so closely resembles the former that there can be little doubt of their genetic relationship.

The cranial capacity of the Sinanthropus group varies from 915 c.c. to 1,225 c.c., with an average of 1,043 c.c. The average brain size of *Sinanthropus* is about 20 per cent greater than that of *Pithecanthropus.* The frontal region of the skull shows a bump-like development, a more globular form, than is the case in *Pithecanthropus* in which the same region is relatively flat, while the frontal sinus is less expanded in the former than in the latter. The occipital region is comparatively narrow and elongated in *Sinanthropus* and broad and rounded in *Pithecanthropus,* and the mandible is considerably more robust in the latter than in the former. There is no diastema between the maxillary canine and the lateral incisor in *Sinanthropus,* whereas in one form at least of *Pithecanthropus* an appreciable diastema is present. Apart from these there are no really significant differences between the skulls of *Sinanthropus* and *Pithecanthropus*. Next to *Meganthropus* and *Gigantopithecus* these are the most primitive morphological types of man known.

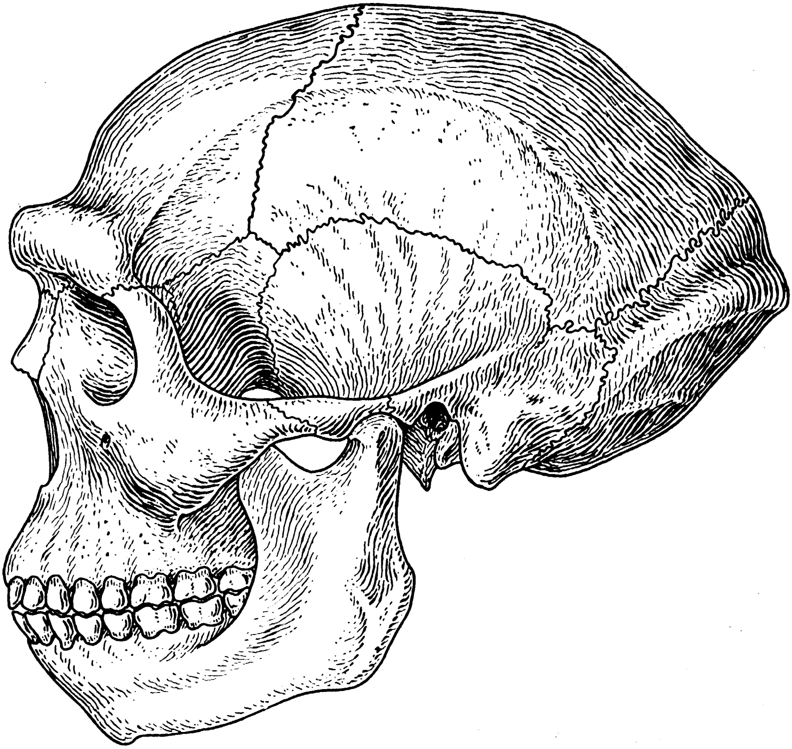


FIG. 66. Reconstruction of a female *Sinanthropus* skull (somewhat modified after Weidenreich).

Taken all in all there can be little question that *Sinanthropus* represents a slightly more advanced stage in the evolution of man than *Pithecanthropus,* the difference in brain size and the absence of a premaxillary diastema would alone be sufficient indication of that. The resemblances, however, between the two forms are such as to suggest that *Sinanthropus* merely represents a geographic race of the Javanese Pithecanthropoid stock.

The flakes, points, scrapers, choppers and cores, of the Trinil beds,

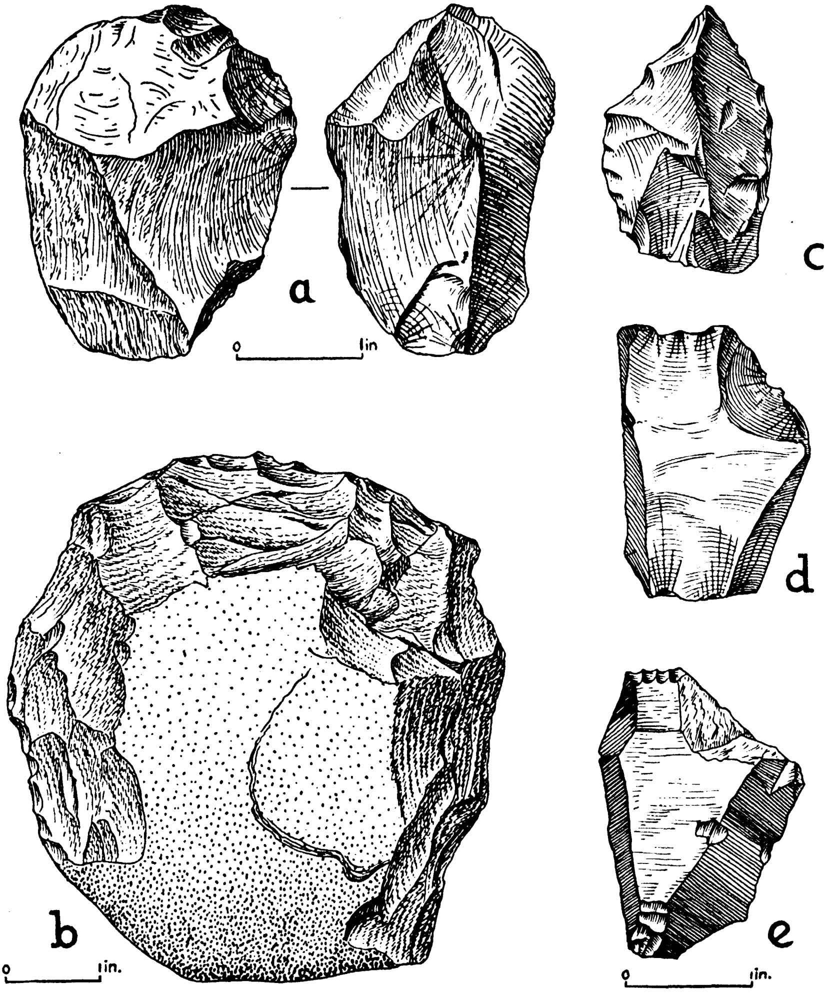


FIG. 67. Stone tools of Pekin Man. *a.* Quartz chopper-tool. *b.* Boulder of greenstone flaked into chopper form. *c.* Pointed flake of quartz. *d.* Bi-polar flake of quartz. *e.* Bi-pyramidal crystal of quartz utilized as tool. After Pei and Black. (From Oakley, *Man The Tool-Maker.* Courtesy, British Museum [Natural History].)

presumed to be the handiwork of *Pithecanthropus,* are very similar to the artifacts which were found associated with *Sinanthropus.*

All these forms are very closely related. As a group of Pithecanthropoids *robustus, modjokertensis, erectus, pekinensis,* and *soloensis,* exhibit the kinds of differences which (save in the case of *modjokertensis* which probably belongs with *robustus*) render it clear that each type represents a geographic race or subspecies of a closely allied group of the same species.

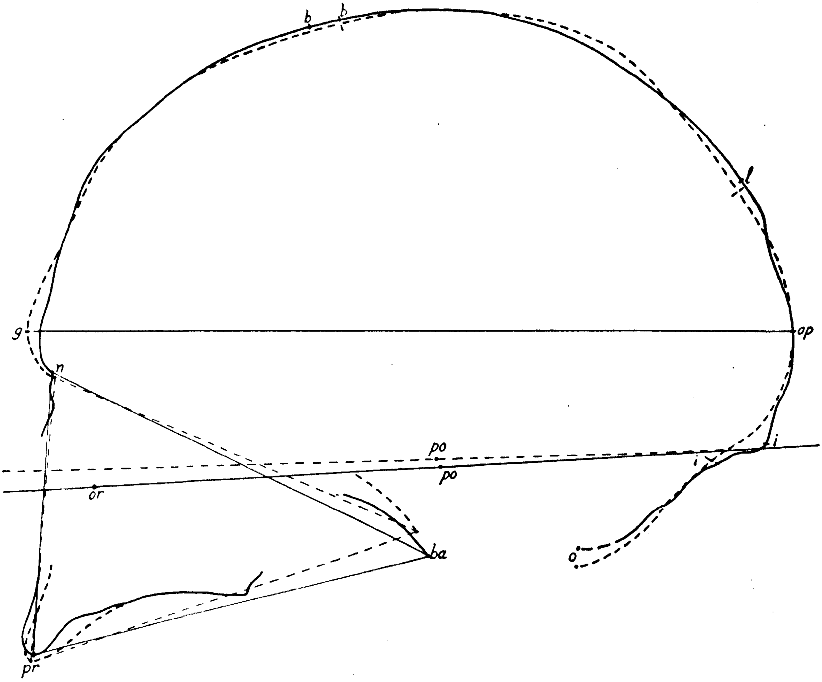


FIG. 68. Mid-sagittal craniograms of Keilor skull ———, and the Wadjak skull II — — —, both superimposed on the glabella-opisthocranion line (g-op) and the opisthocranion. Half natural size. (From Weidenreich. Courtesy, *Am. J. Phys. Anthrop.*)

It has already been pointed out that in view of certain morphological resemblances of Solo man to the skeletal remains found at Broken Hill in Northern Rhodesia, South Africa, and to Neanderthal man, a possible relationship between Solo man and these two types has been suggested.

Wadjak Man. In 1889-90, before his discovery of the original *Pithecanthropus* remains in 1890-97, Dr. Eugene Dubois had discovered two extremely interesting fossil crania at Wadjak, some 60 miles southeast of Trinil, in Java. The discovery of these skulls was not announced until thirty years later, in 1920. In Wadjak I, possibly a female, the cranial capacity is 1,550 c.c., in Wadjak II 1,650 c.c. These skulls, for which Dubois claimed a Pleistocene age, bear a striking resemblance to the Australian aboriginal skull, except that the skull of Wadjak man is appreciably larger in all its dimensions than the Australian. This resemblance has recently assumed considerable significance for in 1940 there was discovered, in a sand-pit one mile north of the village of Keilor, 10 miles northwest of Melbourne, Australia, a fossil skull which is almost identical in form with that of Wadjak man. The Keilor skull was found some 18 feet below the surface of the Maribyrnong River terrace. The deposit, at first believed to be of Riss-Würm Interglacial age, is now suspected to be of more recent age. However this may eventually prove to be, there is strong evidence here of a morphologic

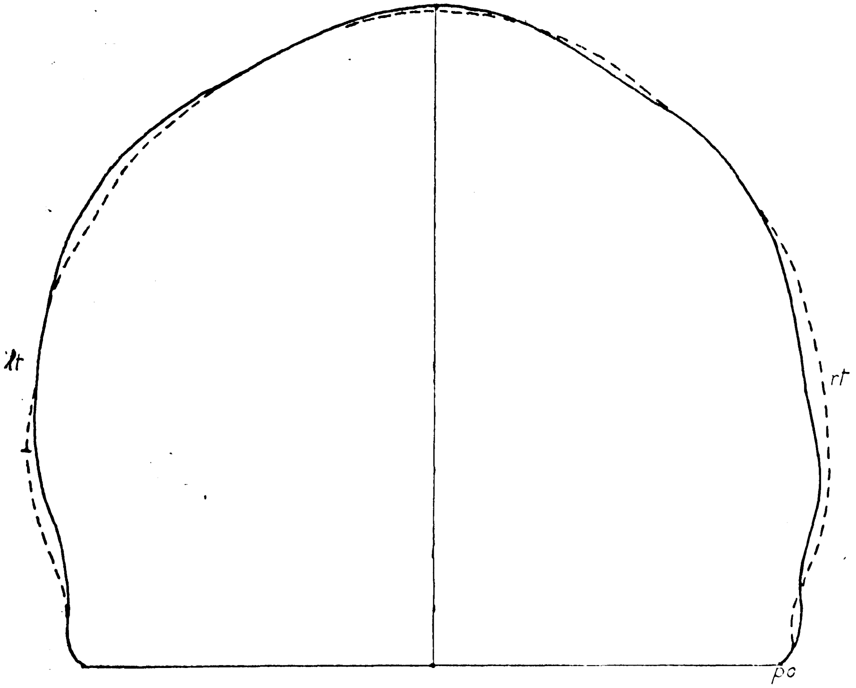


FIG. 69. Transverse diagram of the Keilor skull ———, and the Wadjak skull I, — — — —, both superimposed on the interporion line (po). Two-thirds natural size. (From Weidenreich. Courtesy, *Am. J. Phys. Anthrop.*)

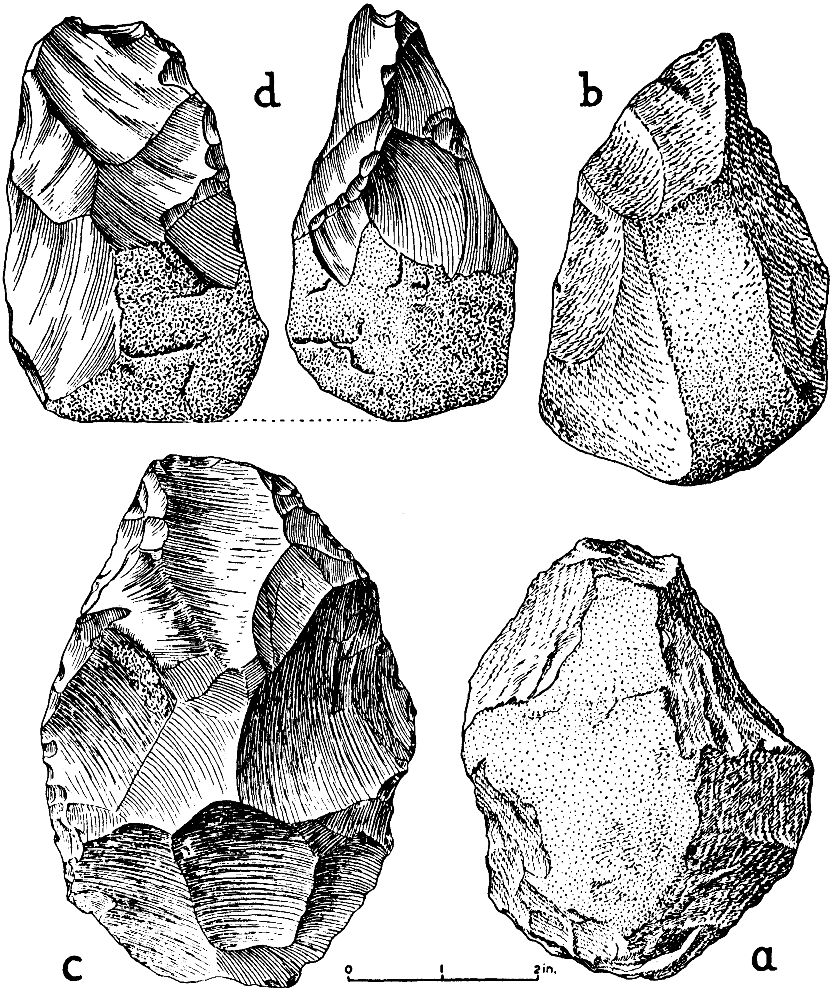


FIG. 70. Abbevillian tools. *a*. Lava hand-axe, Bed II, Oldoway Gorge, Tanganyika. *b*. Quartzite hand-axe 90 metre beach, Morocco. After Neuville and Ruhlmann. *c*. Hand-axe, derived, Chelles-sur-Marne. After Breuil. *d*. Hand-axe, 150 ft. terrace of Thames, near Caversham, Berks. Oxford University Museum. (From Oakley, *Man the Tool-Maker*. Courtesy, British Museum [Natural History].)

relationship between the Javanese Wadjak people and the Australian aborigines, *via* Keilor, an apparent Wadjak type. The Keilor skull, like Wadjak, is much larger than the Australian skull, Keilor having a cranial capacity of 1,593 c.c., well within the range

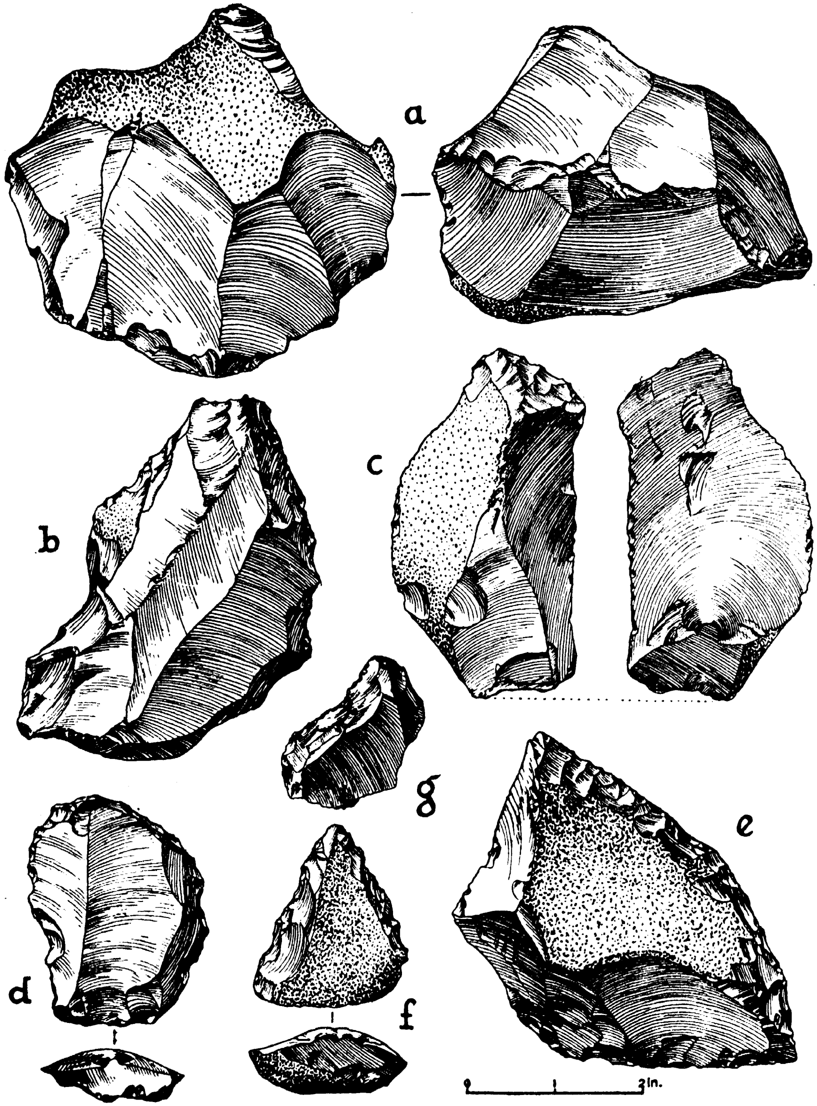


Fig. 71. Clactonian and Tayacian artifacts. *a*. Clactonian flint core, and *b, c,* flake-tools, Lower Gravel, 100 ft. terrace, Swanscombe, Kent. *d*. Flake-tool, *Elephas antiquus* gravel, Clacton-on-Sea, Essex. *e*. Acheulo-Clactonian scraper, High Lodge, Mildenhall, Suffolk. *f*. Tayacian flake-tool, Combe-Capelle, Montferrand (Dordogne). *g*. Tayacian flake (utilized), interglacial river gravel, La Micoque, Tayac (Dordogne). (From Oakley, *Man the Tool-Maker*. Courtesy, British Museum [Natural History].)

of Wadjak, whereas the cranial capacity of the aboriginal Australian skull of the Melbourne region averages 1,338 c.c. Interestingly enough this is the largest average cranial capacity for the Australian group in the whole continent, and it is significant that the Australian cranial type most resembling the Keilor skull is found in the same general region.

It is possible that the Wadjak people reached Australia in late Pleistocene or even in more recent times and possibly by admixture with some Negroid type gave rise to the modern Australian aboriginal. The general resemblance of the Australian skull to the Pithecanthropoid type, the presence of Wadjak man in Java, and the discovery of the Australian Wadjak type, Keilor, in the extreme southeast of the continent, rather than in the extreme northwest, are the sort of loose pieces in the jigsaw puzzle of the evolution of man which the anthropologist delights to fit together. Weidenreich has suggested that we have now an almost continuous phylogenetic line leading from the Pithecanthropus group through Solo man to Wadjak man and thence to the Australian aboriginal. This suggestion, however, very likely errs on the side of over-simplification.

Homo rhodesiensis. In 1921 a complete skull, lacking the lower jaw, and portions of the remainder of the skeleton were found together with more fragmentary remains of a second individual. The cave at Broken Hill in which the remains were found is of Upper Pleistocene age. Until the recent discoveries in China and Java, Rhodesian man constituted even more of a puzzle than he does today. Combining Pithecanthropoid, even gorilloid, and Neanderthaloid characters with a goodly number which might be said to be of early neanthropic type, Rhodesian man had a rather primitively formed brain with a cranial capacity of 1,300 c.c., enormous brow-ridges, a projecting large gorilla-like upper jaw, an unusually broad palate, and a face very large in all its dimensions, the cranial vault seems even more depressed, though it is actually not, than it is in the typical Neanderthaloid; the teeth, on the other hand, are far less specialized than in Neanderthal man, and closely resemble those of modern man. The resemblance between Solo man and Rhodesian man may be accidental, a close genetic relationship between the two types is, however, a possibility. The presence of Neanderthaloid and early neanthropic features conspire to lend Rhodesian man an unusual degree of interest.

Rhodesian man together with Solo man are regarded by some students as early sapiens types which bear no relationship to Neanderthal man at all, but which may possibly be closely related to the Australoid type. Keith regards Rhodesian man as a type which appears in the line leading to the neanthropic type soon after this line "had broken away from the Neanderthal line." A third view would regard Rhodesian man as a possible descendant of Solo man and as a collateral relative of the stock leading to later types of *Homo sapiens* on the one hand and to Neanderthal man on the other. A fourth, but rather unlikely, view regards Rhodesian man as a variant of Neanderthal man, with Negroid

FIG. 72. The skull of Rhodesian Man.

traits, which may serve to make him the prototype of modern Negroids.

These views are not necessarily in conflict with each other, but obviously it is for the present best to leave the question of the relationships of Rhodesian man open.

An interesting feature of the Rhodesian skull is the fact that nearly every one of its teeth was badly decayed, thus proving that caries is not altogether a disease of civilization. The fact remains, however, that fossil men almost always have teeth completely free from decay. Evidence of suppuration in the mastoid region of the skull indicates that this individual suffered from severe mastoiditis. A peculiar lipping at the articular end of the leg-bone, the tibia, suggests the effects of arthritis.

Homo heidelbergensis. In 1907 at Mauer, some six miles southeast of Heidelberg, in Germany, a massive human lower jaw, together with all the teeth *in situ,* was discovered in a Lower Pleistocene deposit of Abbevillian (Chellean) age. No implements were found associated with the jaw, and indeed, records of Abbevillian industry have never been found in Germany. It is, however, possible by comparison of the geological strata of the Mauer sandpit in which the jaw was found, with similar strata elsewhere in Europe, notably in Belgium, to state that the owner of the Mauer jaw probably flourished during the Abbevillian period, probably during the first, and certainly not later than the second, interglacial period.

The massive character of the Mauer mandible, the great breadth of the ramus, the absence of a chin, and the shallowness of the sigmoid notch, all suggest a primitive type. The teeth are remarkably like those of modern man in every respect, save that the pulp cavities are slightly larger, and the crowns and bodies of the molar teeth are somewhat more "swollen" than in modern man. Nevertheless, all these characters fall within the range of variation encountered in the living varieties of man. Weidenreich suggests that the greater length of the roots of the front teeth is associated with the fact that the tooth-bearing portion of the jaw fails to undergo recession and thus, as in modern man, leaves the lower portion of the jaw to jut out as a chin.

In view of the characters of the jaw of Heidelberg man it is generally considered that he was probably ancestral to Neanderthal man, and that he himself was in fact, an early variety of Neanderthal man.

As a Lower Pleistocene form it is quite possible, even probable, that Heidelberg man intermingled with other forms of man, and that one of the varieties subsequently resulting from such intermingling was Neanderthal man. Who, and how many, the actual ancestors of Neanderthal man were, it is at present impossible to say; *Homo soloensis* has already been suggested as a possible one, *Sinanthropus* may be another, and a recently discovered type, *Africanthropus njarasensis,* described below, may represent still another. As our discoveries increase in number and importance the probability increases that we shall some day be able to name the actual groups from which Neanderthal, and other types of man, may have originated.

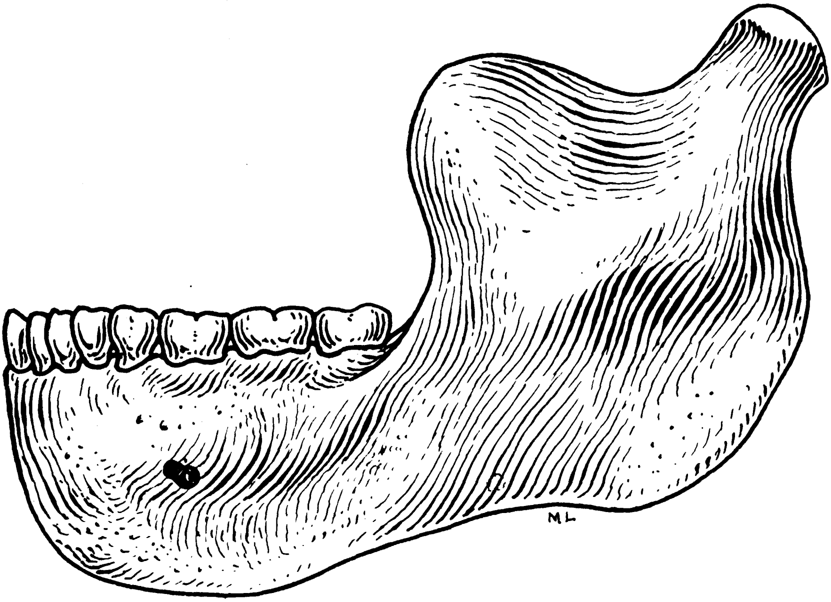


Fig. 73. The Heidelberg Jaw.

Africanthropus njarasensis. In 1934 an important find of the badly crushed and weathered fragments of three skulls was made by Kohl-Larsen in the northern part of what was formerly German

East Africa and is now Tanganyika Territory. The most complete of these skulls, probably that of a male, has been cursorily described by Reck and Kohl-Larsen, by Leakey, and by Weinert. The skulls were recovered from a deposit believed to be of Upper Pleistocene age north-west of Lake Eyasi (Njarasa). They exhibit a number of characters which bear a striking resemblance to those characterizing the *Pithecanthropus-Sinanthropus* group. Kohl-Larsen, the discoverer, and Hans Reck, a German geologist, in a joint paper published in 1936, described this new form of man as *Palaeoanthropus njarasensis,* but Weinert considered the name unsuitable and renamed the find *Africanthropus njarasensis.* The former name has priority, but the latter is the name most frequently used in the literature.

The bones recovered consisted of the greater part of the occipital, left parietal, and left temporal including the mastoid and petrous portions. These parts articulate perfectly with one another at their sutural junctions. Several parts of the frontal bone were also recovered, including a portion of the glabella, and the right supraorbital torus and external orbital angle. In addition there was recovered a fragment of the maxilla containing the broken sockets of the two incisor teeth, the left canine, the first premolar, and the broken socket of the second premolar, and a loose first molar. The canine tooth is of human form, and there was no space between the upper lateral incisor and canine teeth (premaxillary diastema). The right tympanic plate, which was also recovered, is, according to Leakey, very chimpanzee-like in form.

The foramen magnum, part of which is preserved, is inclined backwards at an angle comparable to that found in the anthropoid apes and in Solo man. The greatest width of the skull is in the region of the mastoid processes. The bones of the skull in *Africanthropus* are very thick, and the supraorbital torus, which is very strongly developed, bears a close resemblance to the same structure in *Pithecanthropus* and *Sinanthropus.* The form of the forehead is also much the same as in these two types, the angle of slope (glabello-bregmatic angle) of the forehead, for example, being 36 to 37° in *Africanthropus* as compared with 38° in *Pithecanthropus.* On the other hand, the form of the occiput approaches that of neanthropic man, but actually most closely resembling that of Steinheim man of the early Neanderthaloid type (see p. 158); the occipital torus, for the attachment of some of the muscles of the back of the neck is, however, very strongly developed.

Unfortunately, a thorough description of the skull and teeth of *Africanthropus* has not yet been made available, so that we are not, at the present time, in a position to draw any sound inferences as to its exact characters and relationships. In Fig. 80 is shown an outline of the sagittal section of *Africanthropus* compared with similar outlines of *Sinanthropus I* and *II* and *Homo neanderthalensis,* the latter represented by the old man of La Chapelle-aux-Saints. It will be seen that there is a striking resemblance in the outline of all these forms. The same holds true for many of their physical characters, but the resemblance of *Africanthropus* is obviously closest to the *Pithecanthropus-Sinanthropus* group.

Weinert believes that *Africanthropus* belongs with the *Pithecanthropus-Sinanthropus* group, and that the former undoubtedly bears some relationship to the Neanderthaloid group. The two geologists, Reck and Kohl-Larsen, believe that *Africanthropus* represents the earliest or most primitive member of the Neanderthaloid group, a proto-Neanderthaloid rather than a fully developed member of that group. Dart and Weidenreich believe that *Africanthropus* is most closely related to the Rhodesian Neanderthaloids. Leakey, who studied the skull in 1936, is convinced that it belongs with the *Pithecanthropus-Sinanthropus* group. The morphological facts would seem to support this view.

Reck and Kohl-Larsen stated that with the remains of *Africanthropus* were found associated artifacts of early Levalloisian industry. Weinert, however, stated that the associated artifacts range all the way from Abbevillian to Neolithic. To settle this question Leakey and Mr. G. H. Reeve, a geologist, restudied the site in 1937, and fully confirmed Reck and Kohl-Larsen's statements. The deposit is, without doubt, Upper Pleistocene (Gamblian). The stone culture is developed Levalloisian, which in Kenya has been proven to be contemporary with the Upper Kenya Capsian (Aurignacian).

It is an interesting fact that the types of man associated with the Kenya Capsian culture, Oldoway (1913), Gambles Cave, Elmenteita, (1924), and Naivasha (1940), are all neanthropic types, while the contemporary Levalloisian culture is associated with *Africanthropus.* This latter association fits the European evidence, for in Europe the Mousterian-Levalloisian industries are invariably associated with men of Neanderthal type.

In Africa then, we have good evidence of the contemporaneity of a Pithecanthropoid type of man, *Africanthropus,* and a neanthropic type, as represented by Leakey's Kenya group of Upper Pleistocene types.

Many anthropologists are dubious concerning the claims made for *Africanthropus,* and in the first edition of this book the author took the view, with most other anthropologists, that "it would appear safe to regard him [*Africanthropus*], tentatively, as a proto-Neanderthaloid with close affinities to Rhodesian Neanderthaloids rather than to the Pithecanthropoid-Sinanthropoid group." But it seems to me now, on re-studying the published materials, that the data, such as they are, strongly support the Weinert-Leakey viewpoint, and so I have stated it. It is, however, well to remember, as Kroeber has said in this connection, that no judgment on a fossil human form is wholly reliable until it reflects the consensus of several experts. Perhaps we might tentatively put it at half-a-dozen experts who have actually examined the remains themselves.

Neanderthal Man. Neanderthal man is, perhaps, the best known of our fossil relatives, the remains of more than one hundred individuals, in addition to a good many variant types, having been discovered and described. Neanderthal man is essentially an Upper Pleistocene, late Early, and early Middle Paleolithic form of man, one whose physical characters and mental potentialities have most probably gone into the making of ourselves, and who ends the long line of paleoanthropic types as distinguished from the early and late neanthropic types.

The cranial capacity of Neanderthal man had reached, and even exceeded that of modern man, varying between 1,220 c.c. and 1,610 c.c., with an average of about 1,450 c.c. The average cranial capacity of modern Europeans is about 1,400 c.c. The skull of the Neanderthal child found in 1938 in the Teshik-Tash cave in Southern Uzbekistan—the first Neanderthaloid to be discovered in Central Asia—had a cranial capacity of 1,490 c.c. Its estimated age is nine years, sex is surmised as male. At the same age the average modern European boy has a cranial capacity of 1,350 cc. Thus, the important point emerges that the average cranial capacity of Neanderthal man—even though the frontal lobes were of lesser volume—probably exceeded that of modern man, and the size of his brain suggests that as far as potentialities for intelligence and humanity were concerned he was probably not less well endowed than modern man.

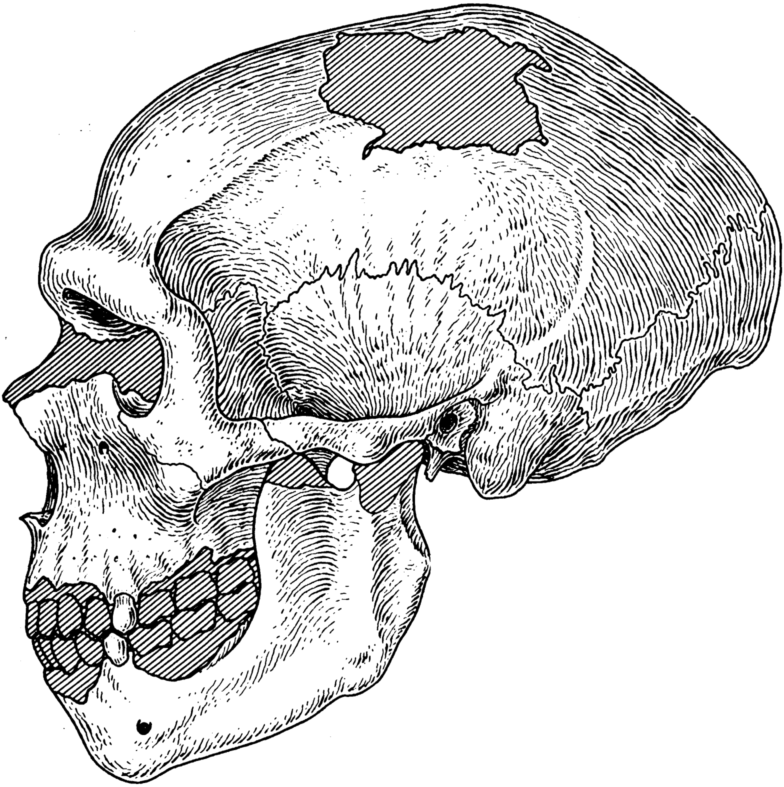


Fig. 74. One type of Neanderthal Man. The Old Man of La Chapelle-aux-Saints.

Compared with modern man Neanderthal man is distinguished by a very low sloping forehead, a marked supraorbital torus, a heavy chinless jaw, and a broad projecting occiput; all these characters occasionally occur in individuals of every living variety of man. In spite of the fact that conclusions relating to mentality drawn from the shape of the normal head have long ago been demonstrated to be utterly valueless, there are still some students who forget themselves so far as to assert that Neanderthal man must have had a poor mind because he had a somewhat lower brow than their own. The fact is that, within a certain range, neither the shape nor the size of the brain in the Hominidae bears any relation whatsoever to intelligence. Persons with low foreheads are known to be not one bit better or worse mentally than those with high ones. Patronizing "highbrow" remarks on the low brain development of our early "lowbrow" relatives are therefore strictly out of order. This is an important point, and we shall have something more to say about it in the next chapter. But before leaving this subject here a few words must be said concerning the reconstructions of the facial appearance and expression of Neanderthal and other early types of man. Such reconstructions have engaged the attention of several anthropologists and these reconstructions have, quite unconsciously no doubt, been determined by their belief that these presumed earlier types of men were nearer to the apes than we are. Hence they have been given a somewhat apelike appearance. On the other hand, early neanthropic man is always made to look very noble indeed. But the real truth is that we know nothing about the soft parts of extinct man, and less than nothing concerning the expression of his features, which were probably not less benign than our own.* The facts, as we know them, do not lend any support to the notion of a beast-like early man.

The handicrafts of Neanderthal man are known from the stone artifacts he left behind him. These characterize a specific culture associated with, but not necessarily peculiar to, Neanderthal

---

* Experiments and experience have led most anatomists to believe that it is impossible to reconstruct the facial appearance and expression of a person, from the skull, with any degree of exactness. See, for example, K. F. Lander, The Examination of a Skeleton of Known Age, Race and Sex. *J. Anat. Physiol.*, *52*:282-291, 1918. See also Jones, F. Wood.: *Man's Place Among the Mammals.* p. 362-365, and Glaister, J. and Brash, J. C.: *Medico-Legal Aspects of the Ruxton Case.* p. 244-248. For a claimed successful reconstruction see W. M. Krogman, The Reconstruction of the Living Head from the Skull. *FBI Law Enforcement Bulletin.* July, 1946.

man wherever found. Such artifacts are known as Mousterian after Le Moustier in France, the type locality where they were first found, though some belong to the still earlier Acheulian culture. The flint ball, which may have been used as a sling stone, is typically associated with Neanderthal man. In addition to the manufacture of perforators, points, discs, scrapers, and stone knives, he introduced the use of mineral pigments into human culture, and practiced ceremonial interment of the dead, thus suggesting the existence of a religious system. To the spiritual life of Neanderthal man we may possibly owe more than we at present remotely suspect.

It was until recently believed that Neanderthal man was exterminated by some other type of man, possibly Cro-Magnon man, but there is now some reason to believe that this was not the case. Discoveries of many varying forms within the Neanderthal group show that there were markedly different types ranging from a heavy supraorbitally-ridged low-browed group to a type very closely resembling neanthropic man. Three of the many types of Neanderthaloids now known may be briefly mentioned.

The earliest representative of the Neanderthaloid type so far discovered in Europe, so-called Steinheim man, exhibits a curious blend of Neanderthal and neanthropic traits. Found at Steinheim-am-Murr in 1933, the Steinheim skull (probably that of a female) was associated with artifacts of Acheulian age, in a deposit of the Mindel-Riss interglacial period of the Middle Pleistocene.

The cranial capacity was 1,070 c.c., rather small for a Neanderthaloid, the facial and occipital parts of the skull display a number of features common to neanthropic rather than to Neanderthal man, though, interestingly enough, the form of the forehead region is reminiscent of *Pithecanthropus.* There can, however, be little doubt of the essential Neanderthaloid character of Steinheim man. It is not unlikely that he was a descendant of Heidelberg man.

Another type was found at Krapina near Zagreb in Northern Croatia in 1899. Krapina man is represented by the skeletal remains of some twenty individuals—all in fragmentary condition—all clearly of a Neanderthaloid character, and associated with a typical Mousterian industry. The typical supraorbital torus, and massive lateral orbital processes are present, but there is also a

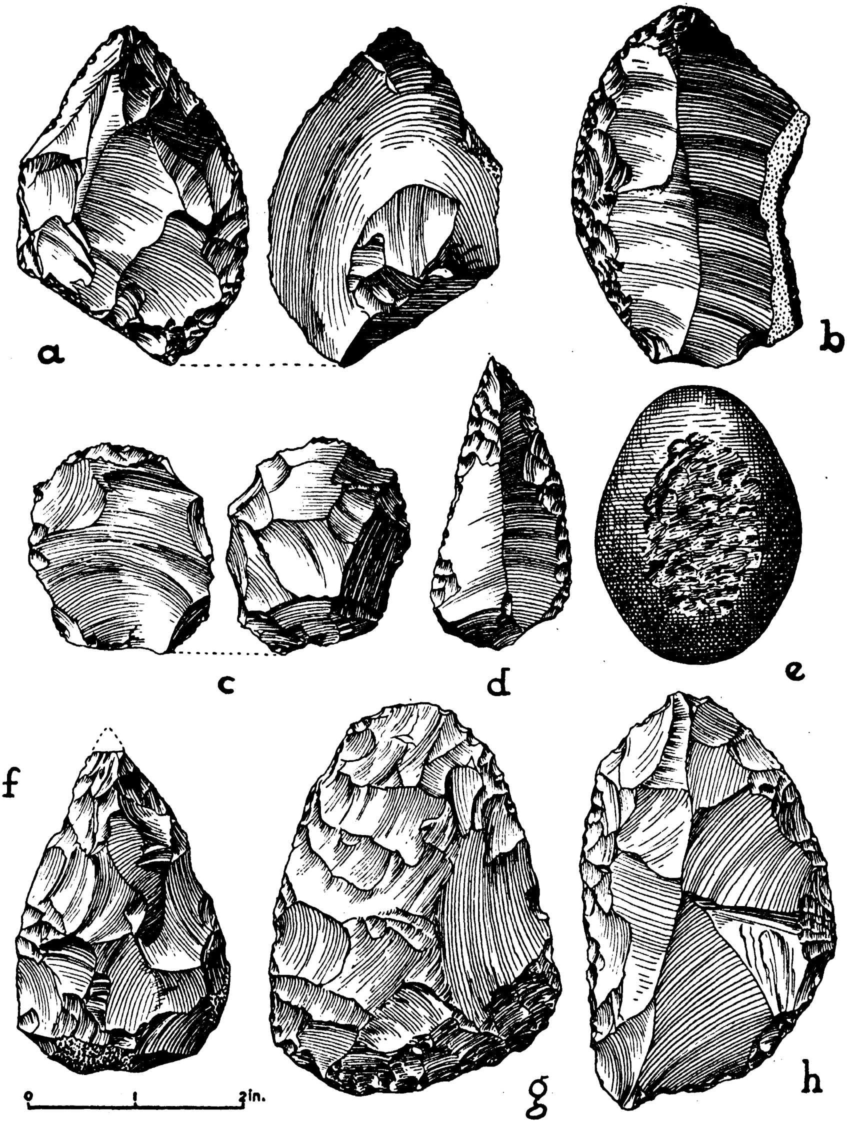


Fig. 75. Mousterian industries. a, b, Side-scrapers (racloirs), c, disc-core, and d, point, from rock-shelter at Le Moustier near Peyzac (Dordogne). e, Small anvil- or hammerstone (pebble of ferruginous grit), Gibraltar caves. f. Hand-axe from Le Moustier. g. Hand-axe (chert), and h, oval flake-tool (flint), from Kent's Cavern, Torquay. a-d. Typical Mousterian; f. Mousterian of Acheulian tradition; g, h, of Acheulo-Levalloisian tradition. (From Oakley, *Man The Tool Maker*. Courtesy British Museum [Natural History].)

strong tendency towards a neanthropic type of forehead and roundheadedness. Brachycephaly, or broad-headedness, occurred in most of the individuals whose skulls could be reconstructed, the best skull yielding an index of 83.7. It is in the Krapina Neanderthaloids that brachycephaly occurs for the first time in the Hominidae.

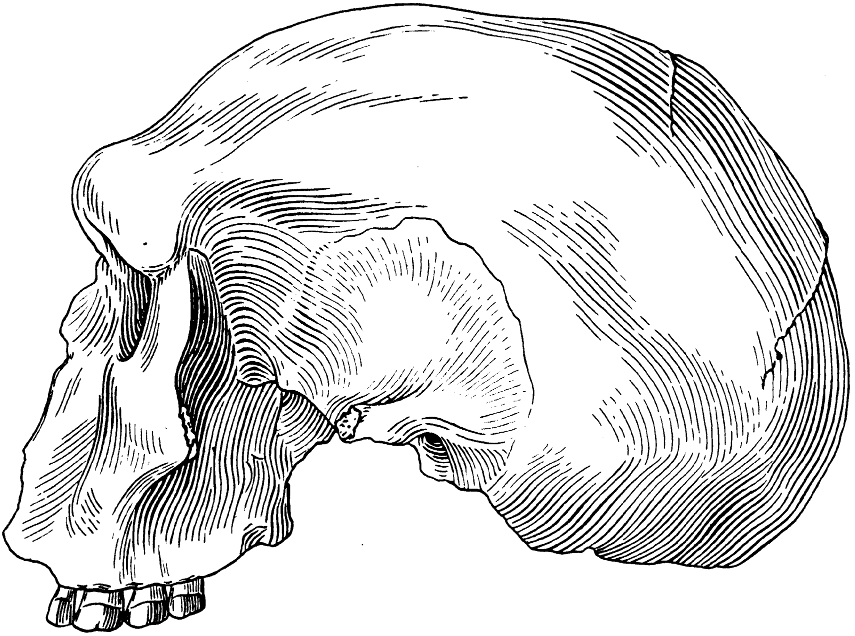


FIG. 76. The Steinheim skull. Right lateral view reversed. (From a cast.)

Discoveries made at Ehringsdorf, a village near Weimar, in Germany, during the years 1914, 1916, and particularly 1925, yielded respectively the greater part of a human jaw, the fragmented skeleton of a child, and the vault and sides of the skull of an adult. Associated with the skull were implements of Pre-Mousterian late Acheulian type. The skull, which was clearly of Neanderthaloid type, was found in a deposit which belongs to the Riss-Würm or third interglacial period, and is therefore somewhat later in age than Steinheim man.

Ehringsdorf man had a cranial capacity of 1,480 c.c. In important features of the skull such as the form of the supraorbital ridges, the position of the ear-hole, the form of the occiput, the jaws and the teeth, Ehringsdorf man is a frank Neanderthaloid, but in almost all other characters this early Neanderthaloid makes a closer approach to the character of the neanthropic skull than do the later and more typical crania of Neanderthal man. He has, for example, a remarkably high forehead—in spite of massive supraorbital ridges—quite like that of neanthropic man, and the head, in spite of its length, is quite high.

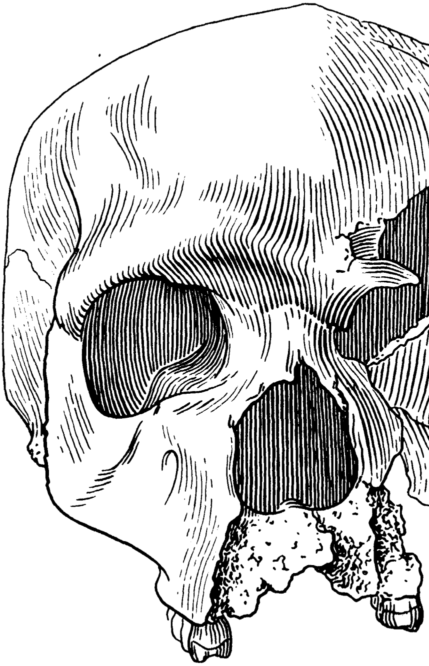


FIG. 77. The Steinheim skull. Frontal view (from a cast).

Such other variant types of Neanderthal man as Spy II (1886), and Galilee (1925), Gibraltar II (1926), all exhibit an approach towards neanthropic man in various important cranial features. It is difficult to believe that so many like mutations can have been responsible for the appearance of these characters, the more likely explanation would seem to lie in a combination of factors in which hybridization probably played an important rôle.

Clear evidence of such mixture or hybridization is to be found in the assemblage of neanderthaloids discovered in 1931-1932 in caves on the slopes of Mount Carmel in Palestine. These consisted of a frankly Neanderthal type, the Tabūn group, and another which had closely approached the neanthropic type in its physical characters, the Skhūl group (see Figs. 78 & 79). Based on a matrix of fundamental likeness, the differences exhibited by these types

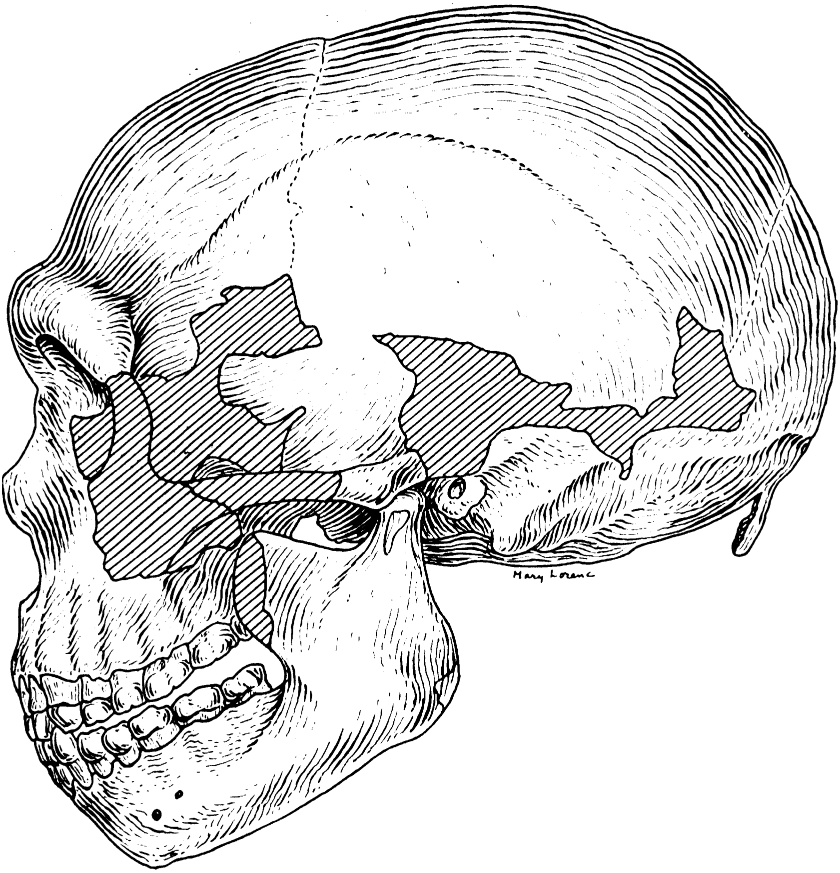


Fig. 78. Tabūn I.

are of such a nature as to render it improbable that they could have arisen spontaneously by mutation. They must be regarded as representing the expression of fairly recent mixture between neanderthaloids and neanthropic types or a form closely resembling the latter .This theory is supported by the presence of a remarkable variety of intergrading types between the Tabūn and

Skhūl groups. Any other theory would have to assume the spontaneous mutation of far too many genes or far too great a change in gene variability to explain the kind of differences exhibited by these two types.

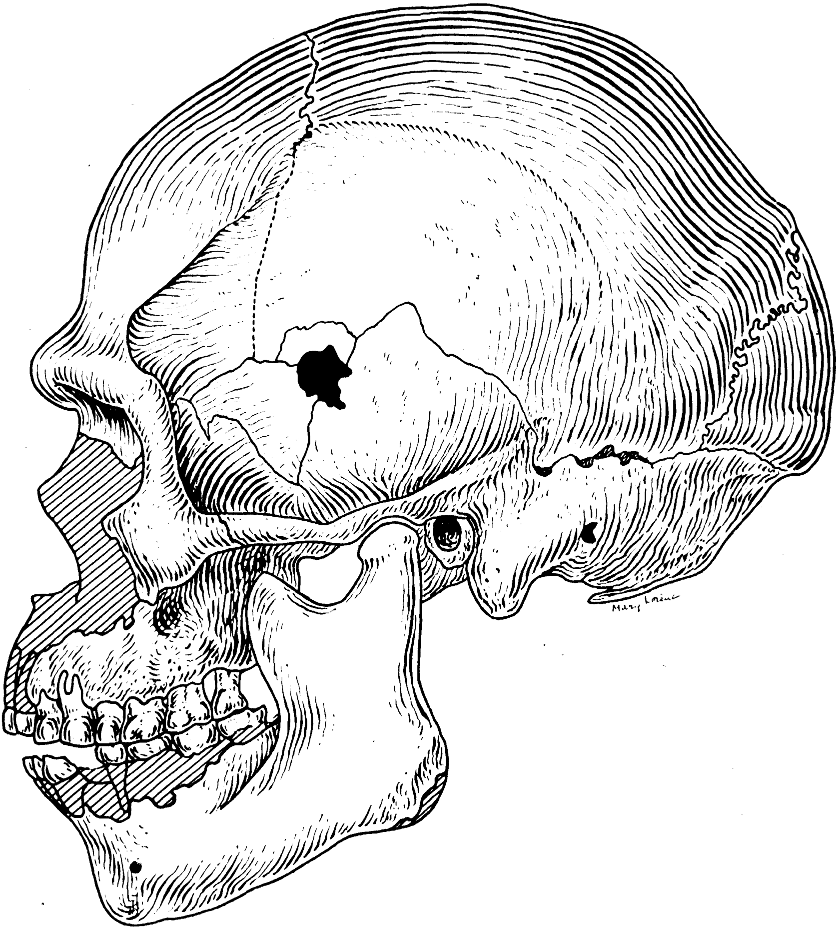


FIG. 79. Skhūl V (right side reversed).

Left to themselves *small* breeding groups very rapidly become homozygous; there is a scattering of variability, and the group tends to become temporarily genetically stable and relatively uniform; in man any radical change within the group is generally produced by the introduction of new genes, by heterozygosity, resulting in an increase in variability, until there is again a synthesizing of the new combinations, and the group is once more relatively homozygous according to the new pattern of genetic combinations. The evidence appears to indicate very strongly that the

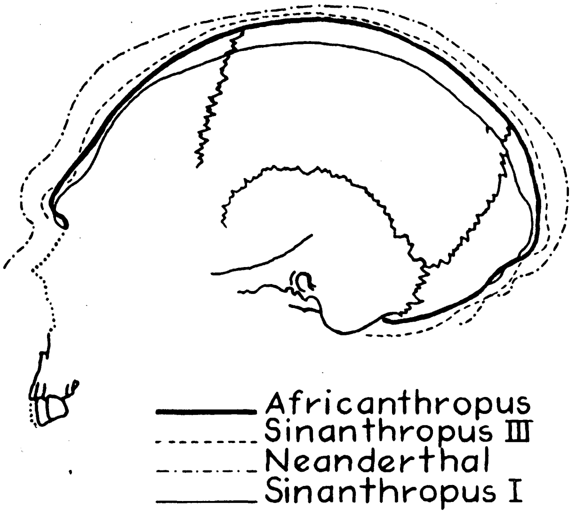


FIG. 80. Left lateral craniograms of four types of fossil skull. (After Weinert.)

neanderthaloids of Mount Carmel represented a group which had recently received a new infusion of genes from some neanthropic group.

While man of the neanthropic type has not yet been found in Palestine, there is a high probability that he will be. At any rate, during the Neanderthal phase of development, and even during the earlier late pithecanthropoid phase, there were several forms of man living, such as Swanscombe, and possibly Rhodesian man, who were of an early neanthropic type. It has even been claimed, by Leakey, that during the pithecanthropoid phase of development there were already in existence several types of man in East Africa who had attained the full status of neanthropic man but the evidence upon which this claim is based, has not yet been fully substantiated (see p. 209). These are facts of the first importance for our understanding of the evolution of man, and they are facts which have become available only during the last two decades. In the light of the discoveries made during the last twenty years the older view that man developed or evolved to his present high estate by a series of jumps from ape to man, has been forced to make way for a more comprehensive view. The notion that a more primitive type simply produced, by spontaneous generation as it were, a more advanced type, and so on in linear succession until modern man was reached, no longer agrees with the facts.

This type of reasoning seems also to have conditioned our conception of the manner in which the existing varieties of man were produced, so that there are some who still tend—incorrectly—to speak of "higher and lower races." It is tacitly assumed that both morphologically and temporally the "higher" types were evolved later than the "primitive" ones.

The facts now available suggest that this is an unsound view, and that while in the phylogeny of man there exist undoubted linear genetic relationships between some primitive and some types more advanced towards the status of modern man, hybridization between different types, differing more or less from each other, was an important agency responsible for the emergence of new types of men. The emergence of new types through hybridization, of course, presupposes the existence of earlier hybridizing parental types which are generally more primitive than their descendants. Since the new types thus produced will be possessed of some qualitatively different characters these have generally been considered as an advance upon the more primitive characters of their ancestors, immediate and remote. In the conception of a "scale" or "ladder" of development such differences were spoken of as "higher" and "lower," but evolution is inadequately envisaged as either a scale or a ladder. It is more akin to a reticulum in which many different strands are interwoven in a variety of different ways and in different patterns. Conceptually the terms "higher" and "lower" tend to inject undesirable meanings into the proper understanding of these matters. The terms "advanced" and "primitive" are scarcely less objectionable.

It must continually be borne in mind that though many discoveries of different types of men have been made during the last few decades these discoveries are probably as nothing compared to those which yet remain to be made. It is more than likely that we

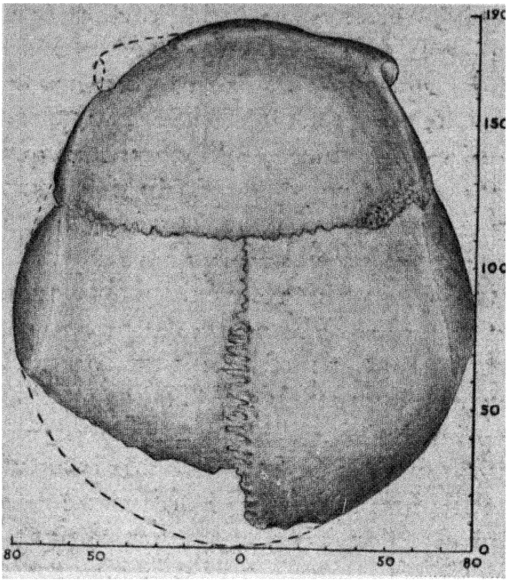


FIG. 81. The Châtelperron Skull. (From Cave. Courtesy of *Archaeologia.*)
See opposite page.

shall eventually find that in the Upper Pliocene and the Lower and Middle Pleistocene there were a fairly large number of different types of men, much greater in variety and morphologic character than is to be found among the varieties of man living at the present day.

Whether some of these type of men originated from independent proto-hominid lines (polygenesis) or from a single such line (monogenesis) and subsequently underwent differentiation are questions to which there is at present no answer. It is quite possible that some early types of men did originate from different proto-hominid lines and that from the mixture of such different early men new types were produced, but the evidence is inconclusive. The majority of students are, however, agreed that the living varieties of man belong to the same single species and that they originated from a common ancestral group. But this is a matter with which we shall deal in the next chapter.

The Châtelperron Skull. During the latter third of the nineteenth century Dr. Joseph Bailleau, a French physician and enthusiastic archeologist, apparently discovered a human calvarium in the

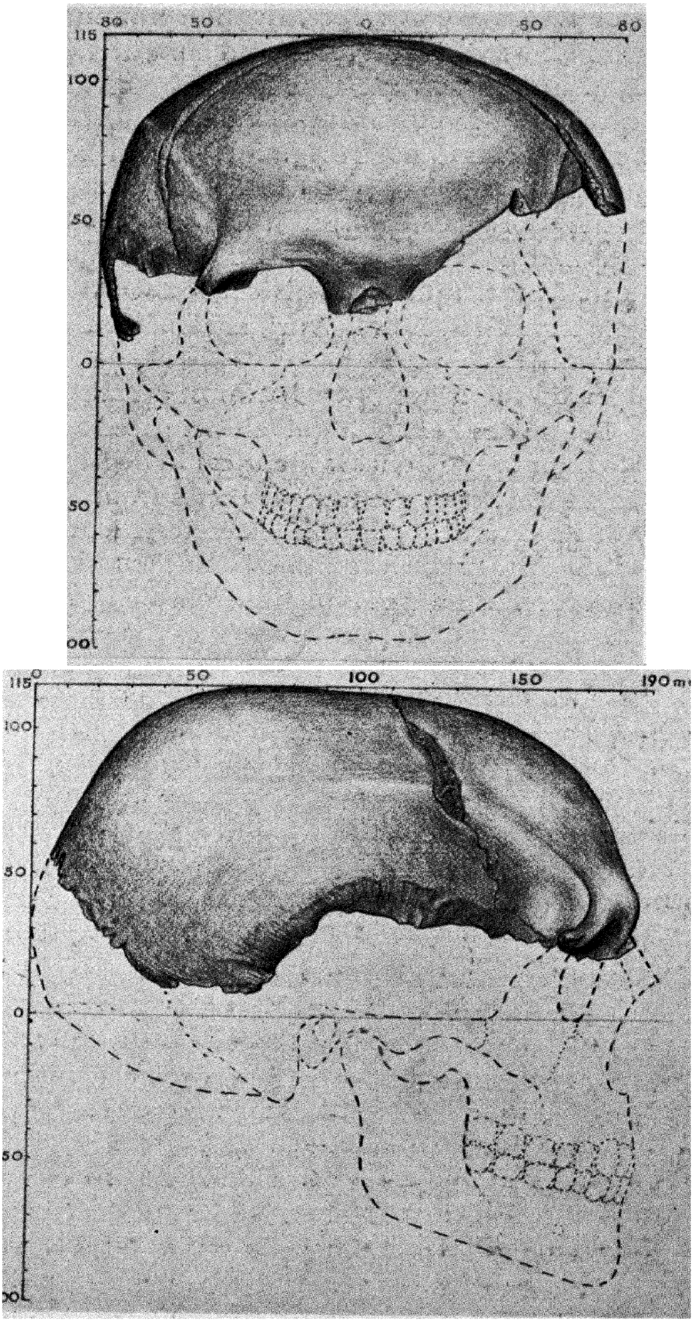


Fig. 81 (Continued)

multiple cave of La Grotte des Fées, in the commune of Châtelperron (Allier) in Central France. Stone and bone artifacts from this cave have long been held to typify the first stage of French Upper Paleolithic culture. This culture was already foreshadowed in Acheulian times. It seems to have originated in south-western Asia and spread to western Europe before the end of Mousterian times. The characteristic tool of Châtelperron is a flint blade knife with one edge straight and razor-like, and the other edge curved over to a point and blunted by trimming. This earliest Upper Paleolithic culture was formerly called Lower Aurignacian, but is now known as Châtelperronian.

The Châtelperron calvarium, which almost certainly came from the cave of La Grotte des Fées, is highly mineralized and extremely heavy. The character of the bones is identical in degree of mineralization and hue with most of the animal bones from Châtelperron. The industry of La Grotte des Fées is characteristic, and there can be little doubt that the calvarium came from the same horizon.

The Châtelperron skull consists of an incomplete skull-cap, comprising the entire right and the greater part of the left parietal, the whole of the right and the greater part of the left frontal. The skull is probably that of a male who died within his fourth decade. The bones are extremely thick, varying between 6.0 to 10.0 in the mediofrontal region, being 7.5 mm. at the right parietal eminence (euryon), and 11.0 mm. at the thickest parts of the parietals. The merest remnant of the bony nose indicates that the nasal skeleton was prominent. The (right) superior orbital margin is sharp and gracile, and terminates laterally in a strikingly developed external angular process.

Perhaps the most striking feature of the skull is its extreme brachycephaly. The maximum length is 186.0 mm. and its maximum breadth 158.0 mm., the cranial index is therefore 85.5, being in fact a little over an inch short of being as broad as it is long. The top and lower sides of the skull exhibit a markedly flattened (platycranial) contour.

When compared with crania of later, Aurignacian culture, such as the Solutrean, Předmost, and Obercassel skulls, the Châtelperron skull is somewhat broader and flatter in the vault, but otherwise very similar in its contours. The cranial capacity of the Châtelperron skull is about 1,425 c.c.

Cro-Magnon Man. It was formerly believed, principally because it was the most convenient theory at the time, that Cro-Magnon man had exterminated Neanderthal man. This would have constituted quite a task, since Neanderthal man is known to have inhabited almost every part of the Old World! On the other hand, there seems good reason to believe that far from exterminating Neanderthal man, Cro-Magnon man, a true neanthropic type was at least, a late contemporary of Neanderthal man and that intermixture between them probably occurred in Europe, if not elsewhere in the world, upon a fairly appreciable scale.

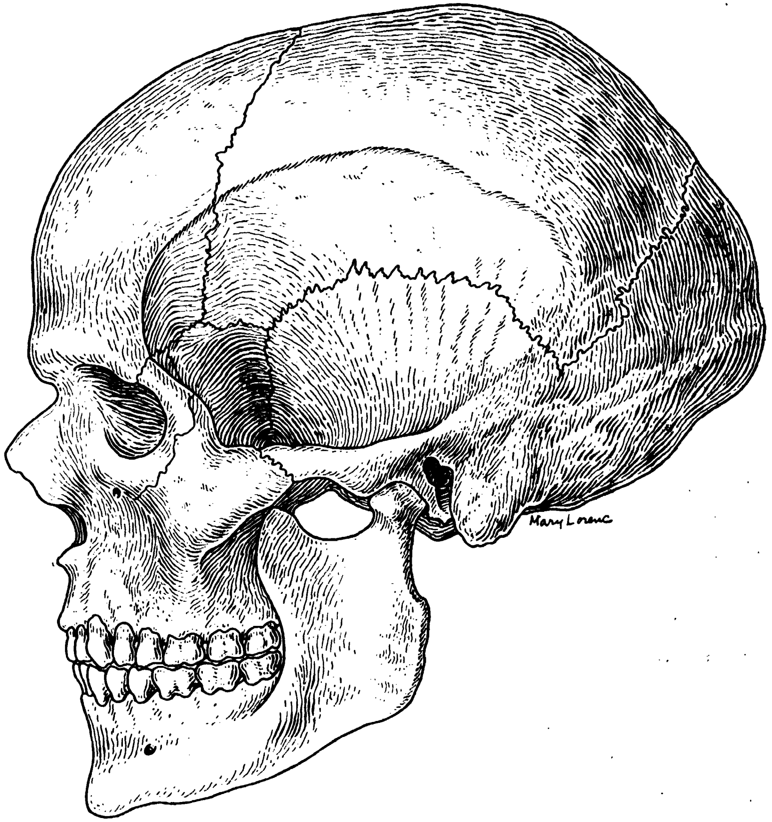


FIG. 82. The skull of a Cro-Magnon male.

The Cro-Magnons were originally discovered in 1868 in a rock shelter in the limestone cliffs of the little village of Cro-Magnon in southern central France. Between 1872 and 1902 the remains of thirteen other Cro-Magnon individuals were discovered in the caves of the Red Rocks of the Côte d'Azur, some forty minutes walk from Mentone on the Italian Riviera. Since these discoveries were made a headless incomplete skeleton found in Paviland Cave in Southwestern Wales in 1823 has been identified as almost certainly a member of the Cro-Magnon variety of man.

The Cro-Magnons were a remarkable people in many ways. Physically they were a very variable group, some of them reaching a height of five feet eleven inches, and a cranial capacity of 1,660 c.c. The size of the brain-case compared to the size of the face, which is a very short, is tremendous. Culturally the Cro-Magnons were the makers of those masterfully worked stone and bone implements which are typically associated with the Aurignacian period. The Cro-Magnons are also believed to be the people responsible for the masterly cave paintings and realistic sculptures of animals which have been discovered in many different parts of Europe.

Where the Cro-Magnons originally came from remains at present a mystery, but it would appear likely from the nature of their physical characters that they must have had quite an interesting biological history behind them.

Grimaldi Man. In one of the caves of the Red Rocks called the Grotte des Enfants, below the village of Grimaldi there was found intruded, by burial, into a Mousterian hearth, the skeletal

»»→

FIG. 83. Upper Paleolithic flint tools. a. Châtelperronian knife-point, Châtelperron (Allier). b. Gravettian knife-point Laussel (Dordogne). c. Trapezoid blade, Creswellian, Kent's Cavern, Torquay. d. Perigordian (Gravettian) graver or *burin,* Laugerie Haute (Dordogne). e. Aurignacian nosed graver (*burin busqué*), Ffynnon Bueno, Vale of Clwyd. f. Aurignacian *burin busqué,* Cro-Magnon, Les Eyzies (Dordogne). g. Magdalenian graver (*burin bec-de-flute*), La Madeleine rock-shelter, Tursac (Dordogne). h. Strangulated blade, or double "spokeshave," Aurignacian, Laugerie Haute. i. Nosed scraper, or "push-plane," Aurignacian, Laugerie Haute. j. End-scraper (*grattoir*), Cae Gwyn, Vale of Clwyd. k. Solutrean piercer, or "hand-drill," Laugerie Haute. l. Double-ended grattoir, Magdalenian, Grotte des Eyzies (Dordogne). m. Magdalenian blade-core, Grotte des Eyzies. n. Fragment of saw-blade, Magdalenian, Laugerie Haute. o. Magdalenian concave end-scraper or "spokeshave," Limeuil (Dordogne). (From Oakley, *Man the Tool-Maker, 1949.* Courtesy, British Museum [Natural History].)

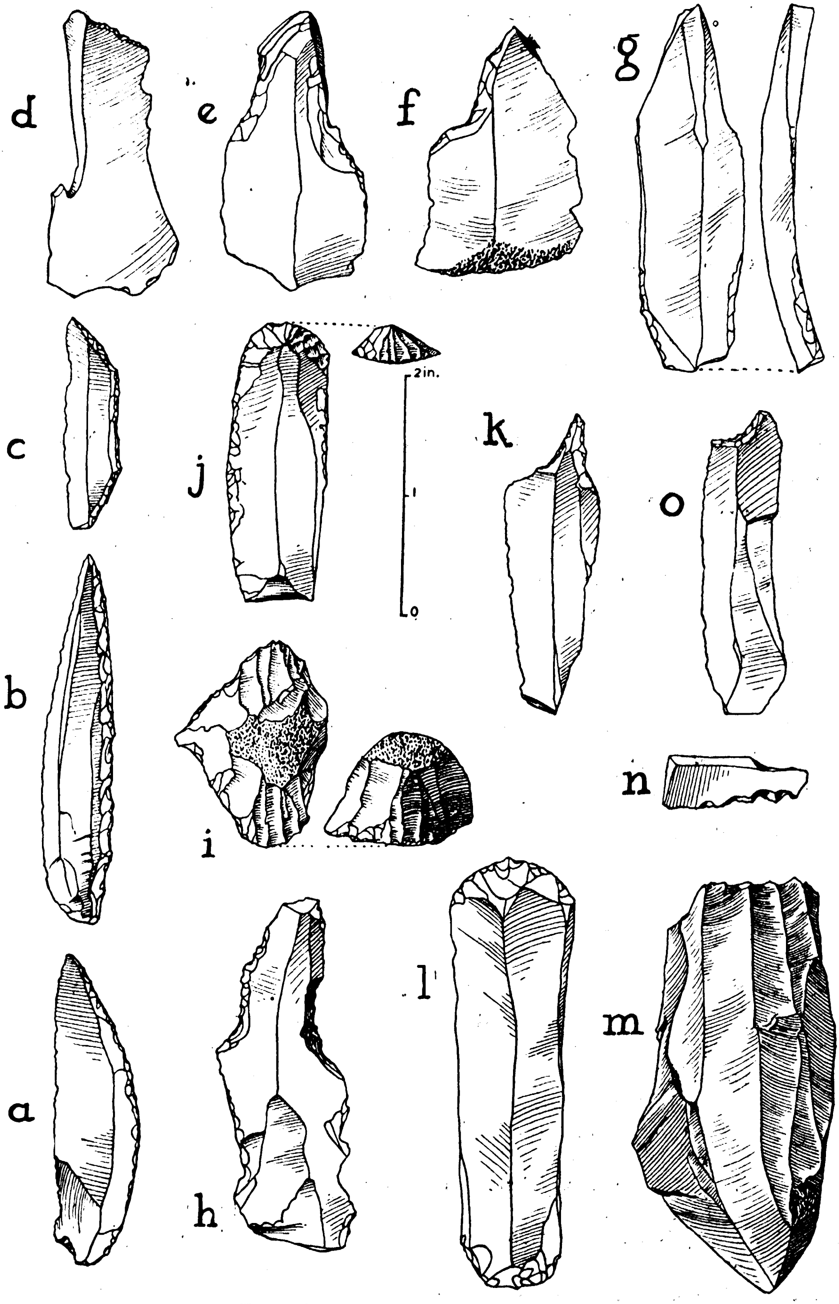


FIG. 83. See legend opposite page.

remains of a female of about 30 years of age and of a boy of about 15. The skeleton of the boy was stained with red ochre. Associated artifacts prove the remains to belong to the early Aurignacian period.

Immediately above these remains, at various levels up to the floor level of the cave, were found the remains of four other Cro-Magnon individuals.

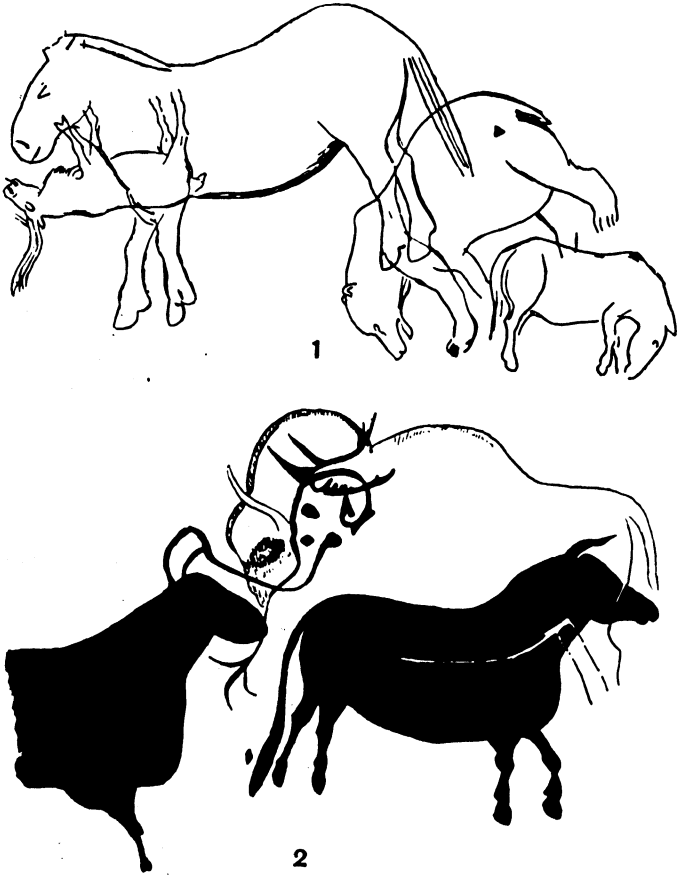


Fig. 84. Superpositions. 1, At Teyjat, superpositions of engravings of the same phase (phase 3) and style. 2, At Font-de-Gaume, superpositions of paintings of different phases—the head of a rhinocerus in red outline (phase I), covered by a shapeless figure in black, covered by oxen in black flat wash (phase 3), covered by a feebly polychrome bison (phase 4). Upper Paleolithic. (From Burkitt. Courtesy, Cambridge University Press.)

The Grimaldi remains are assumed to be those of mother and son since they closely resemble one another. Especially in their cranial characters, which are best seen in the boy, the Grimaldis exhibit certain significant differences from the Cro-Magnons. Thus, the teeth of the boy are large, and are associated with projecting upper and lower jaws. The chin is somewhat receding. The nose is broad, and the lower margin of the nasal opening instead of terminating in a sharp edge, ends in gutters which continue on the outer surface of the upper jaw. The palate is distinguished by the median bony elevation known as the *torus palatinus*. The face is short and broad, but very narrow below the cheekbones, with low broad orbits, as is the case in Bushmen-Hottentots. Cranial capacity was 1,265 c.c. for the female, and 1,454 c.c. for the boy.

The long forearm in proportion to the upper arm, the long lower leg in proportion to the length of the thigh, the flatness of the iliac blades of the pelvis, and the projection of the heel-bone (calcaneus) behind the ankle-joint (astragalo-tibial joint), have been interpreted as Negroid characters, the suggestion being that it would be difficult to account for them upon any other hypothesis than that their bearers were at least partially of Negroid origin.

Some of these Negroid characters, such as the limb-proportions, the projecting heel-bone, and the general characters of the face are retained by the Cro-Magnons, but in all other respects the latter are predominantly Caucasoid in type. In point of fact the Grimaldi skulls exhibit traits which are far more reminiscent of the Archaic Caucasoid than they are of the Negroid type, that is to say they resemble those of Australians or Pre-Dravidians of India and Ceylon more closely than they do those of Negroids. Whatever the truth may be, the relationship between Grimaldi and Cro-Magnon man is a very close one indeed, and the skeletal remains of both these forms of neanthropic man suggest the possibility that a North African Negroid or Asiatic Archaic Caucasoid or Australoid (see pp. 301-350) component played a part in the development of the early populations of Europe. Indeed, it would be difficult to conceive of such a component or components not entering into the formation of any of the peoples living along the fringes of the Mediterranean basin on the one hand, and in northern Europe on the other.

Thus we see that Neanderthal man had two variable types of neanthropic man as possible contemporaries with whom intermixture may have occurred to produce new types of men. There is even a possibility that there were quite a number of additional neanthropic types with whom such mixture may have occurred. These are the men of Engis, Aurignac, and Combe Capelle, all associated with early Aurignacian cultures, The latter have, at one time or another, been cited as possible resultant examples of hybridization of other forms with Neanderthal man. None of them

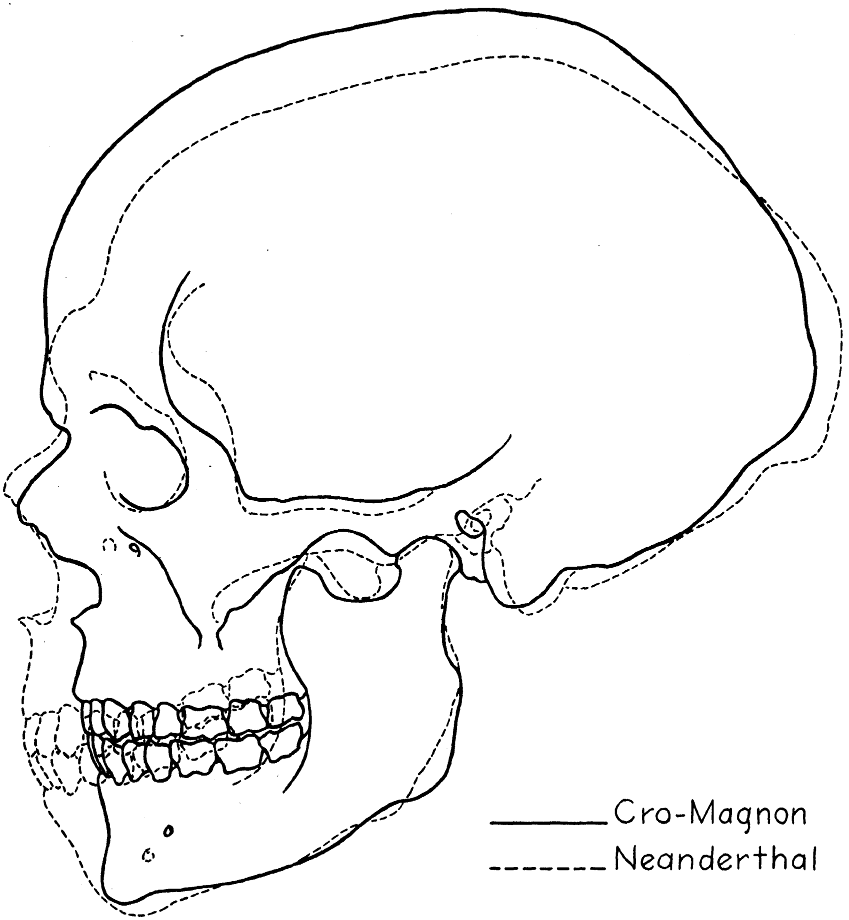


FIG. 85. Craniogram of a Cro-Magnon compared with that of the Neanderthal skull of La Chapelle-aux-Saints.

are definitely known to have been contemporary with Neanderthal man.

A group of neanthropic men who may be the descendants of crossing between Neanderthal man and Cro-Magnon man or simply a local variety of the latter are the people of Brünn and Předmost in Moravia or Czecho-Slovakia, these are generally known as the Předmost people.

The Předmost People. At Brünn in 1888 a skeleton was found, in 1891 a skull, and in 1927 another skeleton, of a neanthropic type associated with artifacts belonging to the late Aurignacian and the early Solutrean period. At Předmost, some fifty miles to the east of Brünn, there were found between 1890 and 1928 the skeletal remains of over 40 individuals of the same type and of the same culture.

The Předmost people exhibit a number of characters which suggest Neanderthal-Cro-Magnon ancestry, with the latter predominating. For example, in the development of the supraorbital ridges, in the preauricular length of the skull, in the retention of some degree of prognathism the Neanderthaloid ancestry of the group is believed to be reflected.

While it is true that the supraorbital ridges are very different in character from those of Neanderthal man, they are nevertheless such as would be expected in the descendants of a Neanderthal-Cro-Magnon cross, an expectation based on the fact that in Australian-Caucasoid crosses, where the Australian has marked supraorbital ridges and a low forehead, while the white has slight supraorbital ridges and a moderately high forehead, the latter conditions are dominant in the hybrids and in their descendants.

The mean cranial capacity of Předmost man is 1,590 c.c., height was about five feet and seven inches, figures which agree with expectation on the Neanderthal-Cro-Magnon theory of their ancestry. Further evidence in support of this theory is to be found in the presence of several Negroid or Australoid traits in the skull of Předmost man, such as its narrow, flat-sided, long and high form, together with an appreciable degree of prognathism, characters also found in the male skull of Combe Capelle. It is practically certain that, at least in one period of his existence, Předmost man was a contemporary of Neanderthal man. However this may be, we now have clear evidence of the existence of the neanthropic type *before* the appearance of Neanderthal man. We may now turn to a consideration of this evidence.

Piltdown Man. Discovered between the years 1909-1915 at Piltdown, near Lewes, in Sussex, England, Piltdown man (*Eoanthropus dawsoni*) is known from two separate finds of skull bones and teeth

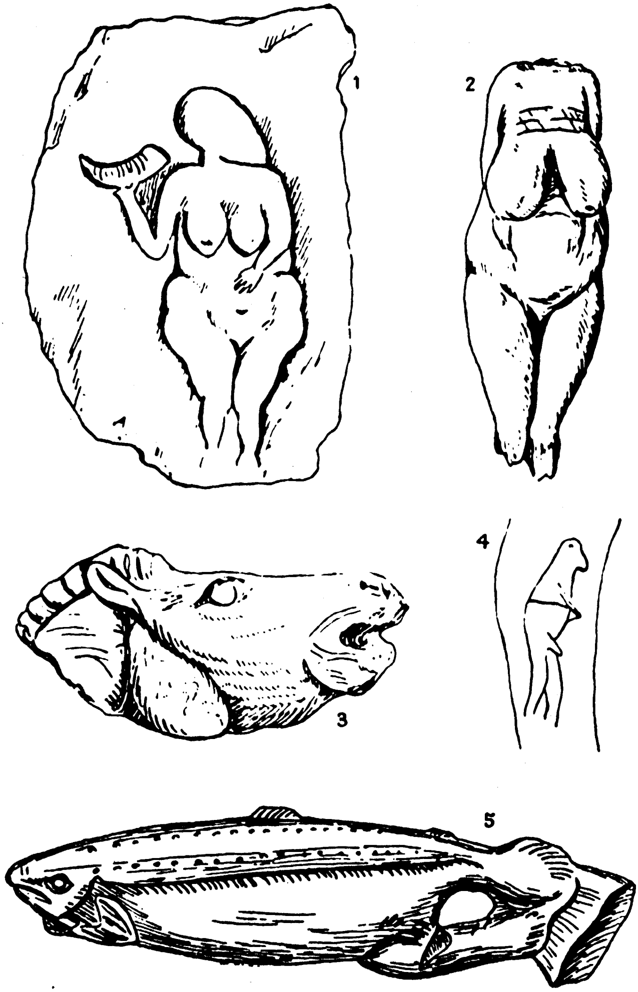


FIG. 86. Upper Paleolithic home art. 1, Venus of Laussel. 2, Venus of Kostenki. 3, Horse's head from Mas d'Azil. 4, Engraving on bone from Cresswell Crags. 5, Fish palette from Grotte de Rey. (From Burkitt. Courtesy, Cambridge University Press.)

belonging to two individuals, comprising the right half of a lower jaw with two molar teeth *in situ,* the left temporal, parietal, and nasal bones, and a good part of the frontal and occipital bones. The second find, said to have been made at a distance of two miles from the first, comprises a molar tooth and parts of the frontal and occipital bones. Part of a third skull, found at Barcombe Mills near Piltdown, remains undescribed. This consists of a complete frontal bone, and each of the zygomatic bones. The latter almost certainly do not belong with the skull. A canine tooth found in 1915 in the

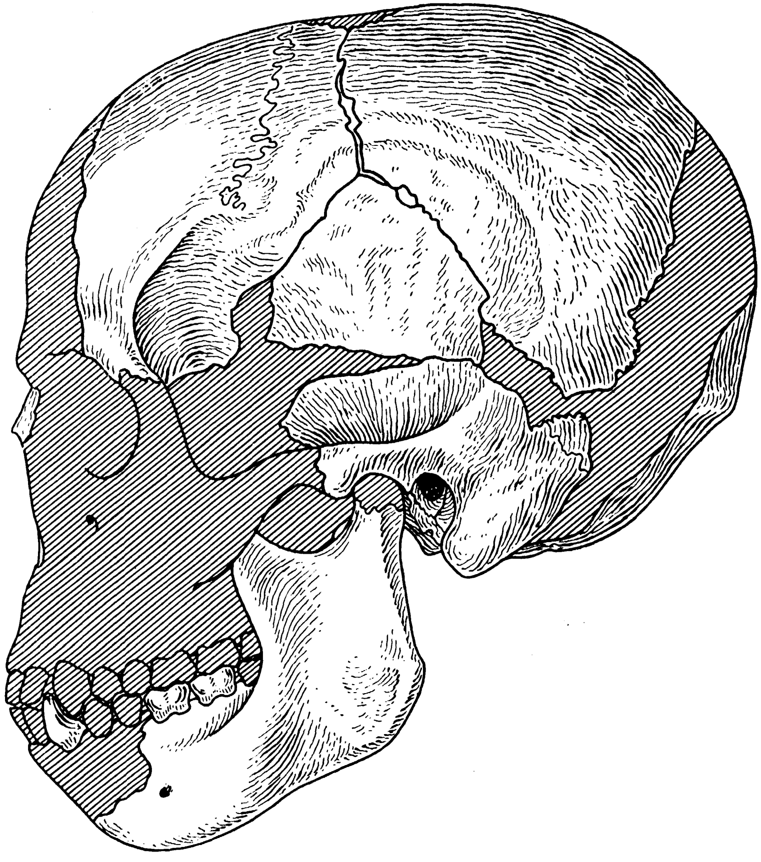


FIG. 87. Reconstruction of the Piltdown skull. Only the *right* side of the mandible, the first two molars *in situ,* and the canine were found. These structures are here drawn as of the left side to match the cranial bones.

same Lower Pleistocene gravels as the original bones, is rather chimpanzee-like in form. It has been disputed whether the jaw and teeth belonged to the owner of the other bones in view of the anthropoid-like character of the former. It is argued that it is extremely unlikely that a chimpanzee-like mandible and canine tooth could have belonged to a skull which is so like that of modern man. Morphologically, the association seems to be so improbable that most students have refused to accept the jaw and canine tooth as belonging to anything but an ape. On the other hand, Broom, who re-examined the Piltdown remains in 1949, has very little doubt that the Piltdown mandible belongs to the same individual as the brain-case. He considers that Piltdown was a big-brained type of man which evolved on a quite different line from true *Homo.* As for the simian shelf (a sort of internal chin) in the Piltdown mandible, he considers that this is probably not an indication of close affinity with the anthropoids, but a specialization due to evolution parallel with that of modern apes, just as the large brain of this type may have been a parallel development to what is found in the line of *Homo.*

There is not the slightest evidence that anthropoid apes ever existed in England. But even if they had it is extremely improbable that an anthropoid ape's mandible would be deposited in the same gravels with a human brain-case. When the thigh-bone of *Pithecanthropus erectus* was described many students refused to accept it as belonging with the skull cap because they felt it was too humanlike for so primitive a skull. Few students today hesitate to accept the two bones as having belonged to the same type, if not the same individual. Evolution, insofar as it affects the various parts of the body, has been asymmetrical. The lower extremities attained their manlike form before the skull. Similarly, the skull in its various parts exhibits evidences of asymmetric evolution. In all early forms of man the mandible seems to lag behind the brain-case in its development. The lack of a developed chin in most early forms of man is a good example. In the case of the Piltdown mandible we are almost certainly dealing with an example of asymmetric evolution in much the terms suggested by Broom. The simian shelf is not a primitive character in the Anthropomorpha. It is not present in any of the early anthropoid fossil types, but is obviously a late specialization. If it developed in the great apes, why not in an aberrant branch of man as well?

If there is any doubt about the hominid character of the mandible and canine there is none concerning the brain-case, for in its reconstructed form this reveals an obvious member of the genus *Homo* of an early neanthropic type with skull bones almost twice as thick as those of modern man. The cranial capacity was between 1,200 cc. and 1,400 cc. McGregor's estimate is 1,240 cc.

In association with the remains were found a number of the simplest type of stone tools or eoliths, a worked flint, and a large bone implement made from the thigh-bone of an elephant, probably *Elephas meridionalis.* Since the latter lived in Europe in the Upper Pliocene and Lower Pleistocene, the antiquity of the Piltdown remains would not be in doubt were it not for the fact that animal fossils of later date are found in the same gravel beds. However, by means of a delicate test for the fluorine content of bones (the test is described in detail in the section on the Galley Hill skeleton pp. 190-196) it has been possible to determine the age of the Piltdown bones. The basis of the test is that a form of calcium phosphate, known as hydroxyapatite, is progressively converted to fluorapatite, as fluorine is absorbed from water in the soil. Under the same conditions, and particularly for neighboring fossils, the oldest bones are therefore those with the highest fluorine content. In September 1949, at a meeting of the British Association for the Advancement of Science, Dr. Kenneth Oakley announced the results of the application of the fluorine test to all the available Piltdown materials.

Oakley and Hoskins found that all the animal remains of undoubted Lower Pleistocene age from the Piltdown mélange showed high fluorine content, while all those known to be of later Pleistocene age in the same bed showed a considerably lower fluorine content. All the remains of Piltdown man—and some 20 microsamples were analysed—showed extremely little fluorine. It is evident that fluorine has been deficient in the Piltdown ground-water since the gravel was accumulated; but nevertheless the test has shown conclusively that none of the bones and teeth attributed to

Piltdown man belongs to the Lower Pleistocene. The mandible and associated brain-case are of the same age, and it is probable that they date from the time of final settling of the gravel, which from physiographic evidence is now considered as not earlier than the last interglacial. The date is unlikely to be more than 100,000 years at most.

In concluding his address Dr. Oakley said that it was still open to

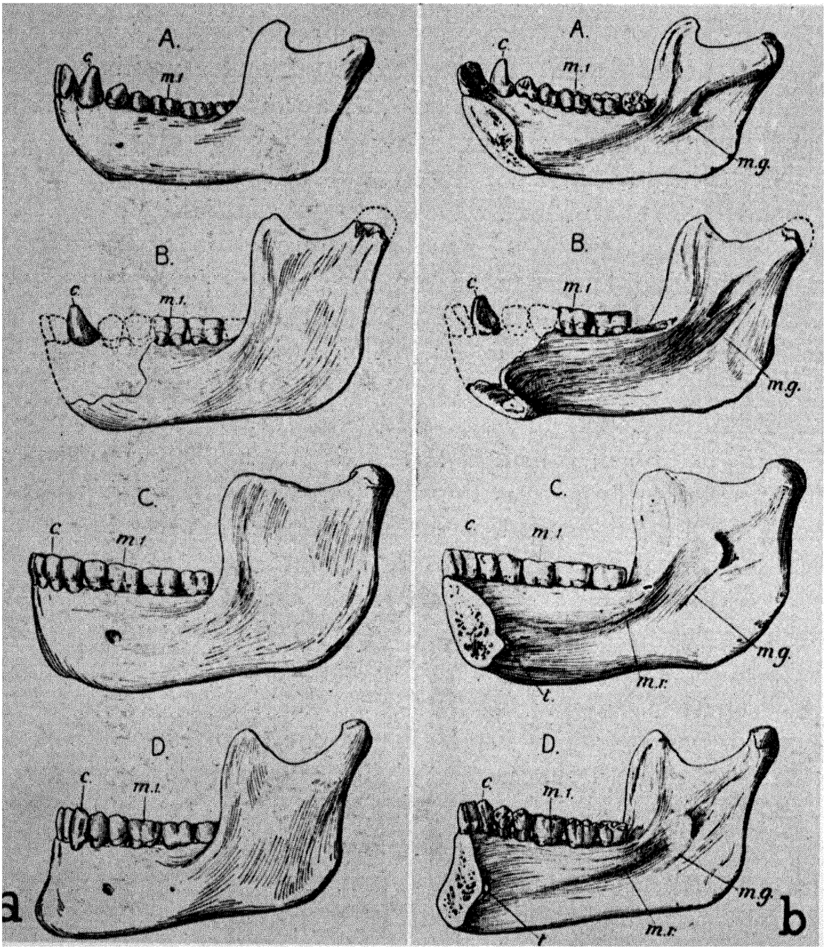


FIG. 88. *a,* Left outer and *b,* right inner side view of lower jaw of Piltdown Man B compared with that of chimpanzee A, Heidelberg Man C, and Modern Man D. c. canine tooth; m.1 = first molar tooth. One-half natural size. (Courtesy, British Museum [Natural History].)

scientists to argue about the naturalness of the association of an ape-like mandible with a typically human brain-case, but in the light of the revised dating he suggested it appeared more probable that they belong to one creature. Oakley urges that consideration should now be given to the possibility that Piltdown man is not primitive

FIG. 89. Bone implement from Piltdown, made from the thigh-bone of an elephant, and retaining part of the concave inner wall of the marrow cavity A, the smooth hinder surface B, and the outer edge C including the third trochanter; nearly one-third natural size. *b,* accidentally broken hollow, *c,* natural break by pressure in the gravel, *p,* inner wall of perforation from which outer walls has been broken away, *x,* beginning of another perforation. (Courtesy, British Museum [Natural History].)

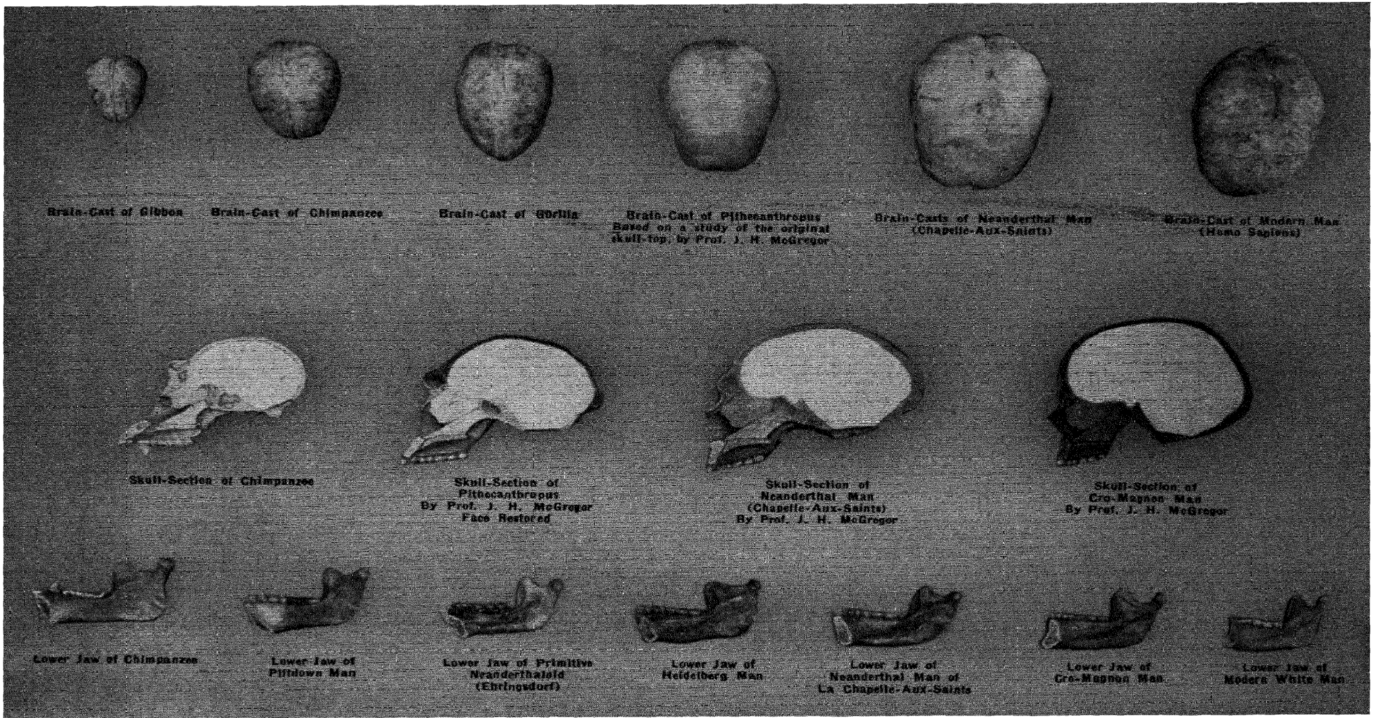


FIG. 90. A comparison of the brains, mid-sagittal sections of the skulls, and inner sides of lower jaws of anthropoids and man. Top row: Brain casts of gibbon, chimpanzee, gorilla, *Pithecanthropus erectus*, Neanderthal Man of La Chapelle-aux-Saints, and Modern Man. Middle row: Chimpanzee, *Pithecanthropus erectus*, Neanderthal Man of La Chapelle-aux-Saints, Cro-Magnon Man. Bottom row: Chimpanzee, Piltdown, Neanderthaloid (Ehringsdorf), Heidelberg, La Chapelle-aux-Saints, Cro-Magnon Man, Modern Man. (Courtesy, American Museum of Natural History.)

in the strict sense, but a specialized forest type which evolved in isolation and became extinct at the beginning of the last glacial period.

No examples of Neanderthal man have ever been found in England, but remains (principally teeth) of undisputed Neanderthal man have been found in the Channel Island of Jersey not many miles away, while in England itself several Mousterian sites have been discovered, affording strong inferential evidence of the presence of Neanderthal man in that country. Hence, it is not impossible that there was some intermixture between Piltdown and Neanderthal man. Weinert considers that Piltdown was almost certainly a contemporary of Neanderthal man, and there can today be very little doubt that he was. As we shall see, the evidence is now beyond dispute that neanthropic types were not only in existence contemporaneously with Neanderthal man, but that they were already flourishing even before the latter's appearance upon the scene at all.

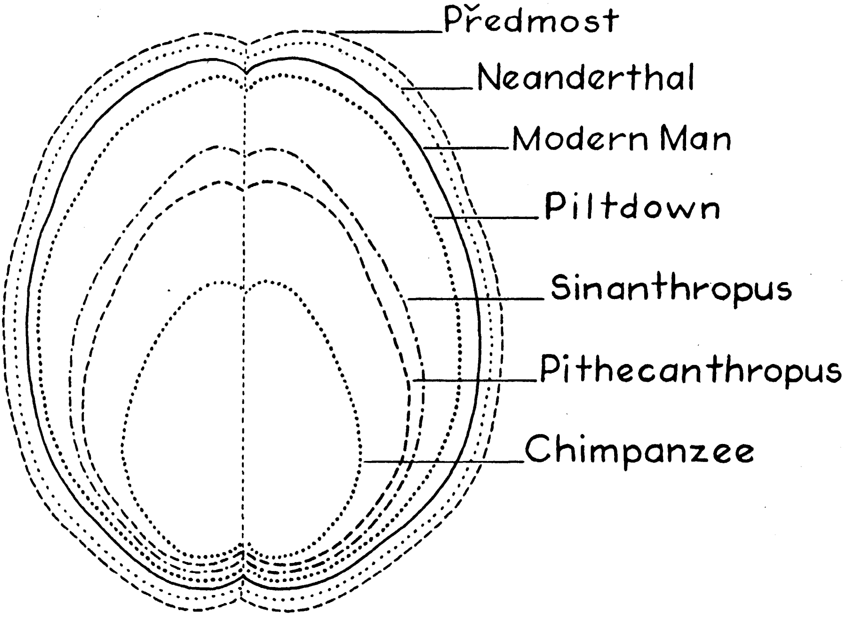


FIG. 91. A comparison in brain sizes. Chimpanzee 400cc. *Pithecanthropus* 860cc. *Sinanthropus* 1075 cc. Piltdown Man 1300 cc. Modern Man 1400cc. Neanderthal Man 1450cc. Předmost 1500cc.

It is important to remember that while Neanderthal man may show some characters morphologically more primitive than Piltdown man, he exhibits several others that are more advanced, such as a reduction in the thickness of the bones of the skull, and an increase in the size of the brain. In fact, Neanderthal man may be interpreted as bearing many of the earmarks of an hybrid type, with a large brain as the primary novel emergent, and a perfectly harmonious mixture of primitive and advanced morphologic traits, almost as if some pithecanthropoid and some neanthropic type had been the hybridizing stocks from which he had emerged. Solo man would be an excellent possible ancestor of the first kind and some early neanthropic type like Piltdown man of the second. On the other hand it is quite possible to envisage Neanderthal man as a larger brained descendant of *Sinanthropus* or *Africanthropus.*

That there were quite a number of early neanthropic types already in existence by the Middle Pleistocene is evidenced by the fact that in Europe alone several such types have been found, and there is also some evidence of their occurrence in Africa.

The London Skull. In November 1925 most of the occipital and left parietal bones, and parts of the right parietal of a single human skull were found in central London, during excavations for the new Lloyd's building. The age of the deposit in which these bones were found is at latest Upper Pleistocene, though there is a possibility that it may be Middle Pleistocene. The bones and the brain cast taken from them display an interesting medley of features, some bearing close affinities to Neanderthal man and some to Piltdown man. It is, indeed, quite possible that the latter were the joint ancestors of the London Lady (the smoothness of the bones and the weakness of the muscular impressions indicate the probability that the sex was female). The rather marked flatness of the reconstructed vault of the skull, the gradual curvature of the parietal and occipital bones, and the presence of an expanded area in the occipito-temporal region of the brain, are all primitive features encountered in Neanderthal man. The cranial capacity has been estimated to have been about 1,260 c.c., some 40 c.c. less than in the average modern English woman. The slightly greater fullness of the parietal region, and the form of the cerebellum and its bony compartment sufficiently distinguish this skull from the

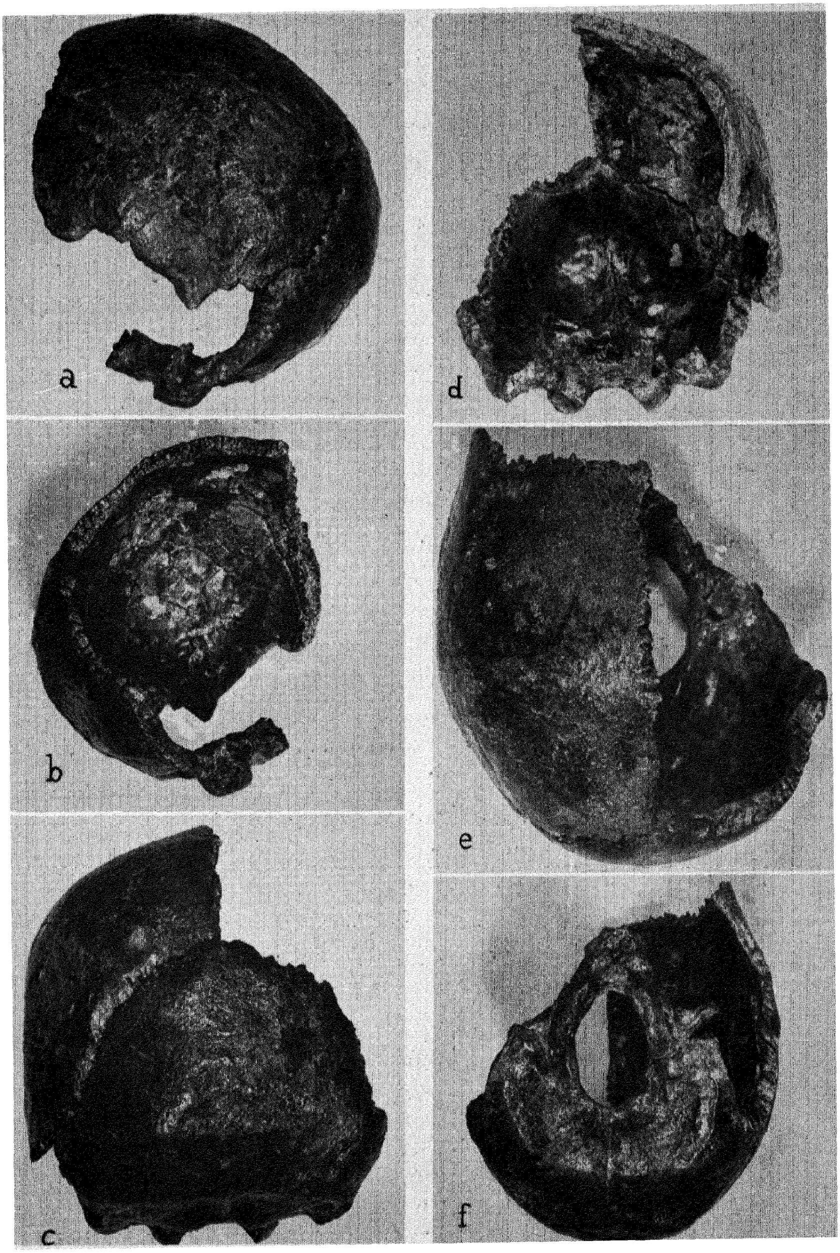


FIG. 92. The Swanscombe skull. a, left lateral view, b, left lateral endocranial view, c, occipital view, d, occipital endocranial view, e, vertical view, f, basilar view. (Courtesy, Dr. G. M. Morant.)

Neanderthal type to bring it within the range of the early neanthropic types.

Sir Arthur Keith has made out an excellent case for the close affinity of the London skull with Piltdown man, reconciling the lesser thickness of the bones of the former as compared with the

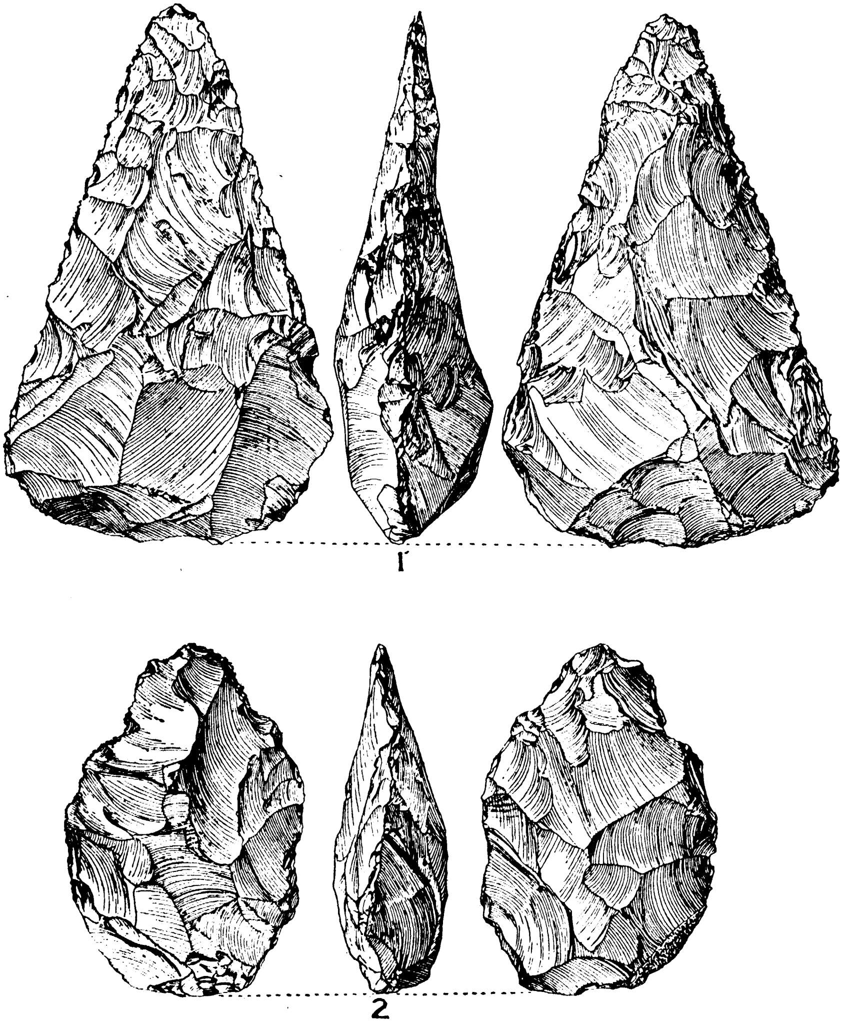


FIG. 93. Acheulian hand-axes associated with the Swanscombe skull. 1, found six feet east of occipital bone, 2, found one foot west of occipital bone. (Courtesy, Royal Anthropological Institute.)

great thickness of those in the latter, in the suggestion that these represent sexual differences, an explanation for which there is some justification in the conditions found in Neanderthal man, and to a lesser degree in contemporary groups of man. In reality, as has already been suggested, it may well be that the type represented by the London Lady represents a descendant of Neanderthal-Piltdown ancestry.

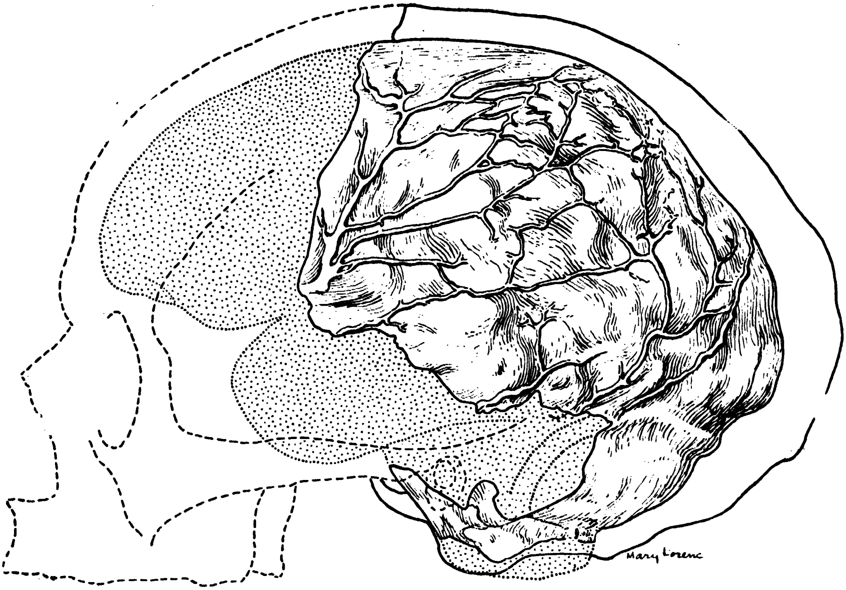


FIG. 94. The Swanscombe endocranial cast of the brain and its reconstruction together with the mid-sagittal section of the parietal and occipital bones as the basis for a reconstruction of the frontal and facial portions of the skull (reconstruction of the brain after Le Gros Clark).

Swanscombe Man. In 1935-36 at Swanscombe, Kent, in England, in a deposit which is not later than the second interglacial of the Middle Pleistocene, an extremely important find was made of a human left parietal and occipital bone. Except for the remarkable thickness and the great breadth of the occipital, these bones are otherwise indistinguishable in form and character from those of modern man, and there can be little doubt that they belonged to an early neanthropic type. Associated with this fragment of the skull were artifacts of Early Middle Acheulian type, that is to say, representing an industry very appreciably antedating the Late Acheulian and Mousterian industries of Neanderthal man.

The importance of the Swanscombe find lies in the fact that it represents the first fully corroborated discovery of a neanthropic type of man in an early geological and cultural horizon.

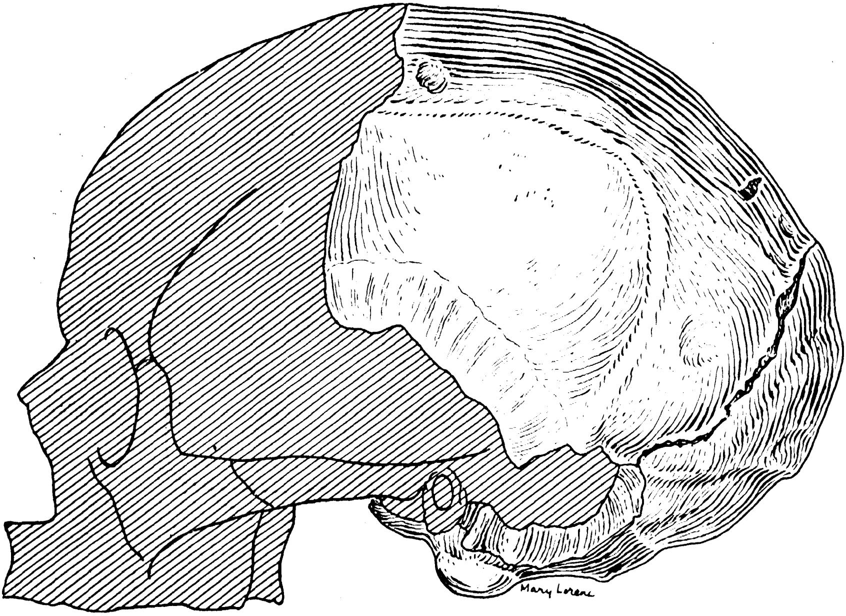


FIG. 95. The Swanscombe parietal and occipital bones with the conjectured neanthropic face added.

The cranial capacity of this, probably female, skull is estimated to have been about 1,325 c.c.

Interestingly enough, about the year 1912 portions of a human calvarium together with part of the upper jaw, the whole of the lower jaw, and the first and second cervical vertebrae were found at a depth of eight or nine feet in the alluvial gravel at Swanscombe, but since the skull was of modern type, it unfortunately seems to have been assumed that it could not have been of the geological antiquity indicated by the deposit in which it was found. The present whereabouts of these remains are unknown.

It is at present quite impossible to speak with any degree of certainty upon the matter, but it is not unlikely that Piltdown is related to Swanscombe man. Keith, assuming the greater antiquity of Piltdown man, has pointed out some striking resemblances between the two types, and suggests that Swanscombe man is best explained as a modified member of the Piltdown phylum. The resemblances are, indeed, of such a nature that some relationship

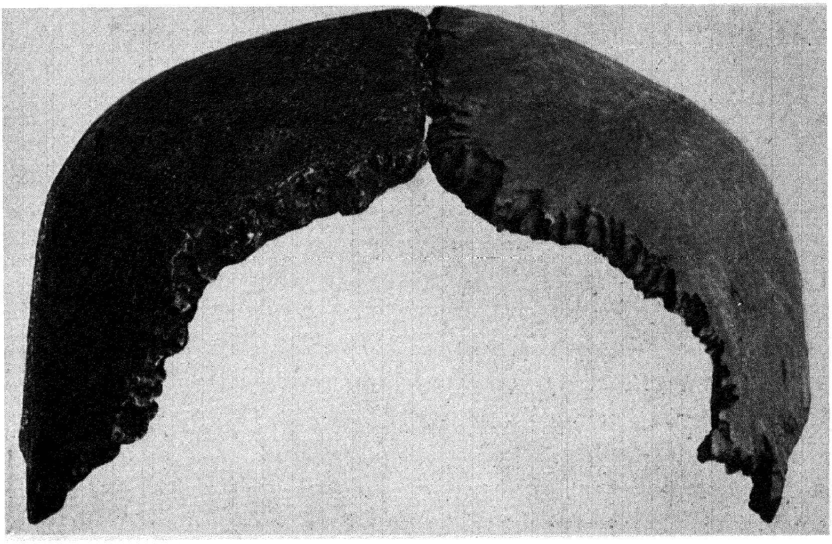


FIG. 96. Left parietal bone of the Swanscombe skull, seen from behind, placed in apposition to the right parietal bone of a modern European skull. (From Le Gros Clark.) (Courtesy, British Museum [Natural History].)

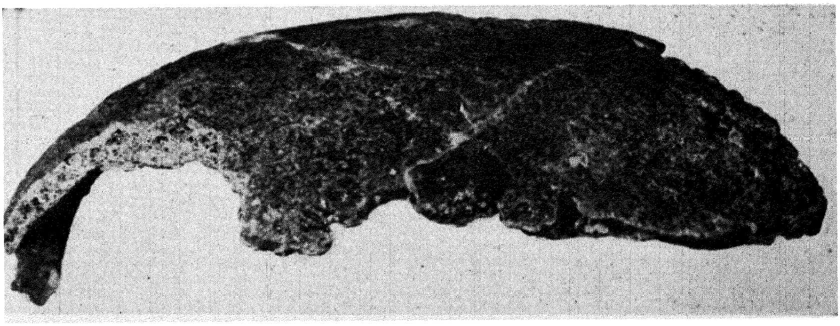


FIG. 97. The Bury St. Edmunds skull fragment. Showing parts of the frontal and parietal bones.

between the two is readily conceivable, and even probable. Swanscombe, the London skull, and possibly the fragments of the skull found at Bury St. Edmunds, in 1882, associated with implements of Acheulian age, may all be related to the Piltdown type. These may very well have been early contemporaries of Neanderthal man, so that intermixture between them is another possibility to be borne in mind.

The Galley Hill Skeleton. The Galley Hill skeleton is referred to here at some length for several reasons. Firstly, because in the recent literature the skeleton has increasingly come to be accepted as a probable representative of second interglacial man. Secondly, in the first edition of this book the antiquity of the Galley Hill skeleton was forcefully defended. In the summer of 1948 the author was able to study not only the skeleton itself, but also the general geological and stratigraphical conditions of the site from which the skeleton was recovered. In addition, the bones have been subjected to a chemical analysis, the results of which would alone be sufficient to disprove all claims to antiquity of the Galley Hill skeleton. It is for these reasons and also because the story of the Galley Hill controversy illumines the nature of the problems as well as the dangers and pitfalls which confront the paleoanthropologist that a somewhat extended account of Galley Hill man is given here. At the same time the account will provide an opportunity to discuss some of the methods by means of which such problems as were presented by the Galley Hill skeleton can be solved.

The Galley Hill skeleton was found by a workman in the Galley Hill pit, some 500 yards from the quarry in which the remains of Swanscombe man were found in 1935-36. The Galley Hill find was made in September 1888. Mr. Robert Elliott, who saw the bones *in situ* soon after they were found, stated that they were "about two feet above the top of the chalk and eight feet from the top of the gravel, portions of bone were projecting from a matrix of clayey loam and sand. . . .

"The section of gravel was 10 or 11 feet thick, and extended for a considerable distance along the south and east end of the pit; several pot-holes or pipes running from it deep into the Chalk . . . the section on either side of the remains . . . presented an unbroken

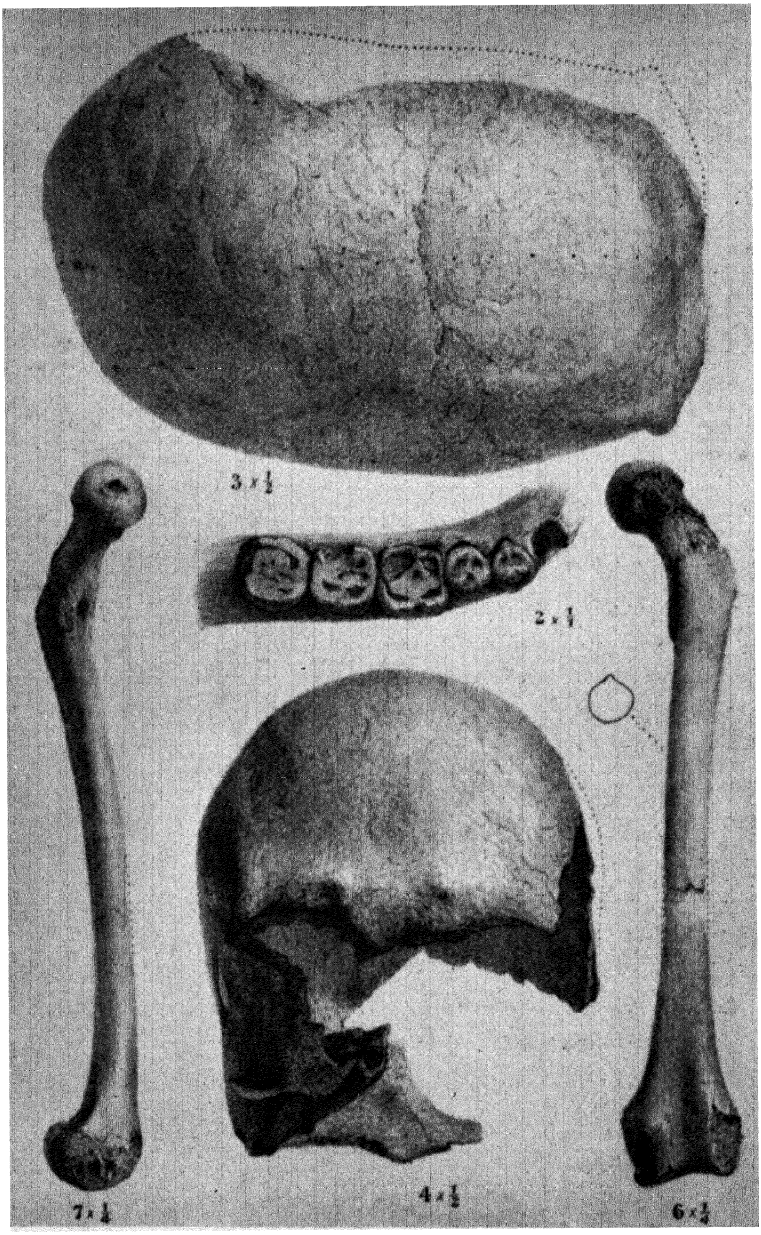


FIG. 98. The Galley Hill skeleton. 2, occlusal view of teeth, 3, vertical view of skull. 4, frontal view of skull, 6, left femur frontal view, 7, left femur medial view. (From Newton. Courtesy, the Geological Society of London.)

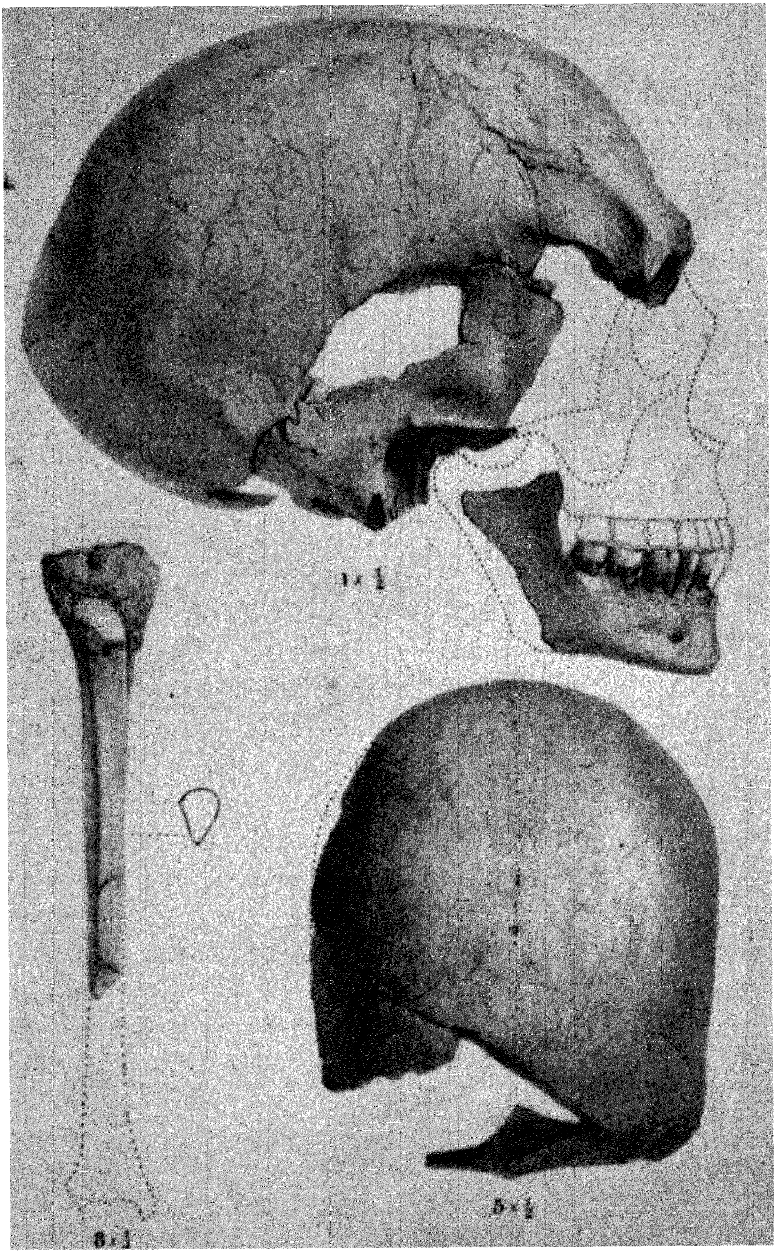


FIG. 99. The Galley Hill skeleton. 1, skull and mandible, 2, occipital view of skull, 3, right tibia. (From Newton. Courtesy, Geological Society of London.)

face of gravel, stratified horizontally in bands of sand, small shingle, gravel, and, lower down, beds of clay and clayey loam, with occasional stones in it—and it was in and below this that the remains were found. We carefully looked for any signs of the section being disturbed, but failed: the stratification being unbroken."

Excavation of the Galley Hill site in 1948 revealed a stratified sandy gravel some eight feet thick, which has been disturbed by the solution of the underlying chalk. The solution of the chalk is due to a downward percolation of carbonic acid laden waters through the gravels. Because this process has been so pronounced at this site no original bones or shells have survived in the gravel. This is a telling bit of evidence. Why should a human skeleton alone have survived? Analysis of the gravels, sands, and loams at Galley Hill shows that they have been completely decalcified (the pH is 6.8*). A human skeleton could scarcely have survived in such an environment since Middle Pleistocene times. It must therefore be concluded that the bones were introduced after the deposits had become decalcified. Furthermore, analysis of samples of soil which were recovered from the site with the skeleton and subsequently, reveal the presence of sand, silt, and clay. The presence of a skeleton embedded in such a mixed matrix is suggestive of artificial burial.

The fact that Elliott and the local schoolmaster detected no signs of disturbance in the overlying gravel, may simply mean that by the time they saw the remnants of the skeleton protruding from the face, the bulk of any evidence of burial had already been destroyed by the gravel digger. In any event, the deposits could very easily have been of such a nature that traces of disturbance due to burial would have been obscure. McKenny Hughes has shown how easily traces of interment are obliterated in Pleistocene deposits. Even experienced geologists have been known to mistake settled layers of tipped gravel for natural strata. In 1913 Duckworth compared the deformation pattern of the Galley Hill skull with that of skulls

---

*pH symbol for hydrogen ion concentration. A pH of 7 indicates equilibrium or neutrality; when the figure is above 7 alkalosis is present, when below 7 acidosis is present.

recovered from Saxon graves, and concluded that the skeleton of Galley Hill man almost certainly represented a burial of comparatively recent date.

The skull had been described as exhibiting the characters of a primitive type of modern man. The primitive features of the Galley Hill skull when I examined it were entirely wanting. The bones of the skull had been described as thick. I found them to be of the same thickness as those of the average modern male. The mandibular or sigmoid notch of the ramus of the mandible was said to be almost absent. It was. But not because it had never been there, but because the margins forming it had been partly broken away. The last molar tooth was said to be longer than the second. I found the opposite to be true. In short, the skeleton revealed not a single primitive feature. Furthermore, there were no evidences of fossilization. What had deceived most of those who had inspected the bones was the fact that they had been treated with a gelatin which had given them a purplish hue, thus endowing the bones with an appearance of great antiquity. But beneath this the internal structure of the bones is quite like that of relatively recent bones.

The great revival of interest in the Galley Hill skeleton in recent years was due to the discovery by Mr. A. T. Marston of the parietal and occipital bones of a woman in the Barnfield pit at Swanscombe in 1935-36. There was no doubt that these fossils were of Early Paleolithic age. When it was shown that these two bones exhibited no features (except thickness) which distinguished them from those of modern man, interest in the Galley Hill skeleton received a new fillip. At any rate there appeared to be less reason for doubting the antiquity of the latter merely on the score of its modern morphology. Familiar only with the published evidence, many authors, the writer among them, accepted the Galley Hill skeleton as of Early Paleolithic age. Clearly, the question of Galley Hill man's antiquity had become a matter of opinion, if not of actual wishful thinking. What was needed was some sort of delicate test by means of which the relative age of the bones could be accurately determined. Such a test was first devised by Middleton, an English geological chemist, and published in 1844.

It was developed by a French geologist, Carnot, in 1893, and has recently been revived by Dr. Kenneth Oakley of the British Museum. This test is in the form of a comparative analysis of the fluorine content of bone.

It is known that the fluorine content of bones relative to the soil in which they are contained increases with geological age. This is due to the fact that the main inorganic salt from which bone is formed, namely, hydroxyapatite $(Ca_3P_2O_8)\,Ca\,(OH)_2$, a form of calcium phosphate, acts as a trap for fluorine ions, which are usually present in small numbers in most ground waters. The hydroxyapatite crystal units become converted one by one into fluorapatite $CaF_2[Ca_3(PO_4)_2]_3$. Fluorapatite is a stable mineral which is resistant to weathering. Fluorine is not easily leached after it has been fixed in bone. Hence the fluorine content will increase with the passage of time. Owing to the porous character of bone, the fluorine tends to be distributed uniformly throughout the bone.

By spectrographic and delicate microchemical analysis it is possible to determine the amount of fluorine present in any bone. Such an absolute datum taken by itself can give us no idea of the age of bone. It is only when bones taken from different geological strata and from the same locality are compared with one another that an estimate of relative age can be arrived at on the basis of their fluorine content. Bones taken from different localities cannot be compared owing to the great variation in the fluorine content of soils in different areas. The bones must be taken from the same locality and from strata above and below those from which the bones have come in which we are chiefly interested. Bones from the older levels will have a higher absolute fluorine content than those at more recent levels. Bones from the same level as those in which we are chiefly interested should have a similar fluorine content. Applying such comparative chemical tests to bones of known geological age from the Galley Hill-Swanscombe locality, and comparing the results with the fluorine content of five different bones of the Galley Hill skeleton, the following percentages were obtained:

PERCENTAGE OF FLUORINE IN BONES FROM THE SWANSCOMBE-GALLEY HILL REGION (OAKLEY AND MONTAGU)

		Fluorine *Per cent*
9 Samples of fossil animal bone from loams and gravels in 100-ft terrace (Middle Pleistocene)		2.0
		2.8
		2.1
		1.7
		1.7
		2.3
		2.0
		2.0
		1.7
Samples of Swanscombe skull	Occipital bone	*c.* 1.9
	Parietal bone	*c.* 2.0
6 Sample of fossil animal bone from loams and gravels in 50-ft. terrace complex (Upper Pleistocene)		1.0
		1.2
		1.4
		0.9
		1.1
		1.0
5 Samples of recent bones from soil or subsoil (Postglacial)		0.1
		0.1
		0.2
		0.3
		0.05
5 Samples of Galley Hill skeleton	petrous bone	0.3
	mandible	0.4
	right tibia	0.4
	limb bone	0.4
	left femur	0.2

From these figures it will be seen that the highest fluorine content of the Galley Hill bones amounts to but one-fifth of the percentage found in Middle Pleistocene bones, and is only one to three-tenths per cent higher than in recent bones. It is clear, then that the Galley Hill skeleton is much more recent than Middle Pleistocene, and as is shown by comparison with bones from the Upper Pleistocene, is even more recent than that age.

It is safe to say that the Galley Hill skeleton represents the remains of a body which was buried in post-glacial times, and is not more than a few thousand years old.

The Wallbrook Skull. In 1943, during excavations in London for the foundations of the new Western Union House, an almost complete frontal bone was found by a workman about 1,000 yards from the site of the London Skull. Unfortunately, the geological position of the find remains ambiguous, owing to the conditions under which it was retrieved. The evidence, however, strongly suggests that the bone was derived from the red gravel of the Upper Floodplain Terrace of the Pleistocene, and was redeposited in alluvial mud. Its state of fossilization, the traces of earth which adhere to the bone, the statements of the workman who found it and of the electrician who witnessed the find, all indicate that it belongs to the same geological horizon as the London Skull. The evidence favors an Upper Pleistocene age.

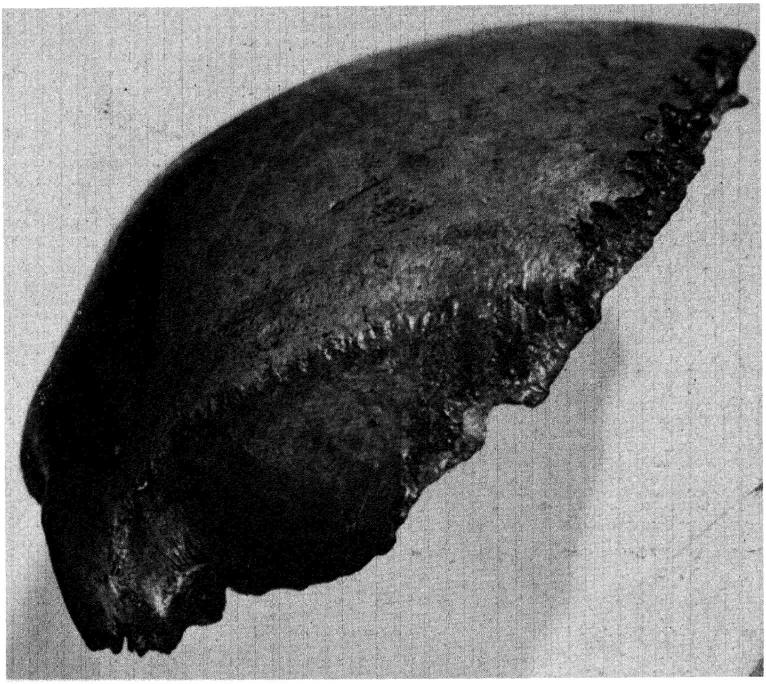


FIG. 100. The Wallbrook frontal bone. (Courtesy, British Museum [Natural History].)

With the exception of a small triangular piece on the right side and nearly the whole of the glabellar region and pars nasalis, the whole of the frontal bone is preserved (broken in two pieces which fit perfectly). The bone is extremely thick, but in every other respect is in no way distinguishable from that of contemporary man. The superciliary arches and the supraorbital margins show no excessive development. The slope, fullness, and 'bossing' of the forehead, are precisely as in contemporary man, and there is no bilateral narrowing.

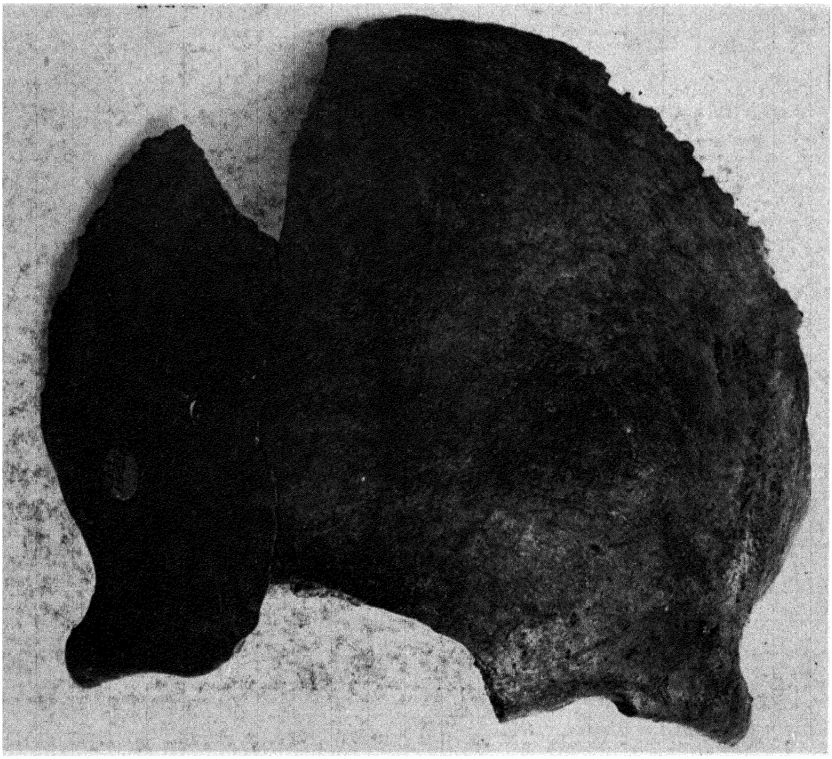


FIG. 101. The Wallbrook frontal bone. (Courtesy, British Museum [Natural History].)

The importance of this skull fragment, altogether apart from its age, is considerable. At the coronal suture the thickness of the bone is slightly greater than that of the Swanscombe parietal at its coronal suture. One of the writers of the report on the Swanscombe skull, Dr. G. M. Morant, considered that the abnormally thick parietal and occipital bones "suggest forcibly not only that the missing frontal bone was abnormally thick, but also that it probably possessed a more massive supraorbital region than any modern specimen." The Wallbrook frontal bone with its thicker coronal border, and supraorbital region which in no way differs from that of modern man, serves to show not only how far wrong one can go in such speculations, but also to underscore the danger of drawing inferences as to the form of the frontal region and face from the thickness of vault bones. The Wallbrook frontal bone is thicker than the Swanscombe parietal, and it is of modern type. In short, the Wallbrook frontal serves to remove the last objection to the possibility that Swanscombe man possessed a forehead and face like that of contemporary man. We need but one thing to be quite certain—the actual bones themselves!

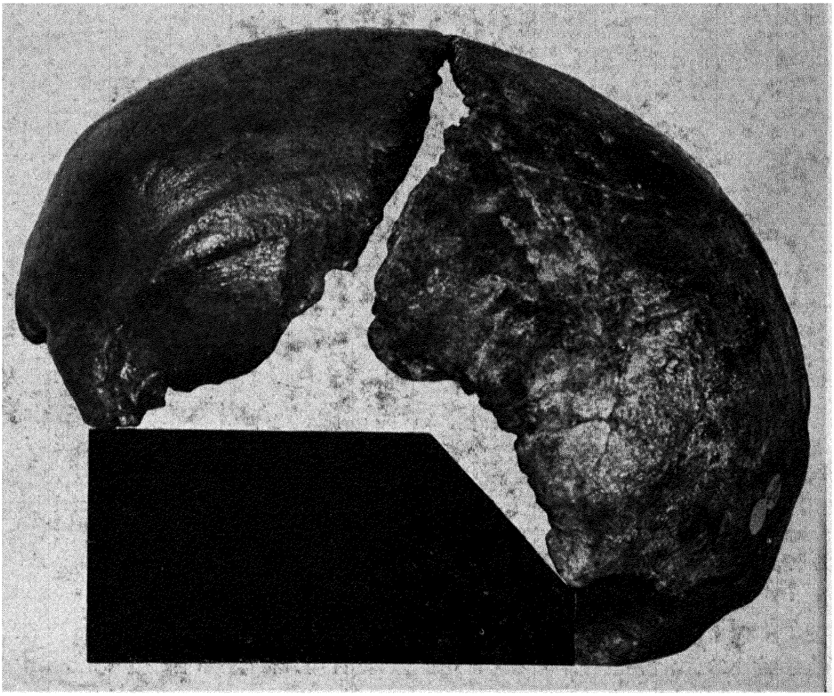


Fig. 102. The Wallbrook frontal bone and the Swanscombe parietal bone approximated at the region of the coronal suture. Left lateral view. (Courtesy, British Museum [Natural History].)

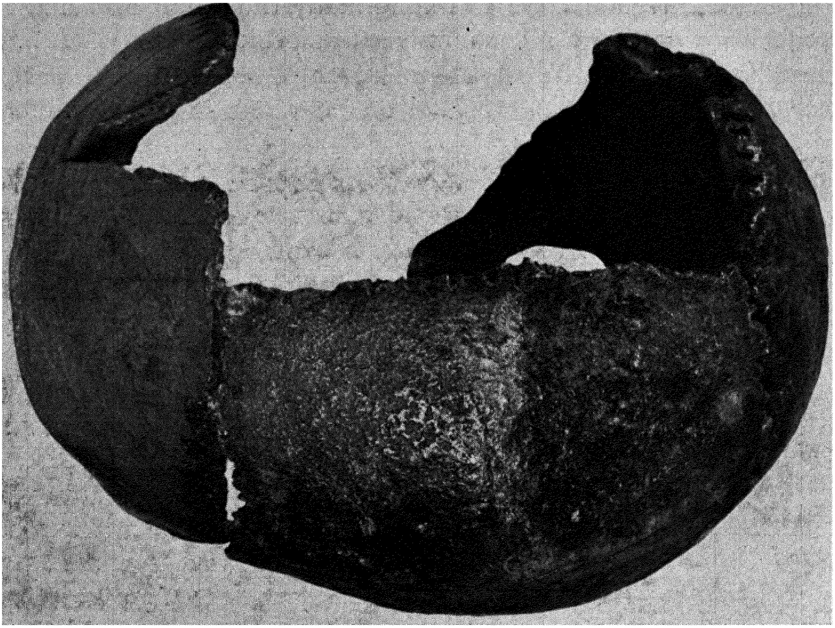


FIG. 103. The Wallbrook frontal bone and the Swanscombe parietal bone approximated at the region of the coronal suture. Vertical view. (Courtesy British Museum [Natural History].)

The Fontéchevade Skulls. In August 1947 in the cave of Fontéchevade, near the village of Montbrun, Department of Charente, France, Mademoiselle Germaine Henri-Martin discovered a human calvarium. This was found beneath the hard stalagmitic floor in the red sandy clay. Associated were crude flint implements consisting mainly of large flakes. These have been assigned to an industry transitional between Mousterian and an earlier period, identical with that found by Abbé Breuil in the lowest archeological horizon at La Micoque, and known as Tayacian. The horizon of the deposit in which the Fontéchevade skull was found is third interglacial. The associated remains of Merck's rhinoceros and a warmth-loving Mediterranean turtle (*Testudo graeca*) help to date the age of the skull. It is about 150,000 years old. It is thus the oldest representative of fossil man ever found in France. It is of interest that it should have come from the very center of the region which has yielded so many remains of Neanderthal man.

Virtually a complete skull-cap was recovered, as shown in Fig.

104. Actually the base of the skull is missing as are the supraorbital portions of the frontal bone. The bones are quite thick, varying from 7 to 9 mm. As is the case in most Paleolithic crania the skull is longheaded. The cranial index actually makes the skull mesocranial, for Vallois has calculated it at 78.9. It is of interest to note that the cranial index is 78.2 in Swanscombe, and 79.4 in Piltdown. Indeed, as Vallois points out, Fontéchevade seems to belong in the same group with these types. The cranial capacity of Fontéchevade has been calculated by Vallois to be 1,470 c.c. Fortunately Mlle. Henri-Martin had somewhat earlier, in the same fossil-bearing layer of the cave, discovered a fragment of bone (Fontéchevade I) which is presumed to have belonged to another individual. This represents the frontal glabellar region just over the root of the nose and including a portion of the left orbit including a supraorbital margin which is as sharp and delicately made as in the most gracile of modern crania. In fact, the gracility of this bone is such that its thickness could not have exceeded that of modern man in the rest of its skull bones.

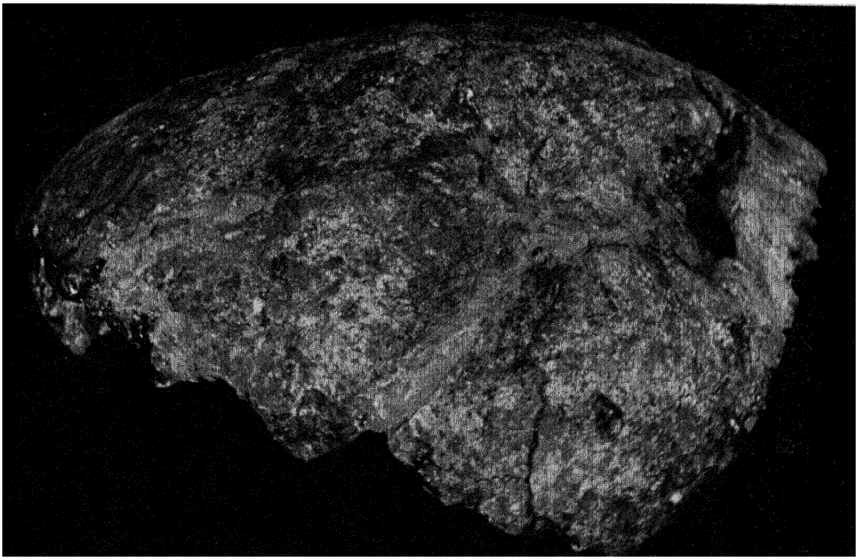


FIG. 104. The Fontéchevade skull II. (From Vallois.) Left lateral view. (Courtesy, *Am. J. Phys. Anthrop.*)

The form of the brain-box of Fontéchevade II and of the supraorbital region of Fontéchevade I renders it clear beyond any possible shadow of doubt that we are here dealing with a type of man scarcely distinguishable from modern man. And yet this type of man clearly antedated Neanderthal man both culturally and temporally in a region from which a majority of Neanderthal remains have been recovered. It is very likely that Fontéchevade types intermixed with the forerunners of Neanderthal man in Europe.

The great importance of the Fontéchevade skulls lies in the fact that for the first time in the history of the subject we now have indisputable proof of the antiquity of the so-called, or rather mis-called, neanthropic type of man.

In Fontéchevade man then, we see yet another type with whom the forerunners of Neanderthal man may have intermixed, and some more definite evidence for this we see in the physical characters of a possible ancestor of Neanderthal man such as Heidelberg man, and even in such a type as Ehringsdorf.

The New Conception of Man's Evolution. It has already been pointed out that in earlier days when but a few fossil remains were available, the extreme differences between such a form as *Pithecanthropus* and another such as Neanderthal or Piltdown man, led students to think of these types as representing different genera. They were therefore so distinguished from one another by being given generic names. Today, however, when so many intermediate forms have become available, the apparently extreme character of the first discovered types has considerably diminished, and it is now seen that they are all closely related, in many instances in much the same way as the different varieties of man are today related. Weidenreich holds that *Pithecanthropus,* for example, does not differ from *Sinanthropus* any more than does an Australian aboriginal from an Arab. However this may be, our problem continues to be the discovery of the exact nature of these relationships, a problem necessarily for the future, when more material relating both to the morphological and cultural evolution of man has become available.

Meanwhile we see that earlier notions of a linear evolution of man, notions which held that man progressively advanced in a straight line from an ape-like stage toward the stage of neanthropic

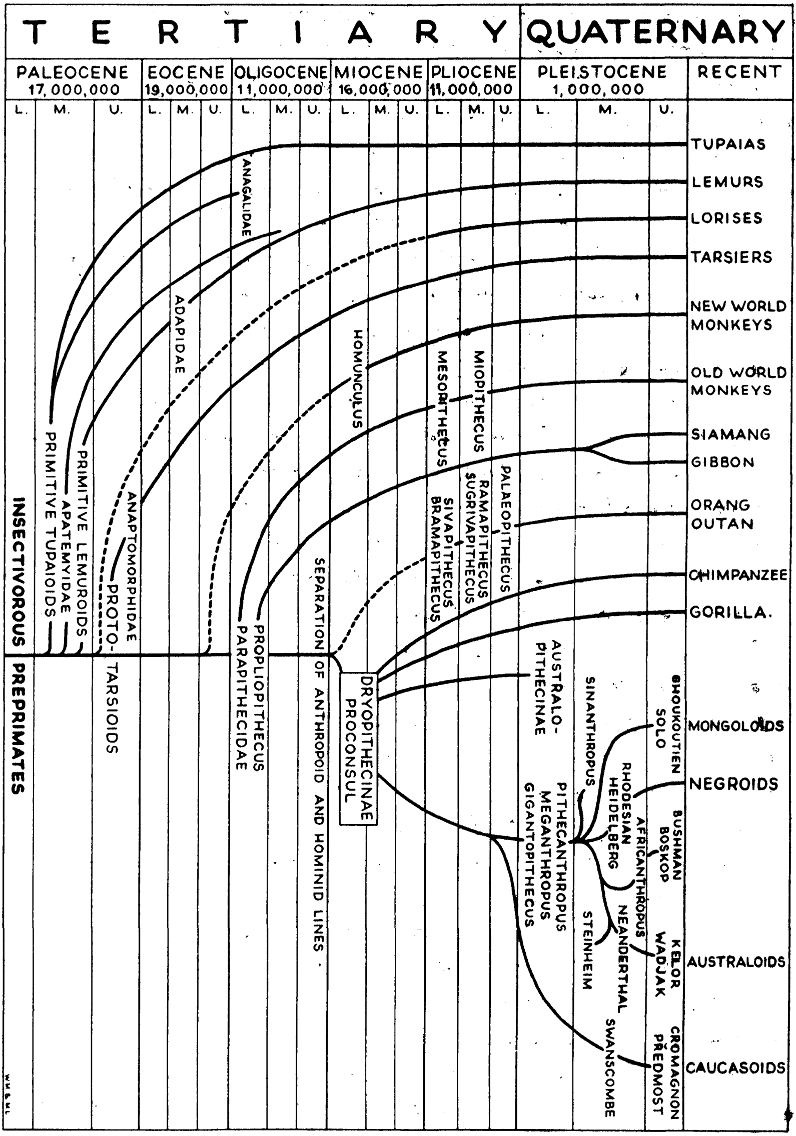


FIG. 105. The phylogenetic relationships of the primates in their geological background. The figures refer to the duration of each epoch. (L = Lower, M = Middle, U = Upper).

or the modern type of man, were too simplified. The modern type of man appears to have been differentiated as a distinct type as early as the middle Pleistocene, almost half a million years ago, while a distinctly different type like Neanderthal man, which morphologically possessed many more primitive characters, appeared considerably later. Be it noted however, that in spite of the fact that Neanderthal man was the possessor of morphologically more primitive physical characters than early neanthropic man, he was culturally more advanced than the latter, as is evidenced by the artifacts he manufactured and the funerary rites which he practiced. This is an important point because in itself it suggests a later advent in time for Neanderthal man. Even more important is that fact that in one very significant morphological feature Neanderthal man may have outdistanced neanthropic man, namely, in size of the brain. In the upper limits of brain size (as measured by cranial capacity) Neanderthal man exceeded neanthropic man with 1,625 c.c. as against say the 1,325 to 1,457 c.c., of such a type as Swanscombe or Fontéchevade with a cranial capacity of 1,470 c.c. While we know nothing of the range of variation in brain size of these two latter types, nor anything of the possible differences in body bulk which may have had some relation to the difference in brain size, it appears highly improbable that the average cranial capacity of early neanthropic man ever exceeded 1,450 c.c.,—the average cranial capacity of Neanderthal man. The interesting fact is that man appears to have attained a large size of the brain quite early in his career.

It was formerly thought that in the large pulp cavities of the molar teeth, a condition known as "taurodontism," Neanderthal man exhibited a unique specialization which excluded him from the ancestry of modern man. It is, however, now known that far from being a specialization peculiar to Neanderthal man, the condition typically occurs in the orang-utan and chimpanzee, and is by no means rare among various human groups such as the Eskimo and Bushman. Furthermore, taurodontism is sometimes seen in the molars of whites, thus suggesting the possibility of persisting strains of Neanderthaloid ancestry or possibly a tendency toward the appearance of a similar variation in modern man. Interestingly

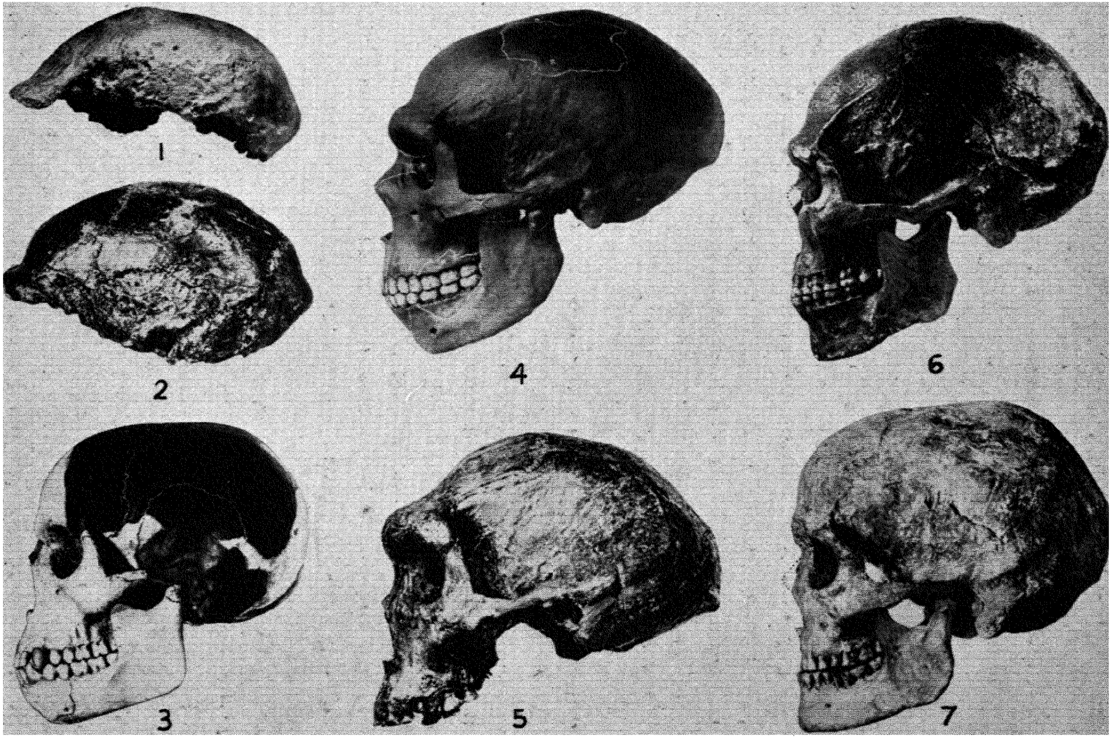


Fig. 106. Seven forms of fossil man. 1, *Pithecanthropus I* (Java). 2, *Sinanthropus* (China). 3, Piltdown (Sussex). 4, Neanderthal Man, from La Chapelle-aux-saints, Corrèze, France. 5, Rhodesian Man (South Africa). 6, Předmost (Brunn race). 7, Cro-Magnon Man (Mentone, Grotte des Enfants, France). (Courtesy, Prof. J. H. McGregor.)

enough Piltdown man possessed teeth with very similar large pulp cavities.

The later neanthropic types, who were identical in almost every respect with Europeans of today, namely, the men of Předmost of the Late Aurignacian had, it will be recalled, a cranial capacity of 1,590 c.c. Modern Europeans have to manage on a cranial capacity of 1,400 c.c.

It may be that Neanderthal man was more advanced in size of brain than both the early neanthropic hominids and their modern descendants.

The difference in the size of the brain between Middle Pleistocene man and modern man has led some students to conclude that the decrease in the size of the brain is to be regarded as a specialization, an evolutionary step in which size of brain is now subordinated to the greater development or increase in the complexity of its cellular structure and organization. It is, however, quite possible that the present size of contemporary man's brain represents the persisting size of the early neanthropic or Swanscombe type of brain *plus* the addition which has accrued from mixture with various other types of man with much larger brains. Although the cranial capacity in Europeans, for example, may vary from 1,000 to 2,000 c.c. the total variability, as measured by the coefficient of variation, is rather low, namely, about 8.0. This indicates a relatively high degree of stabilization in brain size. It is quite possible that the evolution of the brain in man is now solely restricted to specialization in internal structure; but it is well to bear in mind the possibility that the enlargement of the brain may continue to be achieved much as it has been in the past, through increase in surface area by the multiplication and deepening of its convolutions, rather than by linear or volumetric increases in size.

It may be that Neanderthal man, with his larger brain, possessed greater potentialities for development than we do, but this is greatly to be doubted, since brain size, within the limits here being considered, bears no relation to mental capacity.

With respect to the human brain it is now reasonably clear that within the limits of the normal, which ranges from a cranial capacity of 900 c.c. (as in the case of the great French novelist and wit, Anatole France) to a limit of upwards of 2,000 c.c. in modern man, with an average of 1,400 c.c., neither cranial capacity, size, form,

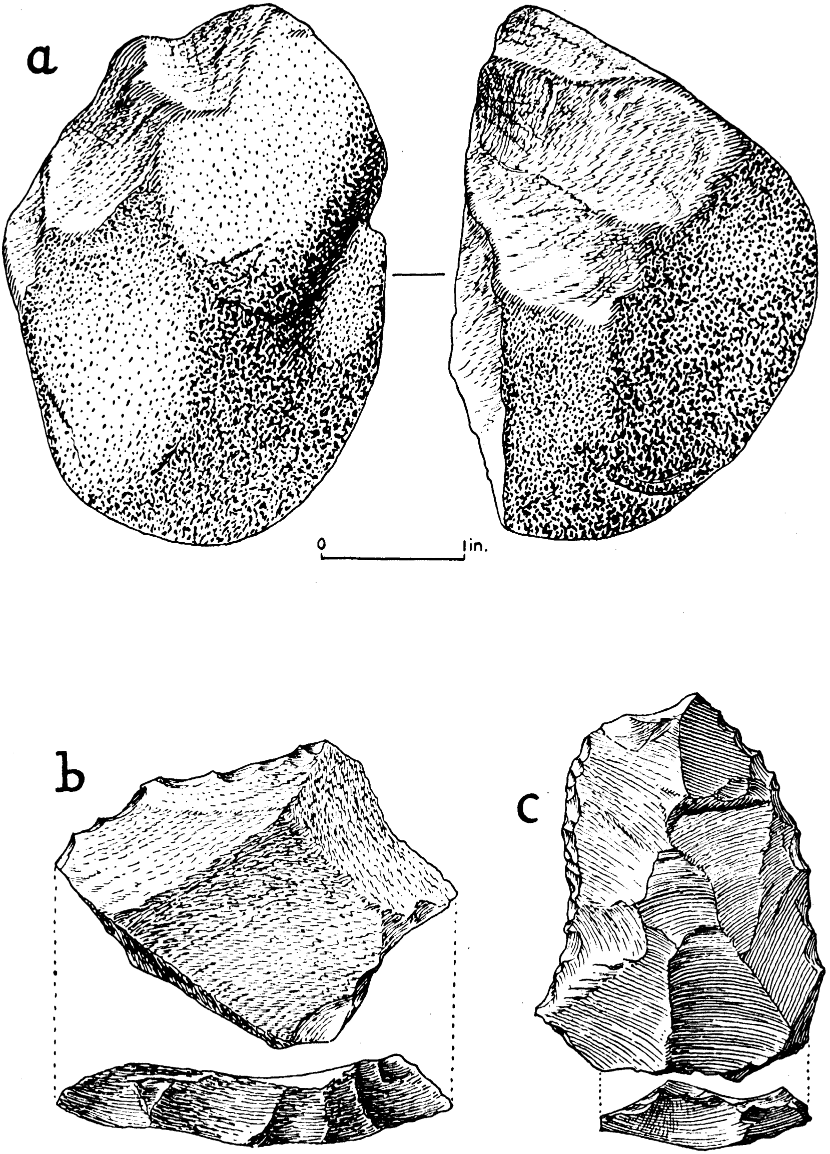


FIG. 107. Artifacts of fossil man in Africa. *a,* Oldowan pebble-tool (quartzose rock), Kanam beds, Kenya. By courtesy of Coryndon Museum, Nairobi. *b,* Levalloisian flake (lava) associated with "Africanthropus," Lake Eyassi, Tanganyika. *c,* Levalloisian flake-tool (lava) from beds with Proto-Bushman skull, Singa, Sudan. (From Oakley, *Man the Tool-Maker.* Courtesy, British Museum [Natural History].)

nor number of convolutions, has anything whatever to do with intelligence or functional capacity. Not even the number of cells contained in the cortex or in the subcortical regions is significant, but what is significant is the number of connections which exist between such cells. In the latter respect it may well be doubted whether there has been any significant change in the human brain for a long time.

Instead of a linear evolution of human types we see, on the other hand, a great diversity of types being produced, and these in turn, most probably by mixture with one another, producing still other types.

The principal agency at work in the evolution of man, as in all other living forms, has been mutation and the action of selection upon that mutation. Isolation, whether produced by geographic or other barriers, has undoubtedly played an important part in the evolution of man, while after natural selection has done its work hybridization must be considered a principal agency in the production or development of new types out of the original materials provided by mutation. We shall consider these agencies in some detail in the next chapter.

The new types produced by hybridization would form a group distinct from their parental types in precisely the same way as the American Negroes form a group more or less distinguishable from their African progenitors on the one hand and their white progenitors on the other. The parental groups would live on as contemporaries of their hybrid offspring, and might even survive them, even—to use a lame analogy—as grandparents sometimes survive their grandchildren. Hence, the possibilities of mixtures of different types with the ever increasing production of new ones grows increasingly larger.

The widespread distribution of Neanderthal types in the Old World suggests the possibility of migrations of some early human groups over extended land surfaces. This, however, is speculative, for we know practically nothing concerning the movements of early populations, and in any event in order to account for the wide distribution of Neanderthal types the notion of migration from a single center is not necessary. The probabilities are that there were many "centers."

Much valuable light has been thrown on the evolution of neanthropic man by recent discoveries in Africa.

A type which is believed by some experts to be the earliest representative of neanthropic man yet found, was discovered by L. S. B. Leakey in 1932. This type is represented by the fragment of the mandible together with its teeth. The discovery was made at West Kanam, on the southern shores of the Kavirondo Gulf of Victoria Nyanza, in Kenya, East Africa. The deposit from which the mandible was recovered is almost certainly of Lower Pleistocene age, according to Leakey, and several other competent investigators who have gone over the site (Oakley, Trevor, *in litteris*). An early report throwing doubt upon the age of the deposit may now be disregarded for the reason that the actual deposit was *not* examined. That deposit has now been largely washed away, the testimony of the discoverer and several observers, the mandible, and a doubt remain.

The Kanam mandible (Fig. 108) in every way resembles that of contemporary man. It is highly fossilized, and there can be little doubt of its great antiquity, but whether it is actually as old as has been claimed is still uncertain. Those observers who have looked over the site are inclined to agree with Leakey that this mandible is of Lower Pleistocene age. It is the opinion of several authorities that time will see Leakey's claim fully justified.

Leakey has also described the skeletal remains of four individuals of modern Negroid type from an early Middle Pleistocene deposit at Kanjera, in Kenya, associated with artifacts of Abbevillian industry. This discovery is somewhat better substantiated than that made at West Kanam, and strongly suggests that types of *Homo sapiens* had migrated over great distances, and had already early differentiated into distinct ethnic groups, even before Neanderthal man had done so.

Leakey has in addition described five crania from Gamble's Cave in Upper Kenya, which were found associated with an Aurignacian industry, and similar crania discovered at Elmenteita, in Kenya, associated with a Mesolithic type of industry.

In spite of some uncertainties in the evidence there can be little doubt as to the great antiquity of man in Africa. Indeed, in view of the existence of clearly demarcated Lower Pleistocene cultures in Uganda and Kenya territories, there can no longer be the least question as to the existence of man in Africa at a very early period.

In South Africa an important series of finds of fossil human types throws some light on the process of raciation in that country. The fragmentary skeletal remains found in 1914 near Boskop in the Transvaal are of particular interest. These are of a neanthropic type of indeterminate geologic age, but almost certainly from the Middle Stone Age of South Africa approximately equivalent to the Last Interglacial Mousterian of Europe. The skull is remarkable for a cranial capacity of about 1,700 c.c., small nipple-shaped mastoid processes, a rather straight-faced profile as in most Europeans, a long head, the breadth being 75 per cent of the length, with a great thickness of the parietal bones at their centers of 13 to 14 mm., probably due to nutritional disturbances in early youth. Stature is estimated at five feet six inches.

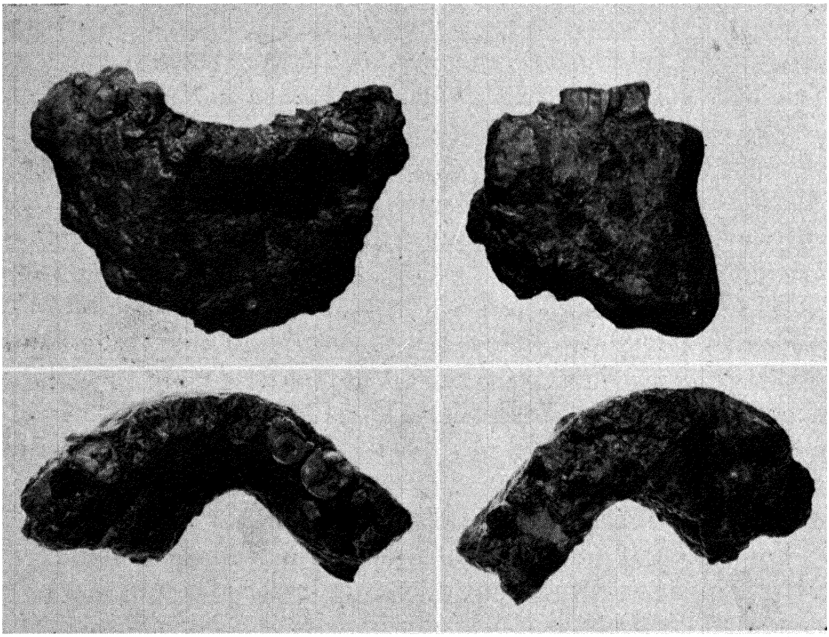


FIG. 108. The Kanam Mandible. (Upper left), anterior view, (Upper right), right lateral view showing chin, (Lower left), occlusal view, (Lower right), basilar view. (Courtesy, British Museum [Natural History].)

Other representatives of the Boskop type which have since been discovered are the Zitzikama woman (1921) with a cranial capacity of about 1,750 c.c., the Fish Hoek (1928) skeletal remains with a cranial capacity of 1,600 c.c., the Matjes River (1929-34) skeletons with cranial capacities varying from 1,400 c.c. to 1,664 c.c., the Springbok Flats skeleton (1929) with a cranial capacity of 1,500 c.c., the Cape Flats (1929) skull with a cranial capacity of 1,230 c.c., and the Plettenberg Bay skeleton (1931-32).

Another extremely interesting type of fossil man found in South Africa is represented by the Florisbad skull (1932). Associated with the cranial remains were artifacts of Mousterian-Levalloisian affinities, and the remains of extinct fauna which endow this skull with, at the least, a Middle Pleistocene age. It thus antedates the Boskop type. The restored skull (Fig. 109) exhibits a rather flattish neanderthaloid frontal region with markedly forward and laterally projecting supraorbital toruses. While broader than in Neanderthal man the torus is not continuous as in the latter but is interrupted over the nasal region. The narrow nasal bones are slightly elevated at the internasal suture, and the root of the nose is deeply recessed under the overhanging supranasal region. The face is somewhat prognathic. The single much worn tooth recovered, a very long-rooted upper third molar with fused roots, is not in any way remarkable.

The Florisbad skull bears some striking resemblances to the Rhodesian and Neanderthal types, and it has been suggested that Florisbad man represents a type transitional between these paleoanthropic types and neanthropic man. Florisbad man is conceived to be ancestral to the Boskopoid type, a type which is thought to have ranged from the Cape to Kenya, and from the Indian coast across Central Africa, and which has its modern representatives in the Bushman-Hottentots. The latter are, in fact, simply small Boskopoids.

Galloway sees in the Australoid Florisbad-Boskop types close resemblances to the Wadjak, Keilor, and modern Australian types.

The large brain case and small face of the Boskopoid type has caused Drennan to suggest that this phenomenon is due to fetalization (pedomorphosis or neoteny), that is to say, the process whereby the young features of the ancestor are retained in the adult stage of the descendant. He has further suggested that this process affords a possible explanation of the mechanism whereby paleoanthropic was transformed into neanthropic man. In line with this reasoning Buxton and De Beer had earlier pointed out that neanthropic man could be regarded as descended by fetalization (neoteny) from a juvenile stage of the neanderthaloid type.

FIG. 109. The Florisbad skull. Right lateral view reversed. (From a cast and photographs.)

Fetalization implies a relative retardation in the rate of body development as compared with the rate of reproductive development, so that the body does not pass through as many developmental stages in the descendant as it did in that of the ancestor. Bolk and De Beer have cited such features as the relatively great size and weight of the brain, the anterior position of the foramen magnum, brachycephaly, the character of the cranial flexure, the retarded closure of the cranial sutures, the absence of brow ridges, the retarded development of the dentition, the flatness of the face, hairlessness of the body, light color of the skin, and a number of other features, as evidence of fetalization in man. That fetalization is a genuine phenomenon there can be little doubt, but the notion has been somewhat overworked as a factor in the evolution of man. It is a subject which requires much more intensive study than it has yet received.

A Middle Stone Age skull found at Ingwavuma (1942), with a cranial capacity of about 1,450 c.c., stands morphologically intermediate between the Florisbad and Boskop types.

Without much doubt, then, it may be said that these Boskopoid types stand in the direct line of Bushman-Hottentot ancestry, and that among living ethnic groups the Bushman is perhaps the best provided with fossil ancestors reaching back to a fairly respectable antiquity.

India, Burma, and Thailand have also yielded definite evidence of the handicrafts of early Pleistocene man, some of whom were possibly of neanthropic type, while others were of the type embraced within the pithecanthropoid group, which types and their cultures or industries extended from China and Java into Burma and India.

A possible example of a population descended from a cross between a Neanderthal and a neanthropic type is the North African Afalou type.

Incomplete evidence of the existence of Neanderthaloid types in North Africa comes to us in the form of the left half of the maxilla and several teeth from a cave near Tangier. There are also several sites in North Africa which have yielded implements of Mousterian type.

Afalou man is known from some 50 skeletons from Afalou bou Rummel. These were recovered from a rock-shelter site of Upper Pleistocene age, where they were found associated with implements of Oranian (Capsian) culture. Implements of Oranian culture are closely related to those of Aurignacian origin in Europe. Another series of the same type, associated with Capsian culture, comes from Mechta el 'Arbi.

The Afalou type closely resembles the European physical type of the Middle and Late Aurignacian, that is to say, Cro-Magnon man. Except for the fact that the nasal aperture is broader, and the upper face and the length of the vault are slightly shorter, and the latter is slightly higher, in Afalou than in Cro-Magnon, the two series are in all other respects remarkably similar.

The fossilized skeleton of an Upper Pleistocene Negroid type found at Asselar, in the center of the Sahara Desert, some 400 kilometers northeast of Timbuktu, is of some interest because the type is not unlike that of the Nilotic type living in Africa today. There can be little reasonable doubt that most African types were already differentiated before the Upper Pleistocene.

Bearing upon this matter of the probable early differentiation of human ethnic groups is the interesting find made in the Upper

---

»»→

FIG. 110. Distribution and Suggested Relationships of the Cultural Traditions of Early Man. Reproduced from K. P. Oakley, *Man the Tool-Maker* (1949), by permission of the Trustees of the British Museum (Natural History), London.

Broken lines have been drawn wherever the connections or time-ranges are mainly speculative.

An encircled letter plotted in relation to the name of a culture shows tha fossil remains of a bearer of the tradition have been found in deposits of the age and location indicated. Thus in the European Acheulian Ⓖ indicates the skull found in deposits dating from the end of the second inter glacial, at Swanscombe, Kent.

The following is a key to the localities of fossil man:

A, Kanam (Kenya); B, Piltdown (Sussex); C, Heidelberg (Germany); D, Djetis beds (Java); E, Trinil beds (Java); F, Choukoutien (near Pekin); G, Swanscombe (Kent); H, Steinheim (Germany); I, Fontéchevade (Charente); J, Ehringsdorf (Germany); K, Saccopastore (near Rome); L, Le Moustier (Dordogne); M, Gibraltar; N, Tabūn Cave, Mount Carmel (Palestine); O, Skhūl Cave, Mount Carmel (Palestine); P, Solo River (Java); Q, Tangier; R, Lake Eyassi (Tanganyika); S, Rabat (Morocco); T, Broken Hill (N. Rhodesia); U, Singa (Sudan), also Fish Hoek and Boskop (S. Africa); V, Combe-Capelle (Dordogne); W, Cro-Magnon (Dordogne); X, Předmost (Czechoslovakia); Y, Chancelade (Dordogne); Z, Cheddar (Somerset), Whaley and Langwith (Derbyshire). The remains from D, E, F and possibly R belong to the *Pithecanthropus* group of men; those from K, L, M, N, J, P, Q, S and T to the Neanderthal group. Those from H, J and O are Neanderthaloids close to the neanthropic group; U, V, W, X, Y and Z are referable to the neanthropic group, and A, G and I probably so. Information which became available while this was in the press, suggests that the correct position of B (Piltdown) may be approximately on a level with I, but in what cultural stream is unknown.

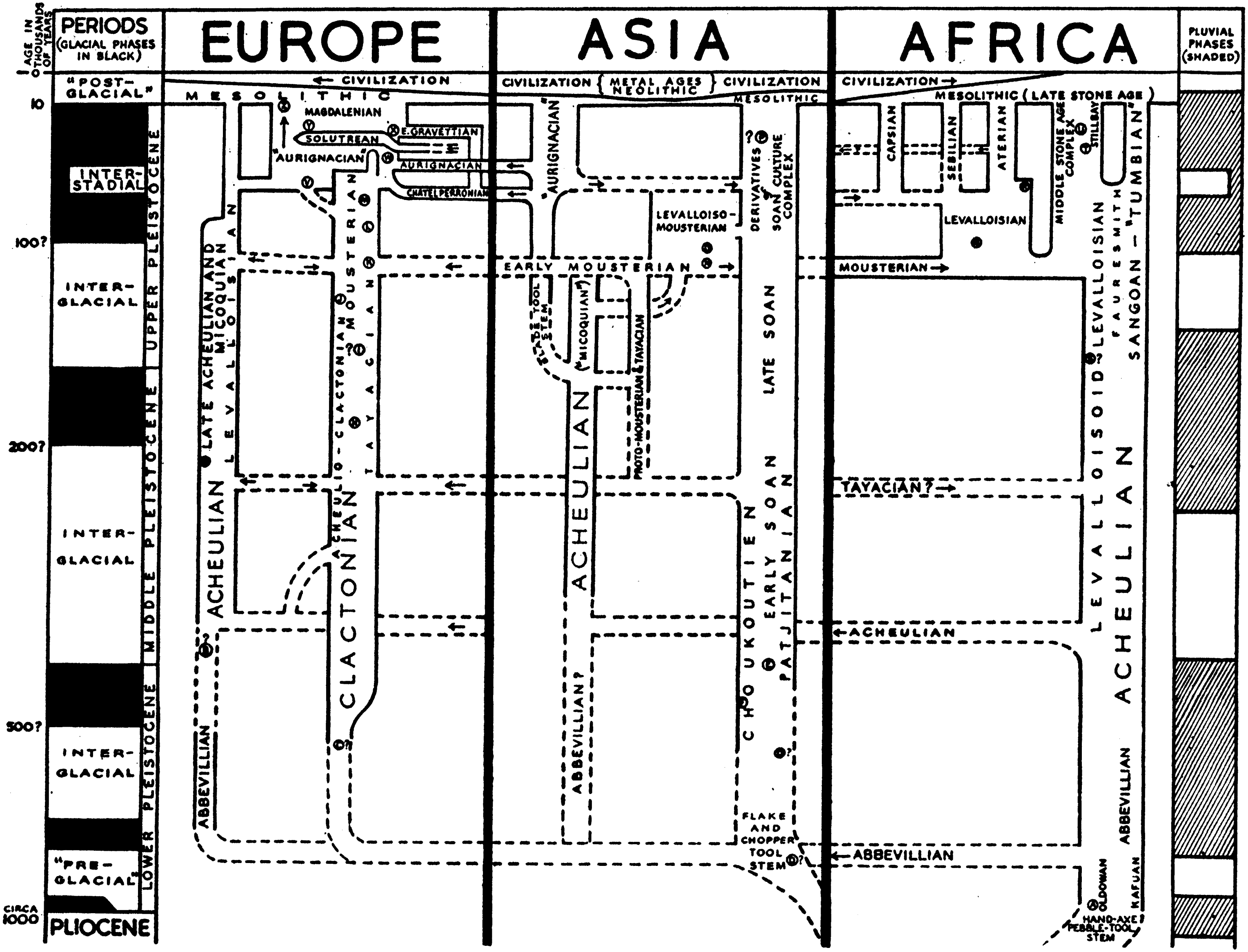

AGE IN THOUSANDS OF YEARS
PERIODS (GLACIAL PHASES IN BLACK)
EUROPE
ASIA
AFRICA
PLUVIAL PHASES (SHADED)
"POST-GLACIAL"
10
INTER-STADIAL
100?
INTER-GLACIAL
200?
INTER-GLACIAL
500?
INTER-GLACIAL
"PRE-GLACIAL"
CIRCA 1000
PLIOCENE
UPPER PLEISTOCENE
MIDDLE PLEISTOCENE
LOWER PLEISTOCENE
← CIVILIZATION
MESOLITHIC
MAGDALENIAN
SOLUTREAN
E. GRAVETTIAN
"AURIGNACIAN"
AURIGNACIAN
CHATELPERRONIAN
LATE ACHEULIAN AND MICOQUIAN
LEVALLOISIAN
MOUSTERIAN
TAYACIAN
CLACTONIAN
CLACTONIAN
ACHEULIAN
ABBEVILLIAN
CIVILIZATION
METAL AGES
NEOLITHIC
CIVILIZATION
MESOLITHIC
"AURIGNACIAN"
LEVALLOISO-MOUSTERIAN
DERIVATIVES
SOAN CULTURE COMPLEX
EARLY MOUSTERIAN
FLAKE TOOL STEM
"MICOQUIAN"
PROTO-MOUSTERIAN & TAYACIAN
ACHEULIAN
ABBEVILLIAN?
LATE SOAN
CHOUKOUTIEN
EARLY SOAN
PATJITANIAN
FLAKE AND CHOPPER TOOL STEM
CIVILIZATION →
MESOLITHIC (LATE STONE AGE)
CAPSIAN
SEBILIAN
ATERIAN
MIDDLE STONE AGE COMPLEX
STILLBAY
LEVALLOISIAN
MOUSTERIAN →
LEVALLOISOID
FAURESMITH
SANGOAN — "TUMBIAN"
TAYACIAN? →
← ACHEULIAN
ACHEULIAN
← ABBEVILLIAN
ABBEVILLIAN
OLDOWAN
KAFUAN
HAND-AXE PEBBLE-TOOL STEM

FIG. 110

Cave at Chou K'ou Tien of ten human skeletons, which yielded three well preserved skulls. One skull is of an old male, and this presents the appearance of an Archaic White or Ainu-like type. Weidenreich thinks of the "Old man" as a prototypic Mongoloid; Hooton as more closely resembling a primitive European white. The second skull is of a middle-aged woman, and this looks like the skull of an Eskimo. The third skull, that of a young woman, resembles the contemporary Melanesian type. Weidenreich comments, "The surprising fact is not the occurrence of palaeolithic types of modern man which resemble racial types of today but their assemblage in one place and even in a single family, considering that these types are found today settled in far remote regions."

The occurrence of these three types within the same Upper Paleolithic population would appear to constitute yet another evidence of the antiquity of ethnic mixture. It would be difficult to account for such marked variability within a small breeding population upon any other hypothesis. It requires, however, to be pointed out, that this variability does not necessarily mean that Archaic White, Eskimoid, and Melanesoid ethnic groups, entered into the production of these types, but it does mean that admixture between morphologically different ethnic groups most probably occurred, at least to throw up the Eskimoid and Melanesoid types. The "Old Man" probably represents the original type of the group with which the newcomers mixed.

When the time comes for the history of paleoanthropology to be written it may be predicted that two ideas will be found to have been mainly responsible for the confusion and misdirection of thought which, during the first half of the twentieth century, characterized the attempt to understand the manner of man's evolution.

The first of these is the conception of orthogenetic evolution, the notion that the evolution of man has been linear, that is to say, in a more or less straight line.

The second is the idea of "the missing link" or "missing links," which, so it was conceived, when recovered would join together the broken parts of a chain of being which would then stretch all the way from some earlier period to our own time. The links being completed in a vertical direction, from below upwards.

Which of these two practically complementary notions has had a more stultifying effect upon the development of our understanding of man's evolution it would be difficult to say. Together their effects have been serious.

The conditioning effect upon students of man's evolution, of such pretty 19th century demonstrations as Marsh's representation of the evolution of the horse neatly arranged in a convincing and orderly succession of types from the tiny Eocene *Eohippus* to the modern horse *Equus* cannot be overestimated. The fact that such a linear arrangement is purely arbitrary was, and still tends to be, overlooked. A scattergram may be arbitrarily abstracted into one or more straight lines, but it would be quite false to assume that the scattered dots had so arranged themselves. It would also be false to assume that all the dots through which the upper part of the line passed were produced later than those in the region of the lower segment.

Yet the scattering and criss-crossing of variability which occurs during the evolutionary process is vastly more complicated than the most complex of scattergrams. Evolution is not a straight line process. On the contrary, evolution is a labile reticulate process occuring within the varying environmental matrices of space-time, with repeated intercrossing between different lines, at once convergent and divergent. While very definite trends may be perceived in the evolution of groups, those trends are rarely if ever the result of the addition of variations which add up to straight lines. On the other hand, it is discontinuous particles and processes derived from numerous different sources which are in continuous process of change and interchange in what at times may be likened to a series of eddies, and often resembling a maelstrom, that renders the concept of orthogenetic evolution unacceptable.

In view of the accumulating evidences most students of the evolution of man are in a mood to drop the concept of orthogenetic evolution and the naive idea of "missing links" and to reconsider the evidence on its merits without prejudging it by the measure of some predetermined theory, however hallowed by time or sanctified by authority.

The notion, for example, that neanthropic man represents the culmination, the end product, of a line which commences with

Pithecanthropus and passes through a Neanderthal phase of development can now be shown to be highly questionable, at least so far as the Neanderthal phase is concerned. The Mount Carmel population, for instance, cannot be accounted for on any other assumption than that they were the products of a neanthropic-Neanderthaloid admixture. Such traits as this population exhibited cannot have been produced without the prior existence of a neanthropic type. It is quite likely that the Galilee, Ehringsdorf, and Steinheim types also represent the effects of such admixture, and that they are not the orthogenetic offspring of a Neanderthaloid type alone. All these forms of men are, in fact, prior in time to the classic Neanderthal type of man, Galilee and Ehringsdorf being of third interglacial and Steinheim of second interglacial date, whereas the Neanderthals proper are of fourth or last glacial age.

From Palestine, France, Germany, and England there is more than strong presumptive evidence of the existence of a neanthropic type before the classic Neanderthal type was fully established.

It is possible, even likely, that a neanthropic type is to be reckoned among the ancestors of Neanderthal man. This is somewhat of a reversal of the traditional view of the relationship, but the facts themselves suggest such an interpretation. It is altogether possible that some proto-Neanderthaloid stock or stocks received infusions of neanthropic genes which then participated in the process of that stock's differentiation into the various Neanderthaloid phases which we know. Subsequently these Neanderthaloid populations mixed again with neanthropic groups and were eventually absorbed into the neanthropic populations.

The origins of the proto-Neanderthaloids are to be looked for in some such stock as the *Pithecanthropus-Sinanthropus* group, through a form possibly such as Solo man, with early representatives such as the first interglacial Mauer and possibly *Africanthropus* types.

The picture which emerges from the evidence as we now have it, quite upsets the older notions of early man recently off the apestem waiting for evolution, as it were, to shove him by a series of graduated pushes in an upward direction into a more advanced type. We perceive, rather, a complicated reticular development of human types to a very large extent brought about by such factors as mutation, natural selection, genetic drift, isolation, and hybridization, each of them processes which are at work upon mankind at the present time. Indeed, if we would understand the nature of the processes which were involved in the evolution of man in the past we can do no better than study those which are operative today in producing the diversification and unification of mankind. We shall discuss this subject further in the next chapter. Before doing so we may conclude the present one with a discussion of early man in America.

Early Man in the Americas. The evidence of archeology and the character of the human skeletal remains thus far discovered suggest that man first arrived in the Americas about 25,000 years ago. The evidence available at the present time strongly suggests that the first Americans entered North America from Siberia, passing across the Bering Straits into Alaska, a distance today of some 56 miles. This distance was certainly much less when the first men to cross over into what is now Alaska navigated it. In winter, when the ice forms, it is possible to walk across the Straits, and it is at any other time easily navigable by boat. Prior to the Eskimo, who arrived in skin boats, man probably reached Alaska by way of the land bridge resulting from the lowered sea level, caused by water being locked in the glaciers.

The original peopling of America probably took place in a series of waves of immigration, the repeating waves of immigrants subsequently becoming dispersed over the length and breadth of America to the extreme tip of South America, Tierra del Fuego, and the islands south of that, the Navarino Islands. These waves of immigrants probably represented different ethnic groups mostly of Mongoloid type, while a few others may have been of Caucasoid type. This, at least, is what the physical characters of the Indian population of the Americas suggest.

Human skeletal remains, and the evidences of extinct cultures, associated with the remains of extinct species of animals, have been found in North and South America, and recently in Mexico. In the case of the skeletal material both the geological evidence and that relating to the association with extinct animals has been open to some question. The association of cultural artifacts with such

GEOLOGICAL PERIOD		GLACIAL OSCILLATIONS	CLIMATE	GLACIAL AND INTERGLACIAL PERIODS	ESTIMATED YEARS AGO (B.C.)	HUMAN TYPES			INDUSTRIES				ARCHEOLOGICAL PERIOD	
						Pithecanthropus Group	Neanderthaloids	Neanthropic Types	Core	Flake		Blade		
PLEISTOCENE	UPPER	WÜRM 3 Interphase 2 WÜRM 2 Interphase 1 WÜRM 1	Humid Cool Cold Mild Cold	LAST GLACIAL PERIOD	25,000 72,000 115,000		Gibraltar, Jersey, La Naulette, Spy, *La Quina, La Chapelle aux Saints*	*Chancelade* Předmost Cro-Magnon Grimaldi *Combe Capelle* *Wadjak*		FINAL MOUSTERIAN MOUSTERIAN	FINAL LEVALLOISIAN LEVALL. V	PRE-TARDENOISIAN FINAL MAGDALENIAN MAGDALENIAN SOLUTRIAN Upper, Middle, Lower AURIGNACIAN	PALEOLITHIC	UPPER
		RISS-WÜRM INTERGLACIAL	Warm Hot Summers	LAST INTERGLACIAL	Duration 60,000	Solo ↑	Tabūn, Skhūl *Galilee*, Taubach, Krapina, *Monte Circeo* *Saccopastore* *Ehringsdorf*	*Keilor* Fontéchevade	MICOQUIAN *Upper Acheulian*	MOUSTERIAN *Tayacian*	*Levall. V* MIDDLE LEVALL.			MIDDLE
	MIDDLE	RISS 2 Interphase RISS 1	Cold Temperate Humid	THIRD GLACIAL PERIOD	187,000 230,000				MIDDLE ACHEULIAN MIDDLE ACHEULIAN	MIDDLE LEVALLOISIAN EARLY LEVALLOISIAN				LOWER
		MINDEL-RISS INTERGLACIAL	Warm	SECOND or GREAT INTERGLACIAL	Duration 190,000 or 240,000	Pithecanthropus erectus	*Steinheim*	Swanscombe, *London,* *Bury St. Edmunds*	MIDDLE ACHEULIAN LOWER ACHEULIAN	CLACTONIAN II				
	LOWER	MINDEL 2 Interphase MINDEL 1	Cold Cool temperate Cold	SECOND GLACIAL PERIOD	435,000 450,000 476,000	Sinanthropus	Heidelberg							
		GÜNZ-MINDEL INTERGLACIAL	Warm	FIRST INTERGLACIAL	Duration 60,000	↑			ABBEVILLIAN	*Clactonian I*				
		GÜNZ 2 Interphase GÜNZ 1	Cold Cool temperate Cold	FIRST GLACIAL PERIOD	550,000 590,000	Pithecanthropus robustus Modjokerto		*Kanam*	CROMERIAN NORWICHIAN IPSWICHIAN					
PLIOCENE		DONAU and earlier stages	VILLAFRANCHIAN		600,000 to 1,000,000				*Abbevillian*	*Pre-Red Crag*			ARCHEOLITHIC	

FIG. 111. Relative Chronology of Paleolithic Man and His Industries. Based on the data for West and Central Europe. Tentative datings in *italics*.

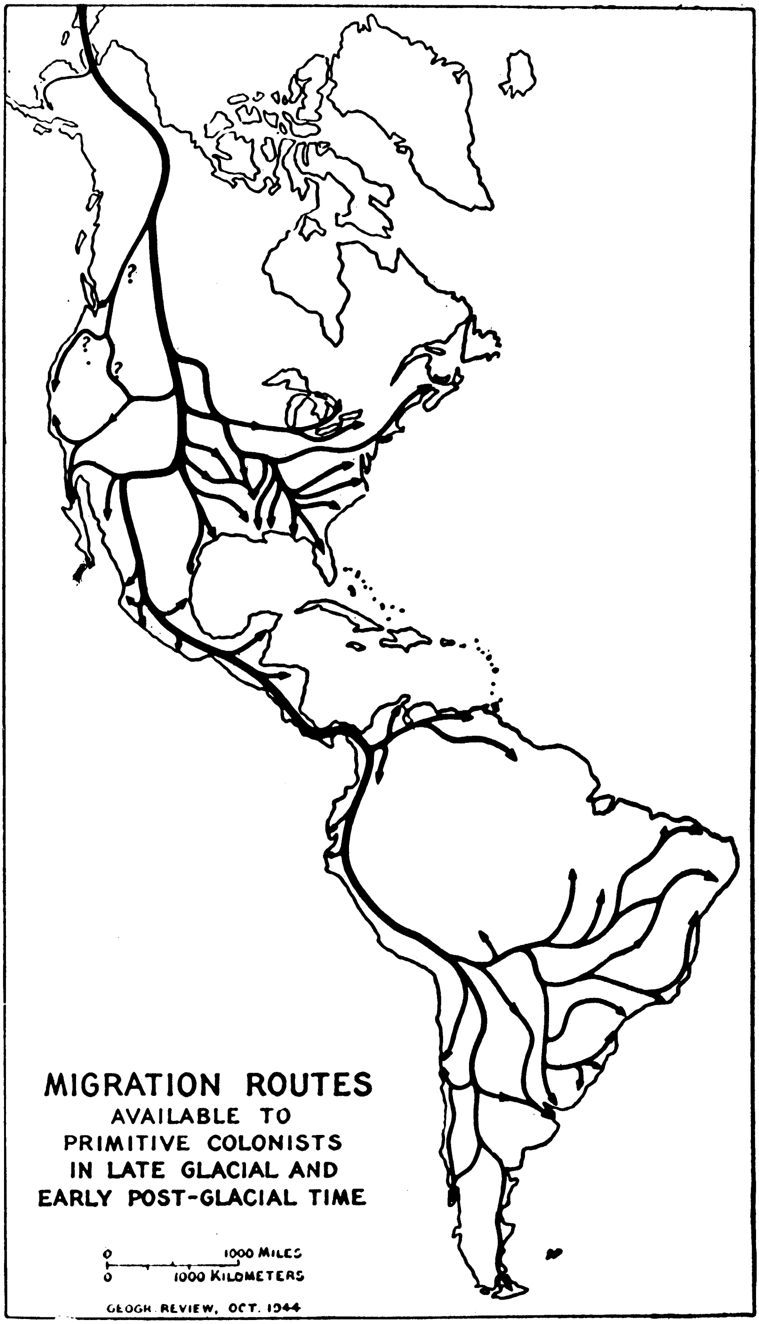


FIG. 112. Migration routes available to primitive colonists in Late Glacial and Early Post-Glacial Time. (From Sauer. Courtesy, *Geographical Review*.)

FIG. 113. Map of areas of Indian culture and principal tribes in North America. (From Collier. Courtesy of Institute of Ethnic Affairs.)

animals is, however, indisputable, and it can therefore only be a matter of time before the skeletal remains of early inhabitants of the Americas are found together with those of extinct mammals such as the great bison, camel, horse, mastodon, and ground sloth. Since it is at present not exactly clear when these animals became

FIG. 114. Map of areas of Indian culture and principal tribes in South America. (From Collier. Courtesy of Institute of Ethnic Affairs.)

extinct—it has been suggested that the mastodon may have become extinct less than 1,000 years ago—it is necessary to proceed with great caution in assigning an age to any human remains found in association with them. Ground sloth and great bison had, however, almost certainly died about 10,000 years ago, the camel possibly earlier. The horse originated in America, spread to the Old World, became extinct in the New World, and was later reintroduced into the New World by the Spaniards. It is, then, possible to assign different cultural artifacts to human beings who must have lived contemporaneously with the animals with whose remains such artifacts have been found. Taken in conjunction with the geological data reasonably accurate determinations of age may be made.

Perhaps the most interesting of skeletal remains found in North America is represented by a hip bone which was discovered at Natchez in Mississippi in the year 1846. This bone was recovered from a clayey deposit in a ravine cut by a tributary in a high terrace of yellow loam or loess. The bone was found under the loam together with the bones of extinct ground sloths, horse, mastodon, bison, and other extinct mammals. Charles Lyell, the English geologist, who visited the site shortly after its discovery, calculated that the deposit from which the bone was recovered was more than 100,000 years old. Hence, he conceived that the bone might easily have been intruded into the deposit in which it was found. In view of the uniqueness of the find he concluded, "it is allowable to suspend our judgment as to the high antiquity of the fossil." It is now impossible to reinvestigate the conditions under which the bone was discovered. All, indeed, that can now be said is that a highly mineralized hip bone together with the remains of extinct mammals, was found at Natchez in a deposit which suggests a possible antiquity for man in America considerably greater than the evidence gathered elsewhere in America would allow.

Since the second quarter of the nineteenth century many discoveries of stone implements in association with extinct mammals have been made in the United States, but until recent years when archeological investigations under scientifically satisfactory conditions have become comparatively frequent, such earlier finds were dismissed as doubtful owing to the scientifically unsatisfactory conditions under which they were made. Some of the earlier discoveries, we now have every reason to believe, were probably quite sound. There is, however, no need to speak of them here. In this place we may briefly refer to the few discoveries which are accepted by the majority of scientists as above suspicion. One of the most important of these to date is the discovery near Folsom, New Mexico, in the summers of 1926 and 1927 of peculiar fluted projectile points. In 1927 such a point was found imbedded in the matrix between the ribs of an extinct bison (Fig. 115). These points, characterized by longitudinal channels or fluting on each face extending from the base towards the point, have since been found at a number of different sites, the most important of these being the Lindenmeier site in northern Colorado; to this latter site an age of between 10,000 and 25,000 years has been assigned. It is today generally believed that the roughly flaked points found in the Sandia Cave, in Las Huertas Canyon, New Mexico, are not less than 25,000 years old. Thus, through his artifacts, but not through his skeletal remains, we have definite knowledge of man's existence in North America possibly 25,000 years ago and at least 10,000 years ago.

FIG. 115. Folsom point and associated bison ribs imbedded in matrix. Folsom, New Mexico. (Photo, Denver Museum of Natural History.)

Archeological discoveries made in many different parts of North America all agree in that the remains, both cultural and human, are assignable to an age which revolves about a period of 15,000 years plus or minus 10,000 years. Some of the better substantiated sites and the ages assigned to them are the following:

Site	*Locality*	*Years Ago*
Folsom	Near Folsom, New Mexico	10,000 to 13,000
Lindenmeier	South of Colorado-Wyoming boundary, Northern Colorado	10,000 to 25,000
Clovis-Portales	Between Clovis and Portales, central-eastern New Mexico	10,000 to 13,000
Sandia	Northern part of Sandia Mountains, New Mexico	15,000 to 25,000
Cochise	Whitewater Draw, northwest of Douglas, Southeastern Arizona	15,000
Ventana Cave	Castle Mountains, Southern Arizona	15,000
Pinto Basin	Riverside County, California	2,000 to 9,000
Lake Mohave	Lake Mohave, Southeastern California	3,000 to 10,000
Gypsum Cave	Frenchman Mountains, east of Las Vegas, Nevada	5,000 to 10,500
Vero	Vero, central-eastern Florida	10,000
Borax Lake	Borax Lake, California	3,000 to 10,000
Great Salt Lake	Great Salt Lake, Utah	10,000 to 15,000
Signal Butte	Near Scottsbluff, western Nebraska	8,000 to 10,000

These represent but a sampling of the sites which have been investigated, there are many more. Claims which have been made for the antiquity of skeletal remains such as those described as Minnesota man, and for so-called primitive traits in these skeletal remains, cannot be critically supported.

The Punin skull discovered at Punin in Ecuador in 1923 under conditions suggesting considerable antiquity, raises a very interesting question. This skull resembles no type as much as that of the Australian aboriginal. So far only one such skull has been found. On the face of it it does not seem likely that this skull represents a sport or extreme variation not peculiar to the population from which it sprung. This gives rise to the remote possibility of an Australoid contribution to the formation of some part of the South American Indian population.

1. Burnet Cave
2. Clovis
3. Cochise Sites
4. Folsom
5. Gypsum Cave
6. Lindenmeier Site
7. Sandia Cave
8. San Jon
9. Tabequache Cave
10. Yuma

FIG. 116. Map of the Southwest showing sites from which archeologic evidences of ancient cultures have been recovered. (From Wormington. Courtesy Denver Museum of Natural History.)

With reference to this possibility it may be mentioned that between 1835 and 1840 P. W. Lund, a well-known Danish explorer examined some 800 caves in the district of Lagôa Santa in the province of Minas Geraes of eastern Brazil. Six of these yielded the skeletal remains of man. Many of the bones were highly mineralized and some of the skeletal remains were found in association with extinct animals. Dating the remains at this remove of time is difficult if not impossible. Lund, who was a most cautious observer, was convinced of their high antiquity. The skulls are interesting. Though dominantly of American Indian type they bear some resemblances to the Australian aboriginal type. The average skull is dolichocranial (c.i., 70.5), hypsicranial (high-vaulted, 80.2), broad-palated, broad-cheeked, and prognathic. Viewed from the back (norma occipitalis) the skull is pentagoid in form, with a tendency to the formation of a high crest in the midline sagittally.

The discovery, in 1935, in the Confins cave in the Lagôa Santa region of a complete skeleton, again under conditions very strongly suggesting a high antiquity, reënforces the claim to antiquity of the Lagôa Santa skeletal remains. The Confins skeleton lay in an extended position, claw marks of rodents on the surface of some of the bones indicate that the individual died where he lay, until he was naturally buried. The undisturbed stratum in which the skeleton was found bore the remains of extinct animals. There can be little doubt of the considerable antiquity of Confins man, but dating is difficult owing to the lack of an adequate chronology. The skull is clearly of American Indian type, and the subnasal prognathism assists to give it a very Mongoloid appearance. The skull is less markedly pyramidal in the vault than most of the earlier Lagôa Santa finds, it is, however, quite clearly of Lagôa Santa type.

On the basis of the fact that certain cultural traits are found both in Oceania and South America, and that it is known that Polynesian navigators traversed great distances in their canoes, it has been suggested that the west coast of South America may have been reached by some boatloads of Pacific Islanders. This is certainly a possibility. However, it would seem most unlikely that such possible trans-Pacific voyages could have been made early and often enough seriously to affect either the populations or the cultures of the New World.

In February 1947 Dr. Helmut de Terra, American archeologist, and Dr. Hans Lundberg, Canadian geologist, using an electrical detecting device, made an important discovery of a human skeleton near the village of Tepexpan, in Mexico. At a depth of 1.12 m. (three feet and eight inches) in a clearly defined undisturbed layer of pluvial clay they found a remarkably well preserved mesocephalic human skull together with some 50 other portions of the skeleton. The age of the layer in which the skeleton lay has been estimated at between 10,000 and 15,000 years. We have, then, in Tepexpan man perhaps the oldest geologically datable human remains so far discovered in the Americas.

The almost complete skull is that of an adult male of between 55 and 65 years of age. From the remainder of the skeleton it has been calculated that stature reached 170 cm. (five feet seven inches). Cranial capacity is 1,540 c.c., and the cranial index is 79.89, that is to say, mesocranic. Tepexpan man is the roundest-headed American Indian of early date thus far discovered. That he represents a typical American Indian, though somewhat rounder-headed than most, there can be not the least doubt. Tepexpan man shows no remarkable skeletal features. He is remarkable only for being the oldest known datable American Indian.

One of the best authenticated discoveries of prehistoric man in South America was made in 1937 by Junius Bird. This is the discovery in the Palli Aike Cave in Patagonia of numerous cultural artifacts associated with human skeletal remains as well as the bones of extinct ground sloth and horse. In this and in another cave some 20 miles west the cultural debris was found mixed with animal bones which showed clear evidence of treatment by man-made fire and pressure. The age of these remains yielded by the radiocarbon method is 8,639± 450 years.

At the present time the evidence indicates that the migration of man into the Americas commenced toward the end of the last great glaciation at a period corresponding to the Solutrean of the Upper Paleolithic of Europe. Further discoveries may show that migration commenced at an earlier period, but at the present time such evidence is wanting, and at most the available evidence permits us to say that the antiquity of man in the Americas is no greater than somewhere between 15,000 and 25,000 years.

A Note on Radiocarbon Dating. A method has recently been developed, by Drs. W. F. Libby and J. R. Arnold of the Institute of Nuclear Physics at the University of Chicago, whereby it is possible to compute the age of any organic material up to 30,000 years ago. This method has been particularly useful in the dating of American Indian remains. The method is based on the fact that radioactive carbon (Carbon 14), which is liberated in the atmosphere as a result of the interaction of cosmic rays with nitrogen, is present in all living organic structures. During the life of the organism an equilibrated and constant percentage of C^{14} is maintained in its carbon structure. This percentage is believed to be the same for every form of life. With death the supply of carbon and C^{14} to the organism abruptly ceases, and the C^{14} atoms begin to disintegrate. It is believed that not only is the concentration of C^{14} the same in all living organisms, but that the rate of C^{14} disintegration after death is also the same. Therefore, if the rate of disintegration of C^{14} can be established for a sample of known age, it becomes possible to check the accuracy of this method of dating. This has been done with considerable success. Recent studies (1951) have shown that after 5568± 30 years have elapsed one half of the C^{14} atoms have disintegrated.

FOR FURTHER READING, CONSULT:

ARNOLD, J. R. and LIBBY, W. F.: Radiocarbon dates. *Science, 113:*111-120, 1951.
Dates for various prehistoric and historic materials by the radiocarbon technique, based on 5568±30 years as the half-life of radiocarbon.

BEER, G. R. DE: *Embryos and Ancestors.* Oxford: at the Clarendon Press, 1939.
An admirably clear discussion of evolutionary embryology, containing a valuable exposition of fetalization (pedomorphism).

BIRD, J.: Antiquity and migrations of the early inhabitants of Patagonia, *Geographical Rev., 28:*250-275, 1938.

———: Before Magellan. *Natur. Hist., 41:*16-28; 77; 79, 1938.
The official and popular accounts of the discoveries of early man in South America.

BLACK, D.: Asia and the dispersal of the primates. *Bull. Geol. Soc. Am., 4:* 1925.
A brilliant work on the ecology and dispersal of the primates and early man.

BONIN, G. VON: On the size of man's brain as indicated by skull capacity. *J. Comp. Neurol., 59:*1-29, 1934.
A lucid and informatively factual study.

BOULE, M.: *Les Hommes Fossiles.* 3rd edition, edited by H. Vallois, Paris, Masson et Cie., 1946.
A standard work.

Braidwood, R. J.: *Prehistoric Men.* Chicago Natural History Museum Popular Series, Anthropology, No. 37, 1948.
A delightful introduction to the period of man's cultural development before written history began.

Evans, F. G.: The names of fossil men. *Science, 102:*16-17, 1945.
A constructively valuable criticism of the nomenclature relating to fossil men.

Galloway, A.: Man in Africa in the light of recent discoveries. *South African J. Sc., 34:*89-120, 1937.
An admirable survey up to the date of publication.

———: Physical anthropology in South and East Africa. *Yearbook of Physical Anthropology, 1948. 4:*40-46, 1949.
The survey continued up to date.

Howard, E. B.: Evidence of early man in North America. *The Museum J.* (Univ. Penn.), *24:*53-120, 1937.
A good discussion of the archeological evidence.

Howells, W. W. (editor): Early man in the Far East. *Stud. Phys. Anthropol., 1:*1949. Philadelphia, Wistar Inst.
An important series of studies by five experts.

Hrdlička, A.: *The Skeletal Remains of Early Man.* Washington, Smithsonian Miscellaneous Collections, 1930, 83 vol.
An authoritative and most readable account, covering the material up to the year 1930.

———: *Early Man in South America.* Washington, Smithsonian Inst., Bureau of American Ethnology, Bulletin 52, 1912.
The authoritative and most exhaustive work on the subject.

Jenness, D. (editor): *The American Aborigines, Their Origin and Antiquity.* Toronto, Univ. Toronto Press, 1933.
Ten papers by different authorities of unusual value and interest.

Keith, A.: *The Antiquity of Man,* 2 vols. London, Williams & Norgate, Ltd., 1929.
A readable text. Its time-scale, however, is far too contracted. The drawings are frequently inaccurate, though the inaccuracies are such as would not in the least impair the reader's appreciation of the points made by the author.

———: *New Discoveries Relating to the Antiquity of Man.* London, Williams & Norgate, Ltd., 1931; New York, Norton, 1931.
The supplement to the above work.

Koenigswald, G. H. R. von: *The South African Man-Apes and Pithecanthropus.* Washington, Carnegie Inst., 1942, publication 530, VIII.
A good discussion together with important illustrations.

——— and Weidenreich, F.: The relationship between Pithecanthropus and Sinanthropus. *Nature, 144:*926-927, 1939.
An authoritative statement.

Leakey, L. S. B.: *Adam's Ancestors.* London, Methuen, 1934.
A readable account of the story of fossil man, containing the discoverer's description of the Kanam and Kanjera finds.

———: A new fossil skull from Eyassi, East Africa. *Nature, 138:*1082, 1936.
A valuable description of the skull of *Africanthropus njarasensis.*

Le Gros Clark, W. E.: Pithecanthropus in Peking. *Antiquity, 10:*1-5, 1945.
A review of Weidenreich's "The Skull of *Sinanthropus pekinensis*" which contains, among other things, an excellent discussion of the relationships

of the Neanderthaloids to *Pithecanthropus* and *Sinanthropus*.

Levin, G:. Racial and inferiority characters in the human brain. *Am. J. Phys. Anthropol., 22:*345-380, 1937.

A demonstration of the nonexistence of such characters.

McCown, T. D. and Keith, A.: *The Stone Age of Mount Carmel,* vol. 2. Oxford, The Clarendon Press, 1939.

The complete description of the skeletal remains. For a critical review, see M. F. Ashley Montagu's "Prehistory," *Am. Anthropol.,* N.S., *43:*518-522, 1940.

McCown, T. D.: The antiquity of man in South America. (J. H. Steward, editor) in *Handbook of South American Indians,* vol. 6, Washington, Smithsonian Institution, 1950, pp. 1-9.

MacCurdy, G. G. (editor): *Early Man.* Philadelphia, Lippincott, 1930.

An important symposium covering a wide range of material.

A good survey.

Macgowan, K.: *Early Man in the New World.* New York, Macmillan, 1950.

A sound popularly written introduction.

Martin, P. S., Quimby, G. I. and Collier, D.: *Indians Before Columbus.* Chicago, Univ. Chicago Press, 1947.

A good introduction for the student to the archeology of North America.

Montagu, M. F. Ashley: Genetics and the antiquity of man in the Americas. *Man, 43:*131-135, 1943.

A suggestive discussion of how the problem of the antiquity and wanderings of man in the Americas may be approached by means of the genetic analysis of certain traits.

——— and Oakley, K. P.: The antiquity of Galley Hill man. *Am. J. Phys. Anthrop.,* N.S. *7:*363-384, 1949.

An analysis of the geological, archeological, chemical, and osteological evidence.

Morant, G. M.: Studies of Palaeolithic Man. *Ann. Eugenics, 1:*257-276, 1926; *2:*318-381, 1927; *3:*337-360, 1928; *4:*109-214, 1930.

A fundamental series of classical studies on the original crania.

Oakley, K. P.: *Man the Tool-Maker.* London, British Museum (Natural History), 2nd edition, 1950.

An admirably clear and well-illustrated account of the cultures of prehistoric man.

——— and C. R. Hoskins: New evidence on the antiquity of Piltdown Man. *Nature, 165:*379-382, 1950.

A detailed account of the comparative fluorine analysis of the Piltdown bones.

——— and Montagu, M. F. Ashley: The Galley Hill Skeleton. *Bull. Brit. Museum Natur. Hist., 1:*25-48, 1949.

A detailed account of the recent investigation of the Galley Hill site and skeleton, which led to the downfall of the latter.

Roberts, F. H., Jr.: Developments in the problems of the North American Paleo-Indian. In Essays in Historical Anthropology of North America. *Smithsonian Miscellaneous Collections, 100:*51-116, 1940.

An invaluable discussion of the antiquity of man in North America.

Sellards, E. H.: Early man in America: Index to localities and selected bibliography. *Bull. Geol. Soc. Am., 51:*373-431, 1940.

An indispensable guide.

STEIN, L.: *The Infancy of Speech and the Speech of Infancy.* London, Methuen, 1949.
An extraordinarily interesting attempt to reconstruct the evolution of speech in prehistoric man.

SWANSCOMBE COMMITTEE: Report on the Swanscombe skull. *J. Roy. Anthropol. Inst., Great Britain and Ireland, 58:*17-98, 1938.
The official report.

WEIDENREICH, F.: Some problems dealing with ancient man. *Am. Anthropol., 42:*373-383, 1940.
An excellent discussion.

———: The "Neanderthal Man" and the ancestors of *"Homo Sapiens." Am. Anthropologist, 45:*39-48, 1943.
A valuable discussion of the relations of the Neanderthaloids to modern man.

———: The skull of Sinanthropus Pekinensis; a comparative study on a primitive Hominid skull. *Palaeontologica Sinica,* S.d., S.127, 1943, p. 1-298, 93 plates.
The official and definitive description of the skulls of the *Sinanthropus* group, containing, in addition, a most valuable discussion of the whole problem of the relationships of fossil man. A highly important volume.

———: The Keilor skull; a Wadjak type from Southeast Australia. *Am. J. Phys. Anthropol., 3:*21-32, 1945.
A comparative study of the Keilor, Wadjak, and Australian skull.

———: Giant early man from Java and South China. *Anthropol. Papers Am. Museum Natur. Hist.,* New York, *40:* 1-134, 1945. 12 plates.
Containing the full description of *Meganthropus palaeojavanicus* and *Gigantantopithecus blacki,* together with a valuable discussion of the *Pithecanthropus* problem, a good description of *Pithecanthropus robustus,* and the relation of the giant fossil men to the Pithecanthropus group.

———: *Apes, Giants and Man.* Chicago, Univ. Chicago Press, 1946.
One of the most stimulating books on the origin and evolution of man available at the present time.

———: *Anthropological Papers of Franz Weidenreich 1939-1948.* Compiled by S. L. Washburn and D. Wolffson. The Viking Fund, Inc., New York, 1950.
Thirteen of Weidenreich's important shorter papers on paleoanthropology, together with an obituary, and a bibliography of Weidenreich's writings.

WEINERT, H.: Africanthropus, der neue Affenmenschfund in Ostafrika. *Ztschr. Morphol. u. Anthropol., 38:*18-24, 1939.
A brief account of *Africanthropus njarasensis.*

WUNDERLY, J.: The Keilor fossil skull; anatomical description. *Mem. Nat. Museum,* Melbourne, *13:*57-69, 1943.
The official very useful description.

WOODWARD, A. SMITH: *The Earliest Englishman.* London, Watts, 1948.
A first hand account of the discovery and possible significance of Piltdown man. Well illustrated, and peppered with an assortment of quaint views.

WORMINGTON, H. M.: *Ancient Man in North America,* 3rd ed. The Denver Museum of Natural History, Denver, Colorado, 1949.
A wholly admirable, thoroughly documented and illustrated account of the archeology of the American Indian.

———: *Prehistoric Indians of the Southwest.* The Denver Museum of Natural History, Denver, Colorado, 1947.
An excellent volume, supplementing the preceding one.

Chapter V

THE CRITERIA AND MECHANISM OF ETHNIC DIFFERENTIATION

THERE exist many distinctive groups of mankind which, as groups, are easily distinguishable from one another. The Chinese and Japanese, for example, are at once recognizable as two members of a very large group the characters of which distinguishes it from all others, and this group has been called the Mongoloid race of man. The African type of man wherever he occurs has been called a member of the Negroid race, and the white wherever he occurs, has been called a member of the White or Caucasoid race. Australian aborigines are in turn distinguishable from all of these, and are therefore spoken of as members of the Australoid race.

But what shall be said of the natives of New Guinea and the Solomons, of the whole region of Melanesia? Are they not a race, the Melanesian race? And what of the Javanese and the peoples of Malaysia, are they not distinct races? Where do the people of India enter in; the people of Ceylon; and Celebes? The American Indian? And what of the Irish, the Jews and the Germans, are they all classifiable as races?

These, and many others, are the questions which are asked of the anthropologist, and different anthropologists have had different answers to return to these questions. The answer will, of course, depend upon what is understood by the term race, and upon this there has not been anything like unanimous agreement. This lack of agreement upon a common meaning for the term, and the utterly abject social and political misuses to which it has been put, has caused the term to fall into disrepute, and even to be altogether rejected by some scientists, so far as its application to man in the modern world is concerned.

The cold light of reason can nonetheless be brought successfully to bear upon even the most passionately discussed of subjects, and whatever the motives may have been of earlier students of the problem of the variety of man, the physical anthropologist of today is ready to revalue his values and to do the best he can to unravel the tangled skein which is the variety of man. In the prosecution of this task the more he has learned about the physical and mental differences existing between the ethnic groups of man the less and less distinct have they become. This in spite of the fact that differences have been sought rather than likenesses.

While authorities have disagreed upon the meaning of the term "race" with reference to man, the layman has generally suffered from no such difficulty. For him "race" has in effect meant any foreign group. For him a foreigner is a member of a different "race" either because of a difference in national origin, religion, language, apparel or appearance. The popular conception of "race" is an unfortunate myth.

All serious definitions of race agree upon the following:

(1) *That the differences which characterize the groups so defined are conditioned by heredity. To the extent that qualities are conditioned by the environment—natural or cultural—they are not considered racial or ethnic characters.*

(2) That mental characters are to a very large extent conditioned by the social environment of the individual and therefore cannot be considered as ethnic characters.

(3) That insofar as nationality is determined by the accident of birth in a particular country, nationality has no necessary connection with ethnic group. Since language is similarly determined, the same holds true for language.

Thus, a person of Japanese parentage may be an American by nationality and speak English only, whereas his parents are Japanese by nationality and speak only Japanese. The grandchildren may be born in different lands in which they grow up as nationals, and speak languages differing from those which their brothers, parents, and grandparents speak.

Language and nationality are not genetically determined and have no inherent relation whatever to the genetic factors which constitute the fundamental determinants in the development of the physical characters of man. Language is culturally determined, nationality is politically determined, membership in any division or ethnic group of man is determined by heredity. In order to arrive at an objective, scientifically satisfactory classification of mankind into different ethnic groups it is clear that neither language, nor nationality, will help us, though language may reveal past contact between groups. We must approach the problem instead through the study of the hereditary characteristics of such groups.

The Criteria of Analysis and Classification

There are many ways in which one may ask questions about the variety of man, and the kind of question asked will largely determine the character of the answer returned. It has frequently been the case that each student has devised his own definition of "race" and has then attempted to classify the varieties of mankind according to the terms laid down in that definition. As T. H. Huxley remarked many years ago, "I speak of 'persistent modifications' or 'stocks' rather than of 'varieties' or 'races,' or 'species,' because each of these last well-known terms implies, on the part of its employer, a preconceived opinion touching one of these problems the solution of which is the ultimate object of science; and in regard to which, therefore, ethnologists are especially bound to keep their minds open and their judgments freely balanced." (*On the Methods and Results of Ethnology,* 1865.) We have had classifications by hair, pigmentation, head shape, eye-color, and combinations of some or all of these characters, and a great many more. Some of these classifications have been bad, some have been better than others, but none has been scientifically satisfactory, in the sense of being able to provide us with really workable accounts of each group of mankind supposedly exhibiting the characters which distinguish them from each other.

The reason for this is simple: The kind of discontinuous, clearcut differences which so many investigators have preconceivedly assumed to exist between the varieties of man were simply not to be found at the level at which they were looked for. Anyone can perceive certain clearcut differences between a Negro and a white at a glance, but Negro and white are in a sense extreme types, in the sense, that is, of presenting "extreme" differences in pigmentation and hair form. Even so, white and black cease to be easily distinguishable where there has been some degree of admixture, so that in America, for example, many persons of Negro-white ancestry readily pass for white. In the latter case the problem would be to say just when a person ceased to be a Negro and became a white. And that precisely is one of the great difficulties which the anthropologist encounters when he attempts to refine his classifications to embrace all the varieties of man. The transitions between the latter are often indeterminable. Where one group leaves off and the other begins it is frequently impossible to say. As Darwin remarked in *The Descent of Man* (1871), "It may be doubted whether any character can be named which is distinctive of race and is constant."

Groups of mankind which are unique for all the characters we can examine do not exist. Hence, in the past the anthropologist selected a few distinctive characters by the use of which he attempted to delimit several large groups of mankind from one another. In a mixed population he claimed, by this means, to be able to distinguish the various races entering into its composition, and in this way he often arbitrarily created races which in fact had no existence outside his method or his imagination. Such arbitrarily drawn lines between one group and another have in fact served to obscure the real truth, namely, that in nature there exists no such line, and that it is the systematist alone who introduces such divisions into nature. Were such arbitrary practices helpful in throwing some light upon the problem of the relationship of the varieties of man to one another, there might be some justification for continuing their use. But as they have been misused in the past they are distinctly not helpful. On the contrary, they have served to obscure the problem and to delay its solution. This is not to say that attempted classifications of mankind are undesirable, indeed, they *are* desirable, but the criteria used in their creation must be soundly based, and not arbitrarily selected. Unfortunately, such criteria have until recently been of the latter order rather than of the former, with the result that great masses of measurements have been accumulated which gave us at best a rather unsatisfactory description of the groups to which they have reference, and tell us disappointingly little concerning either the origins or the relationships of the groups involved.

Racial classifications are intended to have (*a*) a pragmatic meaning, and (*b*) a biological basis, but it frequently happens that the two intentions clash. The problem of the *existence* of ethnic groups is totally distinct from the problem of their *delimitation.* It is one thing to know that such groups exist, it is quite another to be able to delimit and define them. Lines between groups do not exist, but steep or flat places in geographic or character gradients do. The concept of character gradients refers to the fact that as one passes from place to place in a given direction, the physical characters of the inhabitants of the territories traversed change more or less gradually. Neighboring populations tend to resemble one another more closely than do geographically more remote ones. This is the phenomenon of character gradients. Such populations are usually called *clines* in animal biology. It must be the task of the physical anthropologist to recognize and study the significance of such gradients or clines in man.

Until recent years, the anthropologist has been forced to rely upon the external characters of the body for his analysis and classificatory purposes. This, principally, has been the reason for his failure to trace the relationships of the varieties of man to one another, and what is more important, the mechanism of these relationships, because external characters (the phenotype) represent the expression of a large number of individually inherited patterns of genes (the genotype) in interaction with the evironment. Furthermore, taxonomic exercises in the classification of assemblages of phenotypical (external) characters do not lead to the clarification of their significance for the simple reason that it is not assemblages of characters which undergo change as such in the development of the individual and of the group, but single units, the genes, which, in interaction with the environment, determine those characters. This is what the science of genetics has made irrefragably clear.

It is the inheritance of separate traits, and not aggregations of traits, which must be studied, because it is the genes or potentialities for the former and not the latter which are inherited, although linkages and clusters of such traits may, and do, occur.

The materials of evolution are not represented by continuous, rigidly articulated determinants of particular aggregates of characters, but by discontinuous packages of chemicals; each little packet interacting with the others as an independent unit, being only partially responsible for the ultimate form of any character, since it is not independent in its action but is influenced by the presence of other similar packages of chemicals. These chemical packages are the genes, which are chemically best described as giant self-reproducing nucleo-protein molecules.

It has been estimated that about 5,000 different genes enter into the making of the most popular of all experimental animals in the geneticist's laboratory, the fruit fly (*Drosophila melanogaster*). Man has 24 pairs of chromosomes, six times as many as *Drosophila*. Allowing that this is an extrapolation it may be reasoned that if *Drosophila* with four pairs of chromosomes has about 5,000 genes then it is possible that man has about 30,000 genes in the chromosomes of his sex cells. Spuhler has arrived at a similar figure by another method and Evans reasons that there must be well over 5,000 genes, probably between 10^4 and 10^5. Each of these genes retains both its independence and its individual character more or less indefinitely, although they are probably all inherently variable and, in time, capable of mutation. For these reasons any conception of the nature of human variation which operates as if inheritance were a matter of the transmission of gross aggregates of characters is erroneous and stultifying. It is potentialities, implying limits, which are inherited, not characters.

The facts of human variability are best explained by genetic analysis, since the fundamental units involved in producing that variability are the genes.

Very briefly, in each individual (zygote) there are 48 chromosomes or 24 pairs of chromosomes. One member of each of these 24 pairs is derived from the mother and the other member from the father. When the reproductive or germ cells (gametes) are formed, the members of each pair of parental chromosomes or genes separate from each other so that each reproductive cell has one or the other member of each pair but not both. This is known as the principle of gametic purity or segregation. At fertilization the arrangement into gene pairs is restored. Pairs of genes located in different chromosomes assort independently of each other. The genes derived from the mother will not, however, tend to stay together, nor will those derived from the father, but each gene will be assorted independently of the other. This is the principle of independent assortment.

Each member (*allele*) of a gene pair is specifically similar to the other, thus, for example, genes for eye color will always pair together, so will genes for nose shape, but an eye color gene and a nose shape gene will never pair, though they may occur in the same chromosome and may be transmitted together on the same thread in the whole or a part of a chromosome. When such genes are found in association they are spoken of as *linked* genes. Linkage may be defined as the tendency for two or more genes to remain together without recombination. It is obvious that a very large number of genes must be linked. This linkage would definitely put a limit upon the number of possible variations which could occur were it not for the fact that the segments of similar chromosomes are capable of exchanging parts, a process known as *crossing over*. In this way genes that were originally situated on the maternal thread in one chromosome may become attached to the paternal thread of genes in another chromosome, in this way former linkage associations are broken up and new ones created. The limitation of genetic combinations which linkage brings about is counteracted by the possibilities of recombination through crossing over. Linkage and crossing over regulate the degree and amount of reassortment of genes. The facts of segregation and independent assortment together with the phenomenon of crossing over should make it clear that in man, with his many thousands of genes, the number of gene combinations thus rendered possible is of a very large order indeed, i.e., about $2^{30,000}$, and that, therefore, the genetic variability of man is likewise very great. (see p. 353).

To this explanation of the fundamental mechanism of genetic variability must be added the fact that while the genes themselves remain stable, their expression will change according to the conditions under which they develop. That is to say, any character is the product of interaction between the genetic make-up and the environment, and not of the one or the other alone.

Furthermore, in the course of time any gene may undergo a permanent structural change, thus giving rise to a new character or, what is more usual, to some part of a new character, a new hereditary variation. Such a change is known as a mutation. A character may be defined as any structure, function or trait of an organism. At one time it was considered that mutation was a relatively rare process taking the form of perceptible major changes. Today, however, all those small variations which occur in the individual which are of discontinuous character, that is to say, which vary either in number (meristic) or in presence or absence (qualitative), as opposed to normal continuous variation by degree of difference (quantitative), are regarded as due to mutation and recombination. The mode of inheritance is exactly the same for discontinuous as for continuous variation; in the former a few genetic factors are involved, each producing a major effect, in the latter many genetic factors are involved which produce small additive effects, in the shaping of a character. Modern students are generally agreed that mutations and recombinations furnish the only known material of evolution.

The formation of new species in lower animals is explained by the geneticist as being brought about by the gradual accumulation of mutations and the effects of recombinations until a certain threshold is passed which signifies the evolution of a new species. In man there is the additional factor, as a consequence of his migratory habits, of frequent hybridization, a factor which greatly contributes to the process of diversification.

The variation due to recombination in living groups of mankind is so great that such "groups" can only be distinguished by statistical methods and in statistical terms. As Julian Huxley has put it, "In such groups the *mean values* for characters, though still useful, no longer have the same theoretical importance. The *range of variation* of characters is of far greater practical importance, as is also the range of qualitatively different recombination types. The two resultant race-concepts are fundamentally dissimilar."

In order to understand how the varieties of mankind came to possess such characters as they now exhibit, it should be obvious that making omelettes out of the very ingredients, the genes, which it is necessary to isolate and to map, will be of no assistance whatever. The frequencies with which such genes occur in different groups must be studied.

If we arbitrarily recognize, say, forty genes as entering into the determination of the shape of the head, then it should be evident that measuring the shape of the head will tell us no more than what the shape of the head is. By such means we can never hope to learn how the shape of any particular head or group of heads came to be as it now is, and that is the significant point. But by experimental studies on the genetics of the inheritance of each bone and its relation to shape of the head on lower animals, it may eventually be possible to transfer the knowledge thus gained to the analysis of the genetics of cephalic architecture in man. Even so it will always remain true that craniometric similarities by no means necessarily indicate genetic affinity.

Furthermore, the work of Boas on the descendants of immigrants into the United States, of Shapiro on the descendants of Japanese in Hawaii, and of Dornfeldt on the descendants of Eastern European Jews in Berlin, has shown that the potentialities of head shape, as well as other characters of the body, can be significantly modified by the environment. To put it more accurately, latent gene potentialities for head shape express themselves differently in different environments.

Hence, if we are to trace the relationships of the varieties of man to one another, it is necessary that we rely on criteria which possess a more permanent character than the shifting sands of head shape. Such criteria should, as far as possible, be unequivocally objective in character, as much as possible unaffected by environmental factors, as little as possible subject to mutation, and possibly non-adaptive. Such characters are available in the blood groups, in the M-N and in the Rh blood types of man.

The Landsteiner Blood Groups A, B, AB, and O

The genetic mechanism of the blood groups is now fully understood, and their distribution throughout the world has been widely studied. The four principal blood groups of man are denoted by the letters A, B, AB, and O. There are several subgroups of A and B to which reference will be made later (pp. 260-261). The four blood groups are determined by the fact that the red blood corpuscles (erythrocytes) contain two different antigens denoted by the letters A and B. An antigen is a substance which injected into the blood of an animal results, after some time, in the appearance of antibodies in its blood serum. The antibodies are known as agglutinins and the antigens which produce them are known as agglutinogens. The agglutinogens or agglutinative substances can be present either singly, as in blood group A or blood group B, or together as in blood group AB, or be altogether absent as in blood group O.

In the presence of the serum of certain other persons the agglutinogens, with the exception of blood group O, cause the red blood corpuscles to form clusters or clumps, that is, to agglutinate. The agglutination is produced by the two agglutinating substances, the agglutinins anti-A and anti-B, which are found in the blood serum of some persons. The blood serum is the medium in which float the red blood corpuscles containing the agglutinogens. Once the blood corpuscles are agglutinated the agglutinins then proceed to destroy (hemolyse) them.

If a person is of the same blood group as another with whose blood serum some of his own blood is mixed the blood corpuscles will generally disperse themselves evenly. This is due to the fact that members of the same blood group do not carry the substances which would agglutinate their own blood. This is illustrated in Table 1.

It should be clear on purely empirical grounds and from this Table, that the blood serum could not, and does not, normally carry substances which would cause its own red blood cells to agglutinate. It is therefore the rule (Landsteiner) that if an agglutinogen is absent from the red blood corpuscles of a person, then the corresponding agglutinin is present in the serum of that person. In blood transfusion it is important to avoid introducing blood containing agglutinogens that can react with agglutinins present in the serum of the recipient, otherwise the

TABLE 1. THE AGGLUTINOGENS AND AGGLUTININS OF BLOOD GROUPS A, B, AB, AND O

Blood Group	Agglutinogen (in red corpuscles)	Agglutinin (in serum)
AB	A and B	None
A	A—	anti-B
B	—B	anti-A
O	None	anti-A and anti-B

introduced blood will be destroyed or agglutinated, blocking the kidneys and even causing the death of the recipient. It will readily be seen that the blood groups can be determined by testing the unknown blood corpuscles with anti-A and anti-B sera, or by allowing the unknown serum to act on known corpuscles of A and B. The manner in which this may be done is shown in Tables 2 and 3. In Table 4 is shown the usual effect which follows upon adding a donor's blood to a receiver's serum.

TABLE 2. DETERMINATION OF BLOOD GROUPS WITH TWO TEST SERA, ANTI-A AND ANTI-B

	Known Serum Anti-A (Blood Group B)	Known Serum Anti-B (Blood Group A)	Blood Group
Agglutination of the unknown blood corpuscles	–	–	O
	+	–	A
	–	+	B
	+	+	AB

+ = clumping of red cells — = no clumping

TABLE 3. DETERMINATION OF BLOOD GROUPS OF SERA WITH KNOWN BLOOD CORPUSCLES A AND B

	Known Corpuscles A	Known Corpuscles B	Blood Group
Agglutination by the unknown serum	+	+	O
	–	+	A
	+	–	B
	–	–	AB

+ = clumping of red cells — = no clumping

In populations of European origin the commonest type of blood is O, this occurs in about 40 per cent of the population. Since blood group O contains no agglutinogens it was formerly given to receivers irrespective of their blood groups; persons of blood group O were therefore called "universal donors." The ab agglutinins of blood group O are usually of low clumping power (titer), so that they are incapable of agglutinating the agglutinogens of the other blood groups. It happens, however, that some persons of blood group O possess agglutinins of high titer; the use of their blood is therefore dangerous since it may agglutinate the red blood corpuscles of persons of other blood groups. For this reason donors of the same blood group are, whenever possible, used. Since persons belonging to the least common blood group AB, about 5 per cent of the population, possess no agglutinins they were until very recently considered to be capable of receiving the blood of any other group, and were therefore called "universal recipients." But the red blood corpuscles of such "universal recipients" were occasionaly clumped by the introduced donor's agglutinins. For these reasons the use of so-called "universal donors" and "universal recipients" is restricted today to special cases. Blood group A occurs in about 40 per cent of persons of European stock, and blood group B in from 10 to 15 per cent.

TABLE 4. THE USUAL EFFECT OF ADDING A DONOR'S BLOOD TO A RECEIVER'S SERUM

Agglutinins in receiver's serum	Agglutinogens of Donor's Corpuscles			
	(Group A) A	(Group B) B	(Group AB) AB	(Group O) None
(Group A) anti-B	Compatible	Agglutinated	Agglutinated	Compatible
(Group B) anti-A	Agglutinated	Compatible	Agglutinated	Compatible
(Group AB) none	Compatible	Compatible	Compatible	Compatible
(Group O) anti-A, anti-B	Agglutinated	Agglutinated	Agglutinated	Compatible

It has already been stated that the heredity of the blood groups is fully known. The hereditary characters of man, as in all animals and plants, are largely determined by genes. Genes, we have already seen, are giant protein molecules which are carried in the rod-like structures which occur in the nuclei of cells, and these rod-like structures, the chromosomes, occur in pairs. Each chromosome generally carries a number of genes. Each gene in the chromosome has a gene corresponding to it in the other member of the pair of chromosomes, at the corresponding locus.

During the development of the reproductive cells (sperm and ova) these pairs of chromosomes separate (reduction division or meiosis) and each sperm or ovum (the gametes) contains only one of each kind of chromosome, thus forming an exception to the general rule that each cell contains a pair of each kind. When a sperm fertilizes an ovum, the maternal and paternal gametes contribute their chromosomes to restore the arrangement by pairs.

TABLE 5. DETERMINATION OF GENETIC CONSTITUTION OF HUMANS WITH REGARD TO BLOOD GROUPS

Sperm containing chromosome carrying gene	Ovum containing chromosome carrying gene	Genotype	Blood Group (Phenotype)
A	*A*	*AA*	A
A	*O*	*AO*	
O	*A*	*OA*	
B	*B*	*BB*	B
B	*O*	*BO*	
O	*B*	*OB*	
A	*B*	*AB*	AB
B	*A*	*BA*	
O	*O*	*OO*	O

The genes contributed by the parents may be like or unlike, that is, the genes in one member of a pair of chromosomes may match or be unlike those in the opposite member of the pair. It is now known that the blood group to which a person belongs depends upon which pair out of six possible pairs of genes he has inherited from his parents, only one pair of which each parent himself can have possessed. Each of the genes in such a pair is called an allele, and is designated by the italicized letters used for the agglutinogens, *A*, *B*, and *O*. There is only one gene on each chromosome for the agglutinable properties of the red corpuscles. There are, therefore, a total of two in each individual. The genetic constitution of human beings with regard to the blood groups is therefore determined in the manner shown in Table 5.

Genes *A* and *B* are of equal expressive value and therefore the substances which they determine occur together as recognizable agglutinogens. *O* is masked by or recessive to *A* and *B* which are therefore dominant to it, so that *O* is not expressed in the presence of the alleles *A* or *B*. Thus, for a person to belong to group *O* both of the parents must have carried the gene, either in a homozygous condition, where both genes were alike, or in a heterozygous condition, where one gene in each parent was *O* and the other either *A* or *B*. In the former event, all the children would belong to blood group *O*, as for example is the case among such South American Indian tribes as the Chulpie of Argentina, the Guarani of Paraguay, and the Onas, Yámanas, and Alakalufs of Tierra del Fuego; in the latter event the offspring could belong to any one of the four blood groups. The mode of transmission of the genes in the latter case is illustrated in Fig. 117. From these facts it will be seen that the blood group genes yield six genotypes and four phenotypes as shown in Table 6.

TABLE 6. THE GENE COMBINATIONS OR GENOTYPES YIELDING THE PHENOTYPES OR BLOOD GROUPS

Genotype	Phenotype
AA or *AO*	A
BB or *BO*	B
AB	AB
OO	O

By tracing the distributions of the genes for such traits as are exemplified by the blood groups in the different populations and varieties of man, the anthropologist can expect to discover precisely what the hereditary bases are of the differences and likenesses involved. By a simple mathematical procedure known as the gene frequency method it is now possible to calculate the number or percentage of genes present in a given population for any character in that population the mode of inheritance of which is known. The term *frequency* denotes the percentage of a particular gene as determined in a particular population. The frequencies of the genes *A, B,* and *O* in any population are conventionally denoted by the letters p, q, and r respectively. In any population, therefore, in which these genes occur their sum should be equal to 100, thus $p + q + r = 100$. The frequency of the *A* gene, denoted by the letter p is obtained by extracting the square root of the sum of the frequencies of groups B and O multiplied by 10, and subtracting from 100. The frequency of the gene *B*, denoted by the letter *q*, is obtained by extracting the square root of the sum of the frequencies of groups A and O multiplied by 10, and substracting the result from 100. Finally, the frequency of the *O* gene, denoted by the letter *r*, is obtained by subtracting from 100 the sum of the calculated frequencies of the *A* and *B* genes. Other methods of computing these gene frequencies are available but these need not concern us here, except to say that in the past the sum of *p*, *q*, and *r* has often been treated as equal to unity rather than to 100 percent.

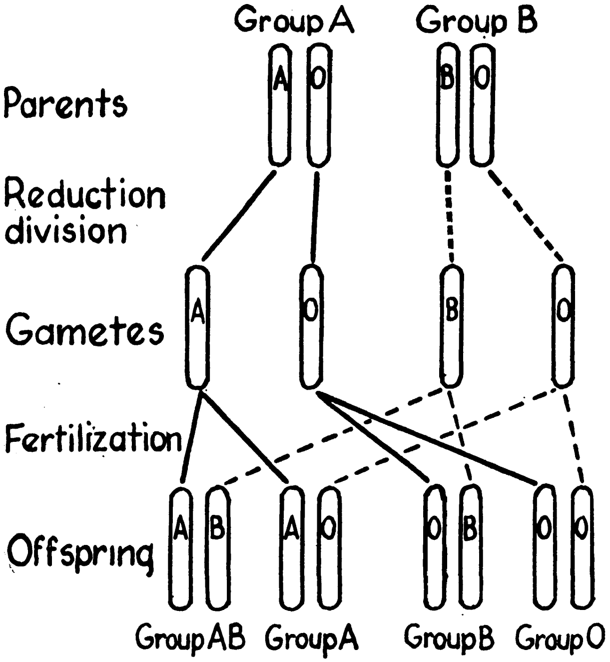


FIG. 117. Chromosome diagram showing the transmission of the genes in the mating of two persons, one of blood group A and the other of blood group B, each being heterozygous for blood group O.

Table 7 shows the kind of distribution of the blood groups A, B, AB, and O, together with their gene frequencies, as encountered in human populations. The populations in this Table were selected on the basis of their ethnic status alone. The distri-

TABLE 7. DISTRIBUTION OF THE BLOOD GROUPS IN RANDOM SAMPLES OF HUMAN POPULATIONS
(Arranged in order of diminishing frequency of *gene Bq*)

Population	Investigator	Number of Subjects	Percentage				Frequencies of Genes		
			O	A	B	AB	*p*	*q*	*r*
Ainu	Wellisch 1935	205	36.0	19.5	38.5	6.0	14.6	26.3	60.0
Asiatic Indians	Wiener *et alii* 1944	156	34.0	25.0	37.2	3.8	18.5	26.1	58.3
Tatars (Tatar Republic)	Gerasimov (*vide* Boyd 1939)	641	28.2	31.3	33.3	7.2	24.0	25.0	53.0
Congo Pygmies	Jadin 1935	1,032	30.6	30.3	29.1	10.0	22.7	21.9	55.4
Hottentots	Pijper 1935	506	34.8	30.6	29.2	5.3	22.0	21.0	59.0
Chinese (New York)	Wiener *et alii* 1944	138	31.2	32.6	27.5	8.5	23.4	20.2	55.8
Japanese (Nagasaki)	Furuhata 1933	6,387	28.0	37.9	22.8	11.3	28.3	18.4	52.9
Filipinos (Philippines)	Simmons 1945	382	45.0	22.0	27.0	6.0	15.2	18.1	67.1
Indonesians (C. Java)	Buining 1934	215	48.8	18.1	27.0	6.1	11.9	17.3	69.8
Chinese (Canton)	Dormanns 1929	992	45.9	22.8	25.2	6.1	15.2	16.6	67.6
Negroes (West Africa)	Muller 1927	325	52.3	21.5	23.0	3.2	13.6	14.5	72.4
Russians (Odessa)	Rubashkin 1929	1,831	31.8	46.2	17.4	4.6	31.9	13.7	56.4
Italians (Sicily)	Nicoletti (*vide* Boyd 1939)	540	45.9	33.4	17.3	3.4	21.3	11.8	67.8
Samoans	Stephenson 1935	500	58.6	17.0	19.4	5.0	10.3	11.8	76.6
Fijians	Simmons *et alii* 1942	200	43.5	34.0	16.5	6.0	22.2	11.6	65.9
Papuans (Schouten Ids.)	Bos 1932	611	63.7	15.4	18.5	2.4	9.2	10.8	79.8
Egyptians (Cairo)	Sharaf 1930	962	47.4	27.0	15.0	10.6	17.4	10.1	68.9
American Whites (New York)	Wiener 1944	1,077	41.7	37.8	13.9	6.7	24.4	10.0	64.6
American Negroes (New York)	Wiener 1944	582	45.8	27.2	19.8	7.0	27.8	9.0	63.7
Italians (Florence)	Ferraro (*vide* Boyd 1939)	214	42.0	43.0	11.7	3.3	27.4	8.5	64.8
Danes	Rosling 1929	2,534	43.9	41.1	11.3	3.7	25.9	8.2	66.3
Irish (Dublin)	Boyd and Boyd 1937	399	55.2	31.1	12.0	1.7	18.6	7.6	74.4
American Whites	Snyder 1929	20,000	45.0	41.0	10.0	4.0	25.7	7.1	67.2
Scottish	Matta (*vide* Boyd 1939)	746	49.6	36.6	9.5	4.3	22.4	6.5	70.4
English	Fisher and Taylor 1940	106,477	45.2	43.2	8.5	3.1	27.0	6.0	67.0
Eskimo (Greenland)	Freuchen 1932	340	43.5	47.1	7.3	2.1	29.2	5.4	66.0
Bushman (S.W. Africa)	Pijper 1932	268	60.4	28.0	7.8	3.8	16.3	4.9	77.7
French (S.E. France)	Vallois 1941	2,882	46.7	44.4	6.9	1.9	27.1	4.8	68.3
Basques	Chalmers *et alii* 1949	383	51.1	43.5	4.1	1.2	25.6	2.6	71.7
Australian Aborigines	Birdsell and Boyd 1940	805	53.2	44.7	2.1	0.0	26.0	1.4	72.9
Maori (North Island)	Graydon *et alii*	267	41.2	58.1	0.7	0.0	35.2	0.4	64.2
Indians (Navaho)	Nigg 1926	457	72.9	26.9	0.2	0.2	14.5	0.1	85.4
Eskimo (Labrador) mixed	Sewall 1934	56	46.5	53.5	0.0	1.0	31.8	0.0	68.2
Eskimo (Labrador) unmixed	Sewall 1934	143	55.6	44.4	0.0	0.0	25.0	0.0	75.0
Indians (Kwakiutl)	Gates and Darby 1934	94	92.6	7.4	0.0	0.0	3.7	0.0	96.3
S. A. Indians (Tierra del Fuego) unmixed	Lipschutz *et alii* 1946	34	100.0	0.0	0.0	0.0	0.0	0.0	100.0

bution of the blood groups and their gene frequencies were omitted from consideration for the purposes of this Table, for it was desired to show in what relationships a number of populations selected at random would fall in respect of their blood groups. The populations were then arranged in order of the diminishing gene frequency, *q*, of blood group B. If the reader will now carefully examine Table 7 he will discover something of the virtues of blood group gene frequency analysis and also something of its limitations.

It will be observed that there is a marked tendency for Asiatic Mongoloids to exhibit the highest frequencies of the gene *q* (*B*). On the other hand the lowest frequencies of *B* are encountered in the North and South American Indians and Eskimos. This is interesting, since on archeological and physical grounds the evidence is clear that the American Indians and the Eskimos are closely related. Were we to rely upon analyses of the four blood groups we should certainly not suspect a relationship between the Asiatic and the American Mongoloids. We find the latter very high in *O*, whereas the former tend to be comparatively low in *O*. The frequency of *A*, however, appears to be similar in both groups, moreover A_2 is absent in both. In short, in the present state of our knowledge we could not rely exclusively upon the four blood groups to prove relationships between populations. However, in conjunction with other serological traits, and to some extent alone, they can be used as indicators. For example, taken alone, the presence of the Congo Pygmies and Hottentots in the Asiatic Mongoloid group supports the belief of some anthropologists that the Hottentots have some Mongoloid ancestry, and raises a question in connection with the Pygmies. Interestingly enough the South African Bushmen who live cheek by jowl in the same territory as the Hottentots, and who are physically scarcely to be distinguished from the latter, are nevertheless very low in *B*. Questions are raised which suggest further researches which may ultimately lead to the answers.

It will be seen from Table 7 that the Asiatic Mongoloids, the American Mongoloids, and the whites of various origins seem to form independent clusters on the basis of their blood groups and and gene frequencies. There is, then, evidence here of a relative

TABLE 8. BLOOD GROUP FREQUENCIES IN NEW ZEALANDERS, DESCENDANTS MAINLY OF ENGLISH AND SCOTTISH SETTLERS, IN ENGLISH AND SCOTCH, AND IN UNMIXED AND MIXED MAORI SHOWING THE PROBABLE EFFECTS OF EUROPEAN ADMIXTURE UPON THE BLOOD GROUP FREQUENCIES OF THE LATTER

Population	Investigator	Number Examined	Percentage Distribution of Blood Groups				Gene Frequencies		
			O	A	B	AB	p	q	r
New Zealanders	Staveley & Godley 1950	2,802	53.0	35.5	8.8	2.6	21.2	5.8	72.8
Scotch	Fisher & Taylor 1940	10,969	52.0	34.2	10.4	3.3	72.2	20.7	6.9
Northern English	Fisher & Taylor 1940	8,716	48.6	40.3	8.5	2.5	69.5	24.5	5.8
Southern English	Fisher & Taylor 1940	106,477	45.2	43.1	8.5	3.0	67.2	26.7	6.0
Maori, Unmixed	Graydon & Simmons, 1945	267	41.2	58.1	0.7	0.0	64.2	35.2	0.4
Maori, Possibly settler admixture	Godley 1946	835	45.3	48.6	4.1	1.9	67.2	29.6	2.9

intra-group homogeneiety, although clearly of a very variable kind.

The hundreds of investigations which have been carried out on the blood groups of different populations are sufficient to convince us that by such means alone we shall never solve the problem of the composition and interrelations of such populations. In conjunction, however, with the information derived from the distribution of the blood types M-N and Rh the indications are that we have in this method a most valuable, though admittedly partial, approach to the analysis of the problem of the variety of man. The type of information we may expect to secure by this means may be illustrated by the following examples.

A colony of Hungarian gypsies were found by Vérzar and Weszeczky to have blood group frequencies more like those of the Hindus of Northern India than those of the Hungarians. On checking the history of this group on the basis of the structure of their language, a philologist discovered that the ancestors of this colony of gypsies had migrated from India some 500 or more years earlier. This case illustrates the fact that ethnic origins cannot be determined by blood group analysis alone, though it can suggest them. Such indicated origins must generally be supported by additional appropriate data.

The same investigators found that a colony of Germans living in Hungary were characterized by blood group frequencies which more closely resembled those of the Germans of Heidelberg, from which their ancestors had migrated 200 years previously, than those of their fellow Hungarian citizens.

In Wales it has recently been found that a significant number of persons bearing Welsh names made up a distinctively different population in their blood group gene frequencies from those bearing English names. The north and south Welsh are different in regard to blood group frequencies, the former resembling the Scots and Irish, while the inhabitants of south Wales, even those bearing Welsh names, are almost as high in the frequencies of certain blood groups (A in particular) as the southern English.

The population of New Zealand is mostly derived from English and Scottish immigrants. The blood groups and blood types of the non-Maori New Zealand population exhibit frequencies intermediate to those of the English and the Scots. On the other hand the mixed and the unmixed Maoris respectively show somewhat different frequencies.

Candela has shown that there is good reason to believe that blood group B was either introduced into Europe or augmented in that area between the 5th and 15th centuries A.D. by the Asiatic armies which invaded Europe during the lapse of those ten centuries. This he has been able to show by combining the data of history, physical anthropology, and the analysis of the blood groups. Candela very properly points out that the results of his studies illustrate the necessity of combining such data rather than to attempt to interpret the blood groups from their purely geographical distribution. This is, of course, not always possible, but in general, it should be obvious, that by means of genetic analyses such as are typified by the blood groups it would be possible to discover the composition of any apparently homogeneous population, and to determine what were the proportions of the different blood groups that entered into its composition.

If, as some students have suggested, mankind was originally characterized by a number of distinct populations, some of which were predominantly of blood group O, while others were predominantly of blood group A or B, it would follow that the present distribution of the blood groups resulted from hybridization succeeded by varying intervals and degrees of isolation. The analysis of that distribution by the gene frequency method, in conjunction with other data, is obviously the method most capable of throwing some light on the history of that process. More refined methods will undoubtedly become available in the future, but even now it is of interest to observe, and not without significance, that certain distinct patterns in blood group distribution can be recognized when the blood groups of different peoples are plotted on a map.

In populations which have been geographically isolated there is a tendency for the variability in the genetic characters of the group to become reduced by being scattered through such isolates, as such populations may be called. There is a general matching up of genes by breeding within the group, so that the population tends towards a level of homozygosity rather than of heterozygosity. Such a population will be characterized by the similarity of the gene pairs (one gene derived from the father, and one from the mother) for, in our present instance, the blood groups. Populations made up of different groups which have at various times contributed towards the composition of the group can, by blood group frequency analyses, be more or less broken up into their component elements, and thus, to a certain extent, the biological character of the population can be determined.

Since the blood groups of prehistoric populations can now to a very limited degree be ascertained by tests carried out on their skeletal or mummified remains,* it may in the future become possible to follow something of the biological and migratory history of such populations, and by this means possibly also something of their origins may be revealed.

Blood Types M, N, and MN

The three blood types M, N, and MN are determined by a single pair of genes designated by the letters *M* and *N*. When a chromosome in which the gene *M* is located pairs with a chromosome containing gene *M* the resulting blood type is M. When a chromosome containing gene *M* pairs with a chromosome with the *N* gene the resulting blood type is MN. When pairing is between chromosomes containing *N* genes at each of their corresponding loci the blood type is N. This is clearly expressed in Table 9.

In man the so-called M and N agglutinogens have no natural iso-agglutinins, hence it is hardly ever necessary to take them into consideration in making transfusions. The test sera are obtained from rabbits which have been injected with human blood of types M and N, and which have developed agglutinins against the agglutinogens.

The *M* and *N* genes are without dominance (although *M* appears to be somewhat stronger than *N*). Since they are quite independent in their inheritance of all other blood groups and types, their distribution in human populations is anthropologically of considerable interest. Something of this distribution is shown in Table 10.

---

* Other blood factors, like M, N, and Rh, have thus far not been determined successfully on skeletal or mummified remains.

Table 10 has been arranged in order of decreasing occurrence of blood type N. From this Table it will be seen that the first five populations, the Papuans, Australian aborigines, Fijians, Indonesians, and the Ainu show an excess of N over M, unlike the remaining twenty populations in which M is always more frequent than N. It is interesting to find the Australian aborigines and the Ainu agreeing in their high frequency of N in view of their long suspected relationship on physical grounds, and it is equally interesting to find the Papuans associated in this respect

TABLE 9. THE HEREDITY OF BLOOD TYPES M, N, AND MN

Sperm containing chromosome carrying gene	Ovum containing chromosome carrying gene	Genotype	Blood Type
M	*M*	*MM*	M
M	*N*	*MN*	MN
N	*M*	*MN*	
N	*N*	*NN*	N

TABLE 10. PERCENTAGE DISTRIBUTION OF THE BLOOD TYPES M, N, AND MN
(In order of decreasing percentage of blood type N)

Population	Investigator	Number of Subjects	M	N	MN
Papuans	Graydon & Simmons 1945	200	7.0	69.0	24.0
Australian Aborigines	Birdsell & Boyd 1940	730	3.0	67.4	29.6
Admiralty Islanders	Simmons *et alii* 1947	112	14.3	46.4	39.3
Fijians	Simmons *et alii* 1942	200	11.0	44.5	44.5
Ainu	Kubo 1936	504	17.9	31.9	50.2
American Negroes	Wiener *et alii* 1945	227	26.0	30.0	44.0
Maori (North Island)	Graydon *et alii* 1946	267	24.3	26.6	49.1
Congo Pygmies	Jadin 1934	92	29.3	26.1	44.5
Indonesians	Simmons *et alii* 1942	296	30.4	24.0	45.6
Filipinos	Simmons & Graydon 1945	382	25.9	23.8	50.3
Irish (Dublin)	Boyd & Boyd 1937	399	30.0	23.3	46.7
Basques	Chalmers *et alii* 1949	383	29.5	21.9	48.5
Chinese (New York)	Wiener *et alii* 1944	138	31.9	21.7	46.4
Russians (Leningrad)	Blinov 1935	701	32.0	21.3	46.7
Danes	Wellisch 1935	1,485	30.0	21.2	48.9
American Whites (N. Y.)	Wiener *et alii* 1945	6,129	29.2	21.2	49.6
Egyptians	Boyd & Boyd 1937	419	26.2	20.7	53.1
Australian Whites			27.1	20.5	52.4
English	Harley 1936	200	32.0	19.5	48.5
Japanese	Ischizu 1935	2,001	27.8	18.3	53.8
Chinese (Hong Kong)	Ride 1935	1,029	33.2	18.2	49.6
Asiatic Indians	Wiener *et alii*	156	40.4	16.0	43.6
Eskimos (Labrador & Baffinland)	Sewall 1939	144	31.2	16.0	52.8
Chinese (Boston)	Boyd & Boyd 1943	101	38.6	15.8	45.5
Welsh (North Wales)	Boyd & Boyd 1937	192	30.7	14.0	53.3
Amer. Indians (Washington)	Landsteiner & Wiener 1942	120	56.7	4.2	39.1
Mexican Indians	Wiener *et alii* 1945	98	61.2	3.1	35.7
Eskimo (E. Greenland)	Fabricius-Hansen 1939	569	83.5	0.8	15.7

with the Australians. The Fijians and the Indonesians might have been predicted to have fallen close together in respect of the percentage of N. The percentage of all three blood types are strikingly similar in the American Negroes and in the Congo Pygmies, but as a combined group these do not significantly differ from the distribution found in other populations. Thus, in Western Europeans, American whites, American Negroes, Congo Pygmies, Chinese, and Japanese, the proportions of the three types are roughly 29 per cent M, 21 per cent N, and 50 per cent MN.

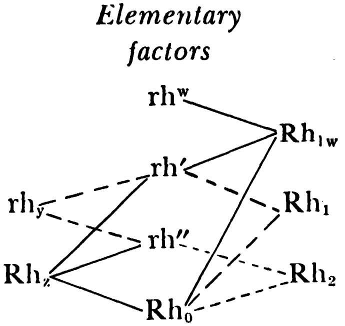
While, on the whole, the Asiatic Mongoloids tend to be relatively high in N, the American Mongoloids are exceptionally low in that blood type.

The Rh Blood Types

Even more valuable than the blood groups and the M-N blood types in the genetic investigation of mankind are the Rh blood types.

When the blood of a rhesus monkey is injected into rabbits or guinea pigs a serum is obtained which has the property of agglutinating the blood of approximately 85 per cent of white persons, quite independently of the blood groups and M-N blood types to which they may belong. Such persons possess an agglutinable factor of some complexity on the surface of their red blood corpuscles, and this (from the first two letters of the name of the *rh*esus monkey, in which it was discovered in 1937 by Landsteiner and Wiener) is now called the Rh factor. Persons possessing this factor are said to be Rh-positive, persons lacking it are said to be Rh-negative. We now know that there are three Rh factors, the original Rh_0, which is by far the most powerful and clinically most important, and rh′, and rh″. Type rh blood lacks all three factors so that it can therefore be safely used in cases of intragroup incompatability due to Rh factors.

The three elementary factors or antigens Rh_0, rh′, and rh″, have three theoretically possible contrasting factors designated Hr_0, hr′ and hr″. Every blood possesses either an Rh factor or an Hr factor or both, derived from the pairs of allelic genes Rh_0-Hr_0, *rh′-hr′*, and *rh″-hr″*. The Hr factors are less antigenic (that is, less capable of stimulating the formation of specific reacting substances) than the Rh factors. The three elementary Rh factors, it is now known, (together with the Hr factors hr′ and hr″) determine 8 agglutinogens, as shown in the following diagram:



Until recently there were believed to be five Rh agglutinogens together with the blood type possessing no Rh agglutinogens, the rh type, determined by six major allelic genes designated R^1, R^2, R^0, *r′*, *r″*, and *r*, the latter being the recessive gene in the series of six. Since every person has but one pair of Rh genes, one derived from the maternal pair and the other from the paternal pair, the possible ways in which any of the six genes can be combined are 21. In other words, 21 genotypes are possible which express themselves in eight Rh blood types or phenotypes. The Rh type of the individual is therefore the expression of his genotype determined by a single pair of genes, each allele or member of the pair being derived from the opposite parent. The 21 possible genotypes (not all of which are at persent serologically recognizable) and the eight Rh blood types are shown in Table 11.

In reality there are probably more than a dozen Rh genes. To the six principal allelic Rh genes which have been referred to above three recently discovered additional Rh genes must be added. These are the genes r^y, R^{1w}, and R^z, making a total of nine completely identified Rh genes, written, in *italics*, as follows: *r*, *r′*, *r″*, r^y, R^0, R^1, R^2, R^{1w}, and R^z. The first four genes belong to the Rh-negative series of the gene *rh*, and the last five genes to the Rh-positive series of gene *Rh*. Each gene determines a corresponding agglutinogen; in order to distinguish the latter from the former the agglutinogens are written un-italicized, the "h" of "rhesus" is retained, and subscripts are used, as follows: rh, rh_{I}, $\mathrm{rh}_{\mathrm{II}}$, rh_{y}, Rh_{0}, Rh_{1}, Rh_{2}, Rh_{1w}, and Rh_{z}. With nine Rh genes the number of theoretical Rh genotypes is increased to 45 with 24 corresponding serologically distinguishable phenotypes. We need not, however, consider these theoretical possibilities here, since they would unnecessarily serve to complicate the picture, and most phenotypes are, in any case, rare. Suffice it to say that of the three recently discovered genes, r^y and R^z are extremely rare in whites, r^y being so rare that there is practically no data on it at all, though the suspicion is that it may occur less rarely in Mongoloids, while R^z is known to occur in 3 to 6 per cent of Asiatics, American Indians, and Australian aborigines.

The distribution of the Rh types in human groups promises to be anthropologically more enlightening than that of any other

TABLE 11. RH BLOOD TYPES, GENOTYPES AND PHENOTYPES

Union of			
Sperm containing chromosome carrying gene	Ovum containing chromosome carrying gene	Genotype	Rh Phenotype
r	r	rr	rh
r	r'	rr'	rh′
r'	r'	$r'r'$	
r	r''	rr''	rh″
r''	r''	$r''r''$	
r'	r''	$r'r''$	rh′rh″ (rhy)
r	R^0	rR^0	Rh_0
R^0	R^0	$\mathrm{R}^0\mathrm{R}^0$	
r	R^1	rR^1	Rh_1
R^0	r^1	R^0r'	
R^0	R^1	R^0R^1	
r'	R^1	$r'R^1$	
R^1	R^1	R^1R^1	
r	R^2	rR^2	Rh_2
R^0	r''	R^0r''	
R^0	R^2	R^0R^2	
r''	R^2	$r''R^2$	
R^2	R^2	R^2R^2	
r'	R^2	$r'R^2$	$\mathrm{Rh}_1\mathrm{Rh}_2$ (rhz)
r''	R^1	$r''R^1$	
R^1	R^2	R^1R^2	

serological trait. Something of this distribution in samples of various populations may be seen from Table 12.

It will be observed from Table 12 that type rh is absent or virtually so from the blood of all groups with known Mongoloid traits. It will also be observed that there is a virtually complete absence of the type rh in the Australian aborigines and in the Papuans of New Guinea. Furthermore, that while the distribution of the 8 Rh types in the Australian aborigines roughly resembles that seen in the Mongoloids, with the exception of a complete absence of type rh the pattern even more closely resembles that seen in whites. This pattern is very different in the Papuans. The Mongoloid plus Caucasoid character of the Rh blood types in the Australian aborigines is extremely interesting for the reason that the latter have usually been classified with the Archaic Caucasoid stock which is of more or less remote Asiatic origin. In the character of their Rh blood types the Australian aborigines may therefore be exhibiting the evidences of a relationship with stocks of Mongoloid character on the one hand and Caucasoid character on the other. The fact that the Australian aborigines are relatively high in Rh_2 is possibly suggestive of the Negroid component in their ancestry. These brief remarks should serve to indicate the manner in which analysis of the blood types may be utilized in anthropological studies. Already this type of analysis has served to indicate remote and unsuspected possible relationships among human groups, and to confirm some which have been suspected on other grounds.

The Rh blood types promise to be among the most useful genetic traits in the study of the biological relationships of human groups, but it is only in combination with the analysis of many other genetically conditioned traits, and by an analysis of each of these traits in relation to the others that these types will have their greatest value.

R. A. Fisher originally proposed the theory of eight genes with 36 genotypes as accounting best for the Rh blood types, and he suggests that we may, in fact, be dealing with 18 genes and 171 possible genotypes. Should this ultimately prove to be true, then we would have in the genetic analysis of the Rh blood types one of the best methods for unravelling the relationships of the ethnic groups to one another.

TABLE 12. DISTRIBUTION OF THE RH BLOOD TYPES

(As Determined by the Use of 3 Sera: Anti-Rh_0, Anti-rh′, Anti-rh″)

Population	Investigators	Number of Subjects Tested	(Rh+)	PERCENTAGE OF RH TYPES							
				(rh)	Rh_1	Rh_2	$Rh_1 Rh_2$	Rh_0	h′	rh″	rh′rh″
Papuans	Simmons *et alii* (1946)	100	100.0	0	93.0	0	7.0	0	0	0	0
Admiralty Islanders	Simmons & Graydon (1947)	112	100.0	0	92.9	0.9	6.2	0	0	0	0
Fijians	Simmons & Graydon (1947)	110	100.0	0	89.1	1.8	9.1	0	0	0	0
Filipinos	Simmons & Graydon (1945)	100	100.0	0	87.0	2.0	11.0	0	0	0	0
New Caledonians (N&NW)	Simmons & Avias (1949)	243	100.0	0	77.4	2.1	20.5	0	0	0	0
Loyalty Islanders	Simmons & Avias (Incomplete)	103	100.0	0	77.7	2.9	19.4	0	0	0	0
Indonesians	Simmons & Graydon (1947)	200	100.0	0	74.0	2.5	22.5	0.5	0	0	0.5
Australian Aborigines	Simmons *et alii* (1948)	234	100.0	0	58.2	8.5	30.4	1.3	1.7	0	0
American Indians (Mexico)	Wiener *et alii* (1945)	95	100.0	0	48.1	9.5	41.2	1.1	0	0	0
American Indians (Oklahoma)	Wiener *et alii* (1946)	105	100.0	0	40.0	17.1	39.1	2.9	0.9	0	0
Maoris	Simmons *et alii* (Incomplete)	32	100.0	0	25.0	31.0	41.0	3.0	0	0	0
Japanese	Miller and Taguchi	180	99.4	0.6	51.7	8.3	39.4	0	0	0	0
Japanese	Waller and Levine	150	98.7	1.3	37.4	13.3	47.3	0	0	0	0.7
Chinese	Wiener *et alii* (1944)	132	98.5	1.5	60.6	3.0	34.1	0.9	0	0	0
Asiatic Indians (Moslems)	Wiener *et alii* (1945)	156	92.9	7.1	70.5	5.1	12.8	1.9	2.6	0	0
American Negroes	Wiener *et alii* (1944)	223	91.9	8.1	20.2	22.4	5.4	41.2	2.7	0	0
American Negroes	Levine *et alii* (1945)	135	92.6	7.4	23.7	16.3	4.4	45.9	1.5	0.7	0
Puerto Ricans	Torregosa *et alii* (1945)	179	89.9	10.1	39.1	19.6	14.0	15.1	1.7	0.5	0
White, Americans	Wiener *et alii* (1946)	766	87.5	12.5	54.7	14.9	14.0	2.2	0.9	0.5	0
White, Americans	Unger *et alii* (1946)	7,317	85.3	14.7	53.5	15.0	12.9	2.2	1.1	0.6	0.01
White, English	Fisher & Race (1946)	927	85.2	14.8	54.9	12.2	13.7	2.5	0.7	1.3	0
White, English	Murray (1946)	1,038	84.7	15.3	54.8	14.7	11.6	2.3	0.6	0.7	0
White, Australians	Simmons *et alii* (1945)	350	85.1	14.9	54.0	12.6	16.6	0.6	0.9	0.6	0
White, Hollanders	Graydon *et alii* (1946)	200	84.6	15.4	51.5	12.3	17.7	1.5	1.5	0	0
White, French	Bessis 1946	501	83.0	17.0	51.7	13.6	13.0	3.6	0.4	0.8	0
Basques	Chalmers *et alii* (1949)	383	69.5	28.8	55.1	7.8	6.0	0.6	1.8	0	0
Basques	Etcheverry (1947)	250	64.4	—	—	—	—	—	—	—	—

Wiener has recently shown that the distribution of the *Rh* (rhesus positive) and *rh* (rhesus negative) genes can best be accounted for on the hypothesis that, at least during postglacial times, ethnic mixture must have been the most important factor influencing the pattern of that distribution.

The Blood Genes as Genetic Indicators

The comparatively stable nature of the blood genes renders them of great potential value in the tracing of ethnic relationships. It is, however, not to be expected that it will be possible to solve anthropological problems merely by turning to blood gene frequency tables, as one would look up the definition of a word in a dictionary. This is particularly worth emphasizing in view of the fact that neither the evolutionary nor the ethnic implications of the characters of the blood are quite clear.

Nevertheless certain distinct patterns do exist in the distributions of these serological traits, and further, a fair amount of correlation exists between these blood frequency patterns and certain patterns of distribution of human populations. Thus far, however, no linkages between blood traits and anatomical traits have been discovered, although linkage between the sickling trait of red blood corpuscles and the M-N blood types has been demonstrated by Snyder and his co-workers. It has already been pointed out that the genetic mechanism governing the inheritance of the blood traits is thoroughly understood, in contrast to the situation which obtains with regard to almost all the other anthropological criteria, the inheritance of but a few of which is at best imperfectly understood. In consequence, the blood trait genes can be made to serve as a test of ethnic paternity.

Further, the blood trait genes can serve as ethno-serological *indicators,* much as radioactive sodium ions act as "tags" in biochemical researches, enabling the biochemist to identify the stages through which a chemical reaction passes, and the changes which occur in the substance under investigation.

For this to be possible in ethno-serological studies it is necessary first to identify the source of the blood group factor which one proposes to use as an indicator. This is by no means an easy task in all instances, in view of the shuffling and reshuffling of populations which has occurred since the earliest times. However, it seems almost certain that all the B in Europe and in eastern Asia, as well as a little of the B in Southeastern Asia and the Pacific area, is derived from the brachycephalic central Asiatic Mongoloid pool exemplified by the Buriat type. Group B in Indonesia (including Madagascar), and in most of Indo-China is attributable, on the other hand, to relatively late colonization from India.

Table 13. Gene Series O, A_2, A_1, B

Genotypes	Phenotypes
OO	O
A_2O	A_2
A_2A_2	
A_2A_1	A_1
A_1O	
A_1A_1	
BO	B
BB	
A_2B	A_2B
A_1B	A_1B

The account given in the preceding pages of the blood groups is accurate as far as it goes. Since 1910 it has been known that there are two sorts of A blood, designated A_1 and A_2, with A_1 apparently dominant over A_2. It has been postulated that there are four rather than three genes involved, namely O, A_2, A_1, and B, giving rise to 10 genotypes and six phenotypes, as shown in Table 13.

Subgroup A_2 is anthropologically of considerable interest, for from the 50 or more studies which have thus far been carried out on various populations this subgroup (see Table 14) appears to be absent in the Australian aborigines, Papuans, all Mongoloids, and Polynesians. At the present time, omitting from consideration the mixed American Negroes among whom both A_2 and A_1 occur, A_2 appears to be largely if not entirely limited to whites of European origin.

In mixing with Mongoloids in eastern Asia the assumption is that some groups of the Archaic Caucasoid divisions acquired large amounts of group B, and corresponding portions of Mongoloid

TABLE 14. DISTRIBUTION OF THE SUBGROUPS OF A AND AB

(In order of increasing frequency of gene p_2)

Population	Investigator	Number of Subjects	Percentage						Frequencies of Genes			
			O	A_1	A_2	B	A_1B	A_2B	p_1	p_2	q	r
Mexican Indians	Wiener *et alii* 1945	98	90.8	6.1	0.0	3.1	0.0	0.0	3.1	0.0	1.6	95.3
American Indians (unmixed)	Landsteiner *et alii* 1942	120	73.3	25.8	0.0	0.8	0.0	0.0	13.9	0.0	0.5	85.6
Indonesians	Simmons *et alii* 1945	296	51.7	22.6	0.0	21.3	4.4	0.0	14.6	0.0	13.8	71.9
Fijians	Simmons *et alii* 1945	200	43.5	34.0	0.0	16.5	6.0	0.0	22.5	0.0	12.0	66.0
Papuans	Simmons *et alii* 1946	455	42.9	27.5	0.0	21.3	8.4	0.0	19.9	0.0	16.1	65.5
Australian Aborigines	Wilson *et alii* 1944	649	43.9	56.1	0.0	0.0	0.0	0.0	25.1	0.0	0.0	74.9
Hawaiians	Nigg 1930	413	36.5	60.8	0.0	2.2	0.5	0.0	28.2	0.0	1.8	60.4
Maoris (North Island)	Graydon *et alii* 1946	267	41.2	58.1	0.0	0.7	0.0	0.0	35.2	0.0	0.4	64.2
American Indians (mixed)	Landsteiner *et alii* 1942	155	58.1	31.6	3.2	4.5	2.6	0.0	18.1	2.1	2.9	76.2
Caucasians (Tiflis)	Boyd & Boyd 1937	268	57.5	25.4	3.7	10.1	1.9	1.5	14.8	2.4	6.4	75.8
Basques	Chalmers *et alii* 1949	383	51.1	37.3	6.2	4.1	1.0	0.0	21.5	4.1	2.6	71.7
American Negroes	Wiener *et alii* 1943	189	48.1	19.6	6.8	22.8	1.6	1.1	12.2	4.8	14.5	69.4
Germans	Dahr *et alii*	416	40.1	37.5	7.0	11.3	3.3	0.8	23.4	5.3	8.4	63.3
English (Hertfordshire)	Shenley	900	42.1	35.8	8.0	10.1	3.1	0.9	21.9	5.9	7.4	64.9
Egyptians (Cairo)	Matta 1937	516	26.6	29.1	6.6	27.1	7.0	3.5	21.3	6.0	21.7	51.6
Irish (Dublin)	Boyd & Boyd 1937	400	55.2	21.7	9.5	11.8	1.0	0.8	12.5	6.1	7.6	74.3
Russians	Blinov 1935	763	33.7	30.8	7.6	20.8	4.0	3.1	20.6	6.2	15.8	58.1
Dutch	Graydon *et alii* 1946	200	46.5	30.5	9.0	9.0	4.5	0.5	18.2	6.3	6.3	68.2
American Whites	Wiener *et alii* 1943	1,077	41.7	29.0	8.9	13.9	5.2	1.4	18.1	6.5	10.0	64.6
Danes	Clausen	1,853	40.0	32.7	9.8	12.4	2.8	2.3	20.2	7.3	9.2	63.3
Welsh (North Wales)	Boyd & Boyd 1937	190	47.3	21.6	11.6	16.3	2.6	0.5	13.0	7.9	10.8	68.8
Swedes	Wolff & Jonsson	1,200	37.9	36.9	9.8	10.3	3.9	1.2	22.9	8.5	7.9	61.6
Finns	Mustakallio	7,120	33.9	32.3	10.7	15.8	4.4	2.9	20.1	9.3	12.3	58.2
Basques (San Sebastian)	Boyd & Boyd 1937	64	51.5	31.2	15.6	1.6	0.0	0.0	17.3	10.2	1.1	71.6

genes; such a group is represented by the Ainu. The Australian aborigines, on the other hand, are exceedingly low in B, and many coastal tribes are wholly lacking in it. Possibly as a result of mixture with a Negroid stock they now possess somewhat greater amounts of O, together with greater amounts of melanin pigments in the skin than the Asiatic Archaic Caucasoids. In addition to the striking difference in the frequency of A_2 in the Caucasoid and the Archaic Caucasoid divisions there is also a fundamental difference between them in the frequency of the M-N blood types. It has already been seen that whereas in whites of European origin the frequency of M is always in excess of that of N, among the Australian aborigines M is scarce and N very high. In the Ainu also, the N factor is more frequent than in the rest of the world populations, but less so than in the Australian aborigines. This may be the result of admixture with carriers of Mongoloid genes or it may be the effect of their more markedly Caucasoid genotype. In being virtually 100 per cent Rh negative the Australian aborigines fall into the Mongoloid pattern, but not so, as we have already seen, with respect to their remaining Rh types which follow the Caucasoid pattern, with the exception of Rh_2 in which they are relatively high, and which suggests the Negroid component in their ancestry.

This brief discussion will suffice to indicate the manner in which the genes for the blood groups and blood types may be used as indicators. For it is obvious, for example, that if it is established that the central Asiatic Mongoloids were the source of European B, then we could use that information to estimate the extent to which the Mongoloids have contributed to the genetic composition of a given population.

In the example which has been cited, a close correlation has been demonstrated between the frequencies of the "new" blood group gene B and the proportions of the "new" somatic (Mongoloid) genes. The latter, being for the most part genetically dominant, are easily discernible in the resultant ethnic mixture. The presence of this close correlation makes us more confident in the application of the method to those other problems of ethnic mixture in which the somatic genes, being recessive, may have failed to leave a visible impression on the phenotype.

While the blood groups and blood types are not chemically quite the same in the apes and monkeys as they are in man, their distribution in these non-human primates is of some assistance in helping us to understand the nature of the possible factors involved in the distribution of the blood groups throughout the world as we find them at the present time.

While some species of monkeys possess two of the three blood group factors, there is a striking tendency for many other species to exhibit but a single blood group, generally either A or B. This is not the case in the anthropoid apes. Thus, the two mountain gorillas thus far tested belong to group A, the 13 lowland gorillas thus far tested to group B. Of the 108 chimpanzees tested 96 are A and 12 are O. Out of 24 orangs tested nine were A, 10 were B, and five AB. The 11 gibbons tested yielded two A, seven B, and two AB.

With the exception of 10 per cent of chimpanzees group O is lacking in the apes. It is also of very low frequency among the monkeys. In man group O occurs in all populations in frequencies varying from 50 per cent to as high as 100 per cent of the O gene.

On the basis of these facts it could be argued the stock from which man, in common with the great apes, was derived, possessed all four blood groups, and that different genes suffered extinction in different isolates of apes and of early man. In such case the pattern of distribution of the blood groups in early man would have been the same or very similar to what it is among the anthropoid apes today. From this we would have to conclude that the present distribution of the blood groups was, in man, brought about by intermixture or hybridization. Furthermore, it could be argued that blood group O in man was originally of very low frequency, and probably limited to a few groups, being subsequently diffused through hybridization. On the other hand it could be argued that these differences indicate that man is only remotely related to the anthropoid apes.

The blood of all chimpanzees thus far tested contains agglutinogens similar to but not identical with the human agglutinogens M and N. The orang-utan, the gibbon, and the catarrhine monkeys exhibit M agglutinogens of progressively more different kinds. An M-like agglutinogen has been found in only one species of platyrrhine monkey.

The Rh blood type has been determined in 15 chimpanzees, in each case proving to be Rh negative. The indication gains strength that the Rh negative blood type constitutes a relatively recent mutation in man's biological history, appearing possibly in the upper paleolithic somewhere in western Europe.

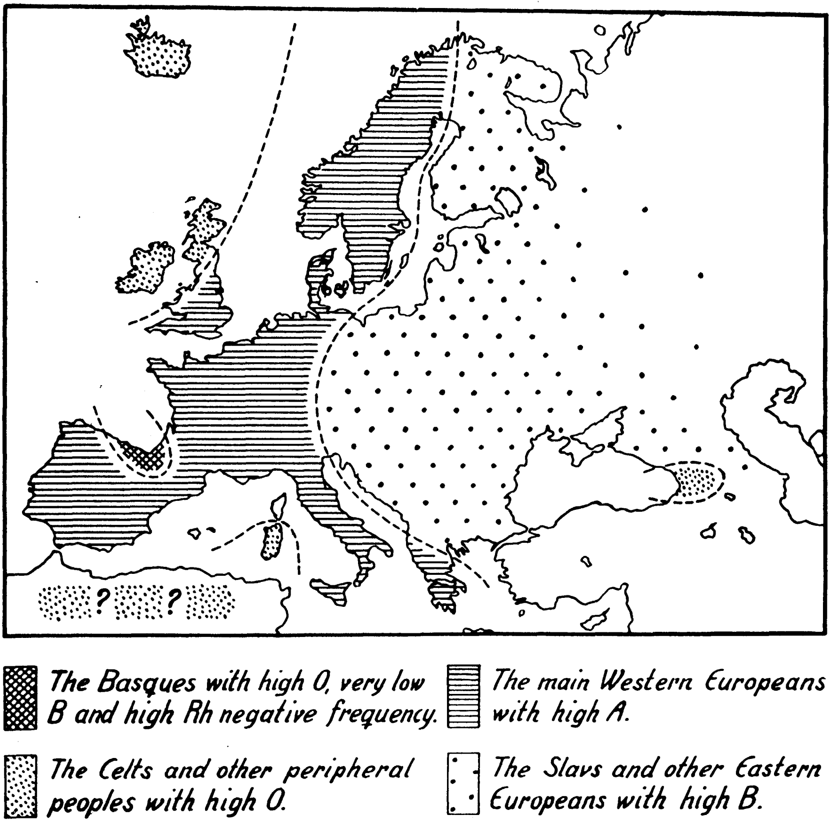


FIG. 118. Blood groups of the Basque People. (From Chalmers, Ikin, and Mourant. Courtesy, *Am. J. Phys. Anthrop.*)

This suggestion has recently been rendered more than plausible by the discovery that the linguistically unique Basque people are characterized by an extraordinarily high frequency of the Rh negative gene. In a total of 250 Basques Etcheverry (1947) found that 35.6 per cent were Rh negative. This is more than twice the highest percentage hitherto known for any human group. In a sample of

383 Basques Chalmers and his co-workers (1949) found the percentage to be 29.0 per cent. The Basques as well as populations containing a large Basque element show a high frequency of group O persons. In this they resemble Icelanders, Scots, Irish, northern Welsh, and Sardinians. The Basques, however, are unique among all the peoples of Europe in their very low frequency of group B. Such facts together with their extraordinarily high Rh negative constitution suggest that the Basques are a relict population which has remained isolated from the general stream of western European admixture.

It is of interest to mention here that in 1945 Boyd and Montagu by plotting the distribution of Rh gene frequencies on a small scale map, were led to conclude that the highest frequency of Rh negative was to be found in the borderland region between northern Spain and southern France. Boyd and Montagu also concluded that it seemed probable that the Rh negative gene originated in a population in this general region. Mourant (1947) and Etcheverry (1947) independently suggested that the Basques are the present-day representatives of a population from which the Rh negative gene in Europeans is derived.

The P and Q agglutinogens, and the two Hr factors complementing the Rh types can only be mentioned here. These and other serological traits will very likely ultimately serve to contribute to our better understanding of the genetic relations of man.

The Secreting Factor

The blood group factors may also be determined from the saliva, gastric juice, mucous secretions, and urine of some persons. Such persons are termed "secretors." Persons whose saliva or other body fluids are nearly free of these factors (in water soluble form) are termed "non-secretors." The heredity of the secreting factor is extremely simple, two genes being involved, one of which is dominant (*S*), and the other is recessive (*s*), thus giving rise to three genotypes (Table 15).

Secreting factors have been found in 78 per cent of Berlin whites, 84.2 per cent of New York whites, and 61.2 per cent of American Negroes. It is also known that secreting factors are present in the anthropoid apes.

The simple hereditary mechanism of the secreting factor and the ease with which it may be tested, renders it admirably suited to ethnic studies.

Another trait of blood which is genetically of promising anthropological value is the tendency of the red blood corpuscles (erythrocytes) in some members of Negroid groups to assume a peculiar sickle shape when placed in an oxygen-deficient medium.

TABLE 15. THE GENOTYPES AND PHENOTYPES OF THE SECRETING FACTOR

Genotype	Phenotype
SS	Secretor
Ss	Secretor
ss	Non-Secretor

A drop of blood of such an individual when sealed under a coverslip on a slide with vaseline will, when observed under the microscope at varying intervals up to three days, show a high proportion of erythrocytes of bizarre oat, sickle, or holly leaf shapes. This condition is known as sicklemia or the sickle cell trait. In American Negroes sicklemia occurs in frequencies ranging from 4.3 to 15.0 per cent, with a mean of about 8.0 per cent. In about 1 out of 40 of those individuals whose cells are capable of sickling, severe chronic anemia develops as a result of excessive destruction of their erythrocytes. This condition is known as sickle cell anemia. In July 1949 Neel showed that the gene responsible for sickling is carried in heterozygous condition in individuals with sicklemia, and in homozygous condition in those with sickle cell anemia. In November 1949 Pauling and his co-workers corroborated this discovery by showing that normal and sickle cell anemia hemoglobin exist in roughly equal proportions in sicklemia hemoglobin preparations. The gene responsible for sickling is identifiable with one of an alternative pair of alleles (allelic genes are situated at corresponding loci in a pair of chromosomes), as *Ss*, where *S* is the gene for sicklemia and *s* the gene for the unaffected hemoglobin molecule. In normal unaffected persons there is a complete absence of the sicklemia gene, while two doses of its normal allele are present, as *ss*. In sickle cell anemia the somatic cells carry two doses of the sickle cell gene, *SS* and show a complete absence of the normal gene. The gene for sickling is therefore seen to behave as a dominant which in the heterozygous condition produces sickling and in the homozygous condition produces sickle cell anemia. These facts are illustrated in the following:

Allele	*Allele*	*Condition*	*Hemoglobin*
s	*s*	Normal	100% Normal
S	*s*	Sicklemia	40% Sickle cell anemia
			60% Normal
S	*S*	Sickle cell anemia	100% Sickle cell anemia

The phenomenon of sickling would appear to occur mainly in Negroid groups. Interestingly enough in those cases in which sicklemia has been reported in non-Negroid families, as for example, in a Sudanese Arab, two brothers of Greek descent, a Cuban boy, in a family line from Calabria, and in several families from Sicily and Brazil, there is fair evidence of Negroid genes being involved.

The great rarity of sicklemia in non-Negroid peoples and its frequency in peoples of Negroid ancestry suggests that this trait may be utilized in tracing the relationships of various Negroid groups, as well as the Negroid component in phenotypically non-Negroid populations and persons.

It is not surprising that sicklemia should occasionally occur in persons of Mediterranean origin. Indeed, it is a trait which, in low frequencies, might have been expected to appear in some persons of Mediterranean origin, if only for the reason that there are some indications that admixture with Negroids, in the past, has been part of the biological history of some Mediterranean populations.

As illustrative of the value of this trait reference may be made to the investigations of Lehman and Raper (1949) on the distribution of sicklemia in the Uganda. Lehman and Raper investigated nearly 5,000 Uganda Negroes from 24 different tribes for sicklemia. Their findings are shown in Table 16. From this table it will be observed that the Hamitic tribes show a relatively low frequency of sicklemia, with the exception of the Teso. The fact of interest here is that the Teso is the only Hamitic-speaking tribe which exhibits marked Negroid physical traits. The Nilotic tribes are remarkably homogeneous in the frequencies of sicklemia, excepting the Madi who live on the Sudan border. Unlike the two

TABLE 16. DISTRIBUTION OF SICKLEMIA IN UGANDA

Language Group	Tribe	Number Examined	Percent of Sicklemia	Frequency of Gene *S*	Frequency of Gene *s*
HAMITIC	Bahima	166	2.4	1.3	98.6
	Sebei	124	0.8		
	Suk	128	3.9		
	Karamojong	156	3.2		
	Teso	416	17.8	9.3	90.6
NILOTIC	Lango	278	27.0	13.7	86.2
	Acholi	141	27.0		
	Jaluo	130	28.0		
	Lugbara	120	21.0		
	Kakwa	101	25.0		
	Aiur	114	25.0		
	Jonam	109	26.0		
	Madi	109	3.0		
BANTU	Bairu	139	2.0		
	Banyuaranda (Bahutu)	496	8.0	4.7	95.2
	Banyoro	91	12.0		
	Batoro	120	12.5		
	Baganda	740	19.0	9.9	90.0
	Bakonjo	102	18.0		
	Barundi	108	19.0		
	Bakenyi	88	26.0		
	Basoga	241	29.0	16.0	83.9
	Bagishu	207	30.0		
	Baamba	140	45.0	25.8	74.1

After Lehman and Raper, 1949; and Elsdon-Drew, 1950.

previous groups the Bantu-speaking tribes are remarkably homogeneous in the frequencies of sicklemia. In short, these findings suggest that in Uganda incidence of sicklemia is inversely proportional to the contact the various tribes have had with the Hamitic invaders.

In the serological traits we have anthropological characters which for the first time provide us with a means of actually breaking through the phenotypical external characters, and determining the genetic character, the genotype, of a population. This, of course, is true only for a very few other traits in addition to the serological traits. Future researches will undoubtedly yield many more such traits which will then become usable in the same way in the genetic analysis of populations.* One such trait which may next be discussed is in the form of a taste-reaction, and should provide the reader with an idea of the great variety of traits which lend themselves to genetic analysis.

Tasting and Non-Tasting

PTC are letters which stand for a white crystalline powder known as phenyl-thio-carbamide. A single crystal placed on the back of the tongue as soon as it is dissolved in saliva is experienced by most persons as a rather bitter taste. Such persons are known as "tasters." Those who are unable to taste PTC are known as "non-tasters." Two genes are involved, one of which is dominant (*T*), and the other recessive (*t*), both giving rise to three genotypes (Table 17). The gene *T* is dominant for tasting and the gene *t* recessive for non-tasting, the non-tasters always being homozygous (*tt*) for that gene.

TABLE 17. THE GENOTYPES AND PHENOTYPES OF TASTING AND NON-TASTING PTC

Genotype	Phenotype
TT	Taster
Tt	Taster
tt	Non-Taster

In the human populations thus far investigated interesting differences have been found in the proportions of non-tasters to tasters. The percentages of tasters are listed in Table 18. Interestingly enough the investigation of the taste reaction of 27 chimpanzees to PTC revealed that seven animals or 26 per cent were non-tasters, a proportion falling well within the range of that encountered in man in whom the range is from 1.8 to 41.3 per cent non-tasters. Since it is hardly conceivable that the relations of the genes to one another has remained the same over the 800,000 or more generations since the separation of the anthropoid and

---

* See pp. 458-468.

hominid stocks, the erroneous inference was made that over this enormous period of time the heterozygotes (*Tt*) for this apparently valueless character have enjoyed a selective advantage over both the homozygotes (*TT, tt*), and this in both the lineage of the evolving chimpanzees and in that of evolving man. There are, apparently, about equal numbers of *T* and *t* genes in the chimpanzees (and in some human populations) yielding, as would be expected,

$$\begin{array}{ll}\left.\begin{array}{l}25\text{ per cent } TT\\ 50\text{ per cent } Tt\end{array}\right\} & \text{tasters}\\ \;\;25\text{ per cent } tt & \text{non-tasters}\end{array}$$

Under conditions of genetic isolation the proportions of the genes and their phenotypic expression will remain constant, and are then said to be in equilibrium.

From Table 18 it will be seen that the variation is such in the proportions of tasters to non-tasters as to indicate significant differences in gene frequencies with respect to the *T* and *t* genes. The study of these gene frequencies in different populations should be particularly rewarding. The genetic analysis of taste-reactions in the non-human primates and in human populations may serve to throw a unique light upon such important problems as the relationship of primate groups to one another, the stability or instability of certain combinations of genes, and their selective value.

How the present differences in the frequency distribution of the blood group, blood type, secreting, sicklemia and taste-reaction genes were probably produced, as well as the many other differences which are to be found in the different divisions and ethnic groups of man, may best be considered below.

Our knowledge of none of the traits here discussed is at present sufficient to permit us to reconstruct the relationships of the divisions and ethnic groups of man to one another. Attention has here been given to an account of these traits principally because they provide the type of criteria which the new physical anthropology is beginning to use, and of which it will make ever increasing use in the future. The mechanism of the inheritance of these traits has been described in order to show to what extent

TABLE 18. ABILITY TO TASTE PHENYL-THIO-CARBAMIDE IN HUMAN POPULATIONS

Population	Place	Investigator	Number Tested	Per cent Tasters
Welsh	Five different towns	Boyd & Boyd 1937	237	58.7
Eskimo, Unmixed	Labrador & Baffin Id.	Sewall 1939	130	59.2
Germans		Gottschick 1937	183	62.3
Danish	Copenhagen	Hartmann 1939	596	62.8
Russians	Zagorsk (n. Moscow)	Boyd & Boyd 1937	486	63.2
Arabs	Syria (interior)	Hudson & Peter (P) 1934	400	63.5
Russians	Kharkov	Boyd & Boyd 1937	161	64.6
American Whites	Montana	Matson 1938	291	64.6
Yemenites	Yemen, Palestine	Yunovitch (P) 1934	59	67.7
Armenians	Syria	Berberian (P) 1934	294	68.0
Ashkenazic Jews	Palestine	Yunovitch (P) 1934	245	68.5
American Whites	Washington, D. C.	Parr 1934	439	69.1
Eskimo, Mixed	Labrador & Baffin Id.	Sewall 1939	49	69.4
American Whites	New York and vicinity	Blakeslee 1932/35	400	70.0
American Whites	Ohio State University	Snyder 1932	3,643	70.2
Swiss	Zurich and vicinity	Botsztejn 1942	544	70.4
Scottish	Glasgow	Riddell & Wybar 1944	60	71.7
Irish	Dublin	Boyd & Boyd 1937	398	71.8
Sephardic Jews	Palestine	Yunovitch (P) 1934	175	72.0
Copts	Cairo, Egypt	Boyd & Boyd 1937	110	73.6
English	London	Falconer & Fisher 1947	629	73.7
East Georgians	Tiflis	Boyd & Boyd 1937	121	74.4
Basques	San Sebastian	Boyd & Boyd 1937	98	74.5
Egyptians	Cairo	Hickman & Marcos (P) 1934	208	75.9
American Negroes	Alabama	Howard & Campbell (P) 1934	533	76.5
West Georgians	Tiflis	Boyd & Boyd 1937	218	78.0
Mohammedans	Cairo	Boyd & Boyd 1937	459	78.9
Flathead Indians, Mixed	Montana	Matson 1938	442	82.6
Mixed Amerinds	Lawrence, Kansas	Levine & Anderson 1932	110	87.2
Formosans Chinese origin	Formosa	Rikimaru 1936	5,933	89.5
Flathead Indians, Unmixed	Montana	Matson 1938	30	90.0
American Negroes	Ohio	Lee 1934	3,156	90.8
African Negroes	Kenya, East Africa	Lee 1934	110	91.9
Amerindians	Alberta	Matson 1938	310	92.4
Japanese	Japan	Rikimaru 1936	8,824	92.9
Unmixed Amerinds	Lawrence, Kansas	Levine & Anderson 1932	183	93.9
Chinese	Washington & New York	Chen & Chain (P) 1934	167	94.0
Formosans	Formosa	Rikimaru 1936	1,756	94.8
African Negroes, Shilluk	Sudan	Lee 1934	805	95.8
Amerindians	Northern Alberta	Matson 1940	559	96.9
Navaho Indians	Ramah, New Mexico	Boyd & Boyd 1949	269	98.2

(P) = Data collected for Parr (*q.v.*).

such traits may be relied upon for tracing the physical relationships of man.

THE MECHANISM OF DIFFERENTIATION OF THE DIVISIONS AND ETHNIC GROUPS OF MAN

In the last chapter we saw that early man was already differentiated into a number of recognizable types, that there was good reason to believe that mixture had occurred between some of these types, and that from some of these mixtures several of the varieties of man as we now know them probably were evolved.

When, in this connection, we use such a word as "evolved" we have a very definite series of processes in mind, and it is these processes, which we shall now consider, which give a definite meaning to what we understand by the evolution of the ethnic groups of man. Such evolutionary processes are at work before our eyes at the present time in every part of the world, where the barriers between different isolates are being broken down or else erected. This is particularly true of the United States where one can observe and study the effects of both processes in action. But this is to anticipate.

When two or more populations are isolated from one another they may be spoken of as *isolates.* It does not matter how large or small the population is. Isolation may be defined as the state or condition of separation from other groups which limits or prevents interbreeding between them. Within any population there are generally a number of different groups which may remain more or less distinct by virtue of marriage regulations, chance factors, or recognized barriers, which serve to maintain the distinctness of the group. Such groups are also *isolates.* Natural geographic barriers such as distance, seas, rivers, forests, and mountains, serve to maintain the independence of isolates. Out of the way villages with poor communications with the outside world provide good examples of isolates in our own country, and still more so in Europe. In western society the tendency to marry into one's own class serves to maintain what may be called the *class isolate,* while the tendency to marry a person of the same religion serves to maintain the *religious isolate.* When, as is usually the case, both are combined, as among Jews, or Catholics —particularly Catholics of Irish and Italian descent—where Jews tend to marry Jews of the same class, and Catholics tend to marry Catholics of the same class and national origin, easily recognizable social isolates are produced, and these are often miscalled "races."

Factors similar to those involved in the production of the isolates just mentioned have probably been operative throughout the long history of mankind, but there have also been others.

Whether we think of the earliest types of man as arising from a common ancestral stock or from several different stocks, ultimately makes very little difference to our understanding of the differentiation of mankind. If they originated from different ancestors and were different to begin with, some of them must have met and interbred and produced hybrids who, in turn, did likewise, and some of the results of these mixtures may have given rise to existing varieties of mankind. A strong case could be made out for this polygenic theory of the origin of the varieties of mankind, but not quite as strong as that which can be made out for the monogenic theory which postulates the origin of the varieties of mankind from a common ancestral stock. One of the principal objections to the polygenic theory is that the living varieties of man so closely resemble one another in all their physical and mental characters that it would be difficult to conceive of them as having originated from distinct lines by a process of convergence. Also while it makes it more difficult to account for the existing differences, the monogenic theory seems to be more in accord with the facts, and with the evolutionary processes involved in the production of other varieties of living creatures.

Our present knowledge is not by any means adequate to provide an entirely satisfactory explanation of the mechanisms of ethnic differentiation in man. Much basic research will have to be carried out before that becomes possible; but by utilizing the findings of geneticists on other animal groups as well as on man it will be possible to give the reader some idea of the nature of the probable mechanism or processes involved in the evolution of the ethnic groups of man. We may begin with the following postulates:

1. The original ancestral human population was genetically relatively heterogeneous.
2. By migration at different times away from the original ancestral population, individual families or groups of families became dispersed over great distances.
3. Some of the groups thus dispersed became geographically isolated from one another, and remained so isolated for more or less considerable periods of time.
4. In all these isolated groups the following factors came into play as conditions leading to evolutionary change:
    - i. *Natural selection*
    - ii. *Mutation*
    - iii. *Isolation*
    - iv. *Genetic drift*
    - v. *Hybridization*
    - vi. *Sexual selection*
    - vii. *Social selection*

Natural Selection

By natural selection is meant the preservation through the action of the environment of such variations as arise and are beneficial to the organism under its conditions of life. Because they adapt the organism to those conditions such variations are called adaptive. Under the selective action of the physical environment those individuals who are lacking in the necessary adaptive characters or qualities tend to die out while those who possess them survive and procreate. Natural selection may, then, be regarded as the creative force which out of the raw materials of mutation determines not only which organisms shall survive, but also which among the many millions of possible organisms will in fact arise.

Darwin's own definition of natural selection may be given here. It is from the introduction to *The Origin of Species*, 1859, page 5:

"As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be *naturally selected*. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form."

Judging from its distribution it is practically certain that skin color is an adaptive character, that is to say a character which has selective value. In man, with few exceptions darkly pigmented skins are geographically distributed in high temperature-sunlight-humidity regions, lightly pigmented skins in regions of lower temperature-sunlight-humidity conditions.

The marked geographic gradients shown by pigmentation in warm-blooded lower animals have been subsumed in Gloger's rule. This rule states that melanin pigmentation tends to increase in the warm and humid parts of the species range. High humidity together with high temperature promotes the formation of black pigmentation (eumelanins), while aridity with high temperature promotes the formation of the reddish, yellowish- and reddish-brown pigments (phaeomelanins). The phaeomelanins tend to be reduced under cooler conditions even if arid, as do the melanins under extreme cases such as the polar regions. The maximum depth of pigmentation is found in humid and hot climates, the minimum in arctic climates. Heat and aridity, as in subtropical deserts, tends to promote yellowish- and reddish-browns, while lower temperature and aridity, as in steppes, tends to promote greys and grey-browns.

With the exception of color varieties which do not occur in man such as greys and grey-browns, and allowing for the shifts which have occurred as a consequence of migration, these relations between climate and skin color would seem to apply equally to man as to lower animals.

It may be that the broad nose of the Negro and the narrow nose of whites also represent adaptive characters. The work of Buxton and Thomson suggests that air at higher temperatures is breathed more easily through a broad than through a narrow nose.

Populations living in regions of extreme cold, such as those of the Arctic Circle, Siberia, Alaska, and Greenland, tend to be relatively short, and well padded with fat. They present a surface area which is less than that exhibited by populations which have been long resident in regions of high temperature. The latter would appear to be built to radiate as much heat as possible—the former as little as possible. Flat padded faces, flattish noses, and "double" upper eyelids—the epicanthic folds—appear to be adapted to protect the exposed and vulnerable face and eyes from cold.

The action of natural selection varies under different conditions, and the rate at which it operates depends upon the character or quality involved. Thus, for example, where inherited lack of immunity to certain diseases such as sleeping sickness, malaria, and tuberculosis, is involved, natural selection would operate very rapidly, and those lacking immunity to these diseases would in a relatively short time tend to die out, while those possessing some degree of immunity would tend to survive and grow stronger.

The gradual dying off of individuals possessing a white skin in a tropical humid climate, so that only those with a dark skin remained, would probably take a very considerable amount of time. There is, however, no direct evidence that in this particular respect, such a differential action of natural selection ever occurred in the development of man.

It must be observed here that in addition to its creative action in the preservation of progressive adaptations, natural selection also operates in favor of those individuals who are already preadapted. Preadaptive traits predispose individuals to take advantage of the environment into which, by chance, they may be thrown. It may be, for example, that the broad nose of Negroids is such a character, that in a particular environment already existing persons with broad noses were able to adapt themselves to the conditions of that environment so efficiently that any other form of nose would have been at a disadvantage in comparison, that hence the broad nose persisted. Natural selection expressed itself here in the preservation of a pre-existing character which was probably characteristic of all or most Negroids to begin with. It is unnecessary, therefore, always to assume that if a character or quality has survived another character or quality not as well adapted to the conditions of the environment must have died out.

The survival and diffusion of mutations has, to a large extent, been dependent upon natural selection, and since it is quite certain that mutation has played a considerable role in the evolution of man, it goes without saying that natural selection has played an equally important role.

The evidence points to the fact that natural selection has been the principal arbiter of man's evolution. Unfortunately, what is involved in the process of natural selection has not always been too clear to many writers on the subject. Ever since the publication of Darwin's *On the Origin of Species by Means of Natural Selection, Or the Preservation of Favoured Races in the Struggle for Life,* in 1859, most writers have dwelt on the "struggle" aspect of natural selection while altogether omitting to consider its very important cooperative aspects. Since 1859 a great deal of evidence has been accumulated which renders it quite clear that cooperation is an indispensable part of the "struggle" for existence. If, instead of thinking, as the social patterns of the nineteenth century suggested, of "struggle" as the ruthless competition between individuals for survival we think rather of "struggle" as endeavor or drive to survive we shall be nearer the truth. Involved in the process of endeavoring to survive there are cooperative as well as competitive elements. The distribution of adaptive characters throughout a group is achieved by cooperation as well as by competition. Organisms possessed of certain selective advantages need the cooperation of their fellow organisms in order to be preserved. If natural selection secures the differential survival or perpetuation of different genotypes, then quite clearly cooperation is an integral part of the process without the action of which the survivors could not long be preserved. It is the cohesive effect of natural selection as represented by its cooperative aspect which secures the perpetuation of the species. It should be fairly evident that no animal group could possibly survive without the cooperative aspect of natural selection to sustain and integrate it. Competition without the cohesive effects of cooperation is powerless to preserve anything. "Favoured races" are not preserved by conflict but by cooperation. By cooperation is meant the support which animals give one another in the struggle for existence. As Kropotkin put it in his great book *Mutual Aid,* "If we resort to an indirect test, and ask Nature: 'Who are the fittest: those who are continually at war with each other, or those who support one another?' we at once see that those animals which acquire habits of mutual aid are undoubtedly the fittest. They have more chances to survive, and they attain, in their respective classes, the highest development of intelligence and bodily organization."

These are most important ideas for the reader to grasp, since the principle of the struggle for life has, in the past, been greatly overemphasized, while the principle of cooperation has been unwarrantably neglected. Natural selection favors the cooperative as opposed to the disoperative struggle for survival. As Burkholder has recently stated, "The most important basis for selection is the ability of associated components to work together harmoniously in the organism and among organisms. All new genetic factors, whether they arise from within by mutation or are incorporated from without by various means, are accepted or rejected according to their cooperation with associated components in the whole aggregation."

The unfortunate habit of thinking in terms of the struggle for existence, by means of which, it is believed, the fittest are alone selected for survival while the weakest are ruthlessly condemned to extinction, is not only an incorrect view of the realities, but is a habit of thought which has done a considerable amount of harm. Only by omitting any reference to such an important evolutionary force as the principle of cooperation, and by viewing evolution as a process of continuous conflict between all living things can man be led to conclude that survival or development depends upon successful aggression. Omitting important facts and basing their arguments on incomplete and false premises the tough Darwinians, but not Darwin himself, could only arrive at false conclusions. In 1944 a group of distinguished biologists resumed the principle of cooperation in the statement that the probability of survival of individual or living things increases with the degree with which they harmoniously adjust themselves to each other and to their environment. So far as man is concerned it is particularly necessary to remember, as Haldane has said, that "in so far as it makes for the survival of one's descendants and near relations, altruistic behaviour is a kind of Darwinian fitness, and may be expected to spread as the result of natural selection."

Mutation

Mutation defines the condition in which a particular gene undergoes a permanent change of some sort, resulting in the appearance of a new form of an old character. Mutations of genes for some characters have almost certainly occurred independently at different rates, and have affected different characters. Thus, for example, in one isolate, mutant genes may have appeared and ultimately become scattered throughout the population, as for instance, may have been the case in the original production of "black" skin color among Negroes.

If we assume that "white" was the primitive skin color of man, then in one isolate mutant genes resulting in a brownish skin color may have appeared, while in still another isolate mutation in the direction of a yellowish skin may have occurred, and by subsequent mutation "black" skin may have made its appearance. However, it is possible that these skin colors were already in existence among the earliest groups of man. In this connection it is of interest to note that chimpanzees present some, at least, of the varieties of skin color found among the living groups of *Homo sapiens.* In different geographic races of these animals individuals are encountered that are completely black or brown skinned, and others in which face, hands, and feet, may be black and the remainder of the body white or brown. But nothing like the kind of variability in skin color that occurs in man is encountered in any non-human primate. There can, therefore, be little doubt that mutation has played some part in providing the raw materials for the great variety of skin colors seen in man.

Mutation of hair-form genes to yield the present variety of hair form would give a better, and probably more accurate picture of the manner in which such problems may be discussed and investigated.

Thus a genetically relatively heterogeneous population from which groups have migrated and become isolated from one another, may by random variation in gene frequencies, and the change in the expression of genes themselves, produce new gene combinations which differ from group to group and thus serve to define the differences existing between such groups. This random variation or recombination together with the occurrence of mutation may be considered as the primary or basic conditions for the evolution of all animal forms. That these processes have played such a fundamental role in the evolution of mankind appears to be a justifiable inference from the facts.

Quite as important are those factors which act upon the shifting pattern of the genetic apparatus and influence its course. These are the secondary factors, such as environment, natural selection, hybridization, sexual, and social selection, inbreeding, and so on, factors which have been unremitting in their action upon the primary one, though the character of that action has been very variable.

Here it is principally desired to emphasize the fact that in the character of the action of gene mutation, we have positive evidence that variation is a natural process which is constantly proceeding in all human groups. But while in man variation brought about by mutation has probably been very great, it has in many discussions too often been permitted to overshadow the variation which has been produced by the action of the secondary factors. Mutations not anthropologically significant occur frequently in man. It is also probable that over long stretches of time more significant mutations occur in one or another human group. But where we know so little the concept of mutation must be used with extreme caution, for it is one which is readily abused, since almost everything can be "explained" by an appeal to mutation.

It should be clear that while mutation presents the raw materials of evolution it does not tell us how that evolution comes about. We know that mutations occur, the real problem is to discover how they (the mutant genes) become differentially distributed, increasing in one group and not in another. If we find that skin color in man has largely arisen as the result of mutation it still remains necessary to explain why some skin colors became localized as, for example, white in Europe, yellowish in a large part of Asia, and black in Africa. Kinky hair, like most other characters, is due to the interaction of several genes (no one knows how many). In order to become established in a population there must be some agent which brings the mutants together and thus ensures their perpetuation. What this agent is we do not know, though it may be strongly suspected that it is selection of some sort.

Bearing these facts in mind, it may then be safely said that some of the physical differences existing between the living varieties of man probably represent the end effects of small gene mutations fitting harmoniously into gene systems which remain relatively unaltered. It is unlikely that the number of genes involved in these differences exceeds more than a very small proportion of the total number carried by each member of the group.

Persons in whom such mutations occurred—for mutations occur in individuals, not in groups—would have to reproduce if the mutation is to survive. Now, an important point to grasp here is that early populations of man consisted of very small breeding groups, much as among the food-gathering and hunting nonliterate peoples of today. In such small groups a mutation, if it possessed some selective advantage, could establish itself very rapidly, in the course of several generations. Such a mutation might become distributed through the whole or only through a portion of the population. In the former case, we would have an isolate distinguished by a unique character for which every member was homozygous; in the latter case we would have a situation ready for the further operation of selective factors. Through the agency of limiting factors or social selection those possessing the mutant character gradually become separated from those not characterized by it, and a new group buds off, as it were, from the old, to form a more or less distinct geographic race. This we know to occur in all other forms of life which have been studied, and there is no reason to believe that the same processes have not occurred in the case of man, though definite evidence for this is wanting.

In environments where life is not easy, and the struggle for survival determines the maintenance of small bands rather than large ones, such budding-off of isolates is a perfectly natural process.

Isolation

By isolation is here meant the separation of a group from all other groups of the same species, so that breeding takes place largely or entirely within the isolate. Under such conditions small breeding groups may tend to become relatively more uniform; the genes tend to become evenly distributed, and the process thus defined becomes temporarily genetically stable, and a type of man distinguishable, in some one or more characters, from all others may thus become established. That isolation is a cause of differentiation has already been remarked. "This" as Julian Huxley says "is due to the nature of the evolutionary process, which proceeds by the presentation of numerous small mutative steps, and by the subsequent incorporation of some of them in the constitution by selection, or in some cases by Sewall Wright's 'drift.' The improbability of the mutative steps being identical in two isolated groups, even if they be pursuing parallel evolution, is enormously high," hence, the fact that no two isolates are ever alike.

It is in this manner that geographically or otherwise isolated groups have doubtless been the source of novel types of mankind, but it should not be supposed that any group of man has ever been completely isolated throughout the whole course of its history. Here, of course, the element of time enters. There can be little doubt that some groups of man have, in the course of their history, been isolated for considerable periods of time, but sooner or later contact is generally established with some other group, and interbreeding occurs. The introduction of new genes for a time produces a certain amount of heterozygosity, and results in a greater variability of the group. If, after such intermixture, the group continues to breed in isolation, there is again produced an even distribution of genes to result once more in a relatively homozygous group. The group will now be different in genotype (in the type of its genes, i.e., in its heredity), and may or may not be different in the appearance of its members, in its phenotype. Whether the group will show any phenotypical difference among its members will depend upon the numbers involved in the original crossings, and upon the characters possessed by each of the mating groups, as well as upon whether marriage is random or otherwise with respect to certain traits.

Genetic Drift

It has already been pointed out that throughout the greater part of his history the numbers entering into the constitution of the various breeding populations of man appear to have been very small. Peoples at the lower hunter stage of cultural development at the present day rarely if ever attain a breeding population size of 1,000. According to Krzywicki's survey tribes numbering more than 500 individuals were a rarity among the Australian aborigines. Such tribes were at least reproductively partially separated from other tribes.

In such partially isolated populations another factor comes into play. This is the 'accident' of the *breeding structure* of small populations which renders it possible for particular mutant genes or gene combinations to survive. Under such conditions genes for traits which are 'neutral,' that is, which possess neither a positive nor a negative adaptive value, may spread throughout the particular population. The blood groups probably represent such neutral traits. The smaller the population and the more isolated it is the more likely is it that a mutation will become fixed

Social Selection

By social selection is meant the regulation of breeding by artificially instituted barriers between socially distinguished individuals or groups within a population, so that mating occurs between individuals preferred by such social standards, rather than at random. Under such conditions strong isolating mechanisms are developed which, in the course of time, may produce considerable modifications in a population. Where, as in America, there are a variety of colored populations, black, brown, and yellow, social barriers more or less successfully tend to keep these groups separate from one another and from the white population. In this way such barriers act as isolating mechanisms akin to natural physiographic isolating factors, which have a similar effect in maintaining the genetic differences between isolated groups.

We may suggest, then, in broad outline, the means by which the evolution of human groups has occurred. Commencing with a single genetically relatively heterogeneous population from which small groups have separated and become more or less isolated from one another, it is possible to see how by the action of selection on intrinsic changes in the character of genes and their action (mutation) new combinations of genes may be preserved and distributed throughout a group and thus serve to differentiate it from others. The selection may be either natural, social, or sexual, or any combination of these. As in all other animal groups we may suspect that natural selection has played the most significant role in the differentiation of mankind. Our suspicion needs critical observations to support it. These are, at present, lacking. They must be gathered. Studies must be instituted to determine the adaptive value of certain traits. Skin color is one of the most obvious of such traits. What is the adaptive value of the different skin colors under different environmental conditions? Temperature, ultra-violet radiation, humidity, and aridity? To what environmental conditions is each skin color best adapted?

It has been said that the broad-cheeked faces of the Mongoloids living in the high steppe lands of Asia are well padded with fat. Whether this is so, in fact, remains to be determined. It has, however, been suggested that such a face is very well adapted to tolerate the strong cold winds which blow in these regions. This is an example of the kind of problem which abounds in anthropology, and which for the want of the necessary facilities for research goes begging. The application of thermocouples to the cheek regions of representative samples of Mongoloids and non-Mongoloids ought to be sufficient to tell us whether the Mongoloid face is more likely to be resistant to windy insults than the non-Mongoloid.

Brachycephaly, in some populations at any rate, seems to have some adaptive advantage over dolichocephaly. But what this advantage may be future research alone can tell us. With a progressive increase in stature, there has been a progressive tendency to maintain the infantile headform in the adult at a cephalic index of about 81.0.

Skin color, head form, face form, eye color, hair color, hair form, and nose form, are a few of the more obvious traits the adaptive value of which has yet to be determined. Until this has been done it will not be possible to arrive at a clear understanding of the manner in which these traits have been evolved.

In addition to natural selection and mutation another important evolutionary factor is that of genetic drift or the random variation in gene frequencies which tend to occur in partially isolated small populations. This process is essentially complementary to the action of natural selection, and hence may result in the establishment of non-adaptive gene combinations. It has already been remarked that the frequency distributions of the blood groups give every indication of having been produced in this way. It is likely that other traits have been established in the same manner. Studies in the size of prehistoric populations, populations being understood to be breeding units, and in the demography of living nonliterate peoples are therefore very necessary. The demographic number and the genetically effective population are not the same things. The latter, the breeding unit, is always smaller. In dealing with man at any stage of cultural development it is generally observed that demographically a hierarchy of populations obtains. Some being larger than others, occupying larger territories, and some being more effectively isolated, so that exchanges of genes between populations, as well as accidental gene losses, may vary considerably in rate, number, and kind. The isolating barriers may be geographic, sheer distance, or social. These are matters which call for more detailed study than they have yet received. We have good evidence that the breeding populations of man in prehistoric times were small, rarely if ever exceeding one thousand individuals. For example, it has been estimated that the population of England and Wales in the latter part of the Old Stone Age was not more than a few hundred individuals (Fleure). Occasionally we have direct evidence of hybridization between diverse populations such as the paleoanthropic Neanderthaloids and the neanthropic types of Mount Carmel. For the rest basic data are wanting and are urgently in need of collection.

Hybridization can easily be overemphasized as a factor in the evolution of man, but it can also be underemphasized. The problem in which we are primarily interested is to discover how the diversity of races arose in the first place. When we speak of hybridization between races we thereby state that this diversity already exists. It tells us nothing concerning the process of initial diversification. Hybridization, however, can be invoked to explain partially, at least, the origin of some intermediate types which may eventually become distinct races. On the other hand, there is always the possibility that the intermediate types arose by the same mechanisms as the parent types. Clearly, then, the concept of hybridization is one which must be used with great caution, since by its misuse it becomes a simple matter to create all sorts of so-called "secondary races" out of "primary races."

There can be little doubt that hybridization has played an important role in the evolution of man, but the extent of that role is a problem which calls for the kind of investigation which has scarcely yet been undertaken. The fact that in the course of man's history intersterile species have not developed would strongly suggest that hybridization between geographic races of man has been the rule. The divergent variability encountered in mankind as a whole would thus be due to the ensuing simple gene recombinations. This crossing and criss-crossing of human races has been visualized as a reticulum or network, and has been called reticulate evolution. As Huxley points out, man's history of progressively increasing "migration and crossing has led to a progressive increase of general variability.

"Man is the only organism to have exploited this method of evolution and variation to an extreme degree, so that a new dominant type in evolution has come to be represented by a single world-wide species instead of showing an adaptive radiation into many intersterile species. Doubtless this is due to his great tendency to individual, group, and mass migration of an irregular nature, coupled with his mental adaptability which enables him to effect cross-mating quite readily in face of differences in colour, appearance, and behaviour which would act as efficient barriers in the case of more instinctive organisms" (354).

The whole problem of sexual selection as a factor in the evolution of prehistoric populations remains uninvestigated. It has been indicated that there is good reason to believe that its role has probably been overestimated.

In short, much fundamental work needs to be done before we shall understand the mechanism of ethnic differentiation. The little, however, that we know of man's evolutionary history appears to conform to the conclusion established by Sewall Wright that the potentialities for rapid evolution are greatest in a large species which is separated into partially isolated groups. Such partial discontinuities favors diversity by local adaptation and also by genetic drift and the establishment of non-adaptive combinations. The fact that the discontinuities or isolates are only partially so, renders considerable the variance of the total diversity potentially available to the species as a whole.

Increase in the availability of this variance has proceeded at an increasingly more rapid rate within the historic period. Dobzhansky has pointed out that the merging in the human species of small population groups in a more or less freely interbreeding whole may be regarded as one of the most important of recent evolutionary events. This process today is being markedly accelerated by the increasing facility of contact between populations or segments thereof.

As the evidence accumulates the distinctive differences between "genera" and "species" of fossil man become less and less marked, just as they do for non-human primates. We begin to suspect that all known forms of man, fossil and living, existing at any one time level belong to a single polytypic species.

A polytypic species has been defined as a group of actually or potentially interbreeding natural populations which is reproductively isolated from other such groups. The actual or potential interbreeding populations are usually more or less separated by geographic barriers, so that an appreciable amount of geographic variation in characters is encountered. Such populations are the polytypes, subspecies, or geographic races which together comprise the species.

Quite clearly the whole of mankind comprises a single polytypic species consisting of a large number of geographic races. Exact knowledge concerning the number of human geographic races, their distribution, and rate of gene exchanges between them, is virtually completely wanting. The data which will lead to such exact knowledge remain to be collected.

The racial variability which mankind exhibits is of the kind which in a large number of other animal groups is known to be peculiar to small geographically partially isolated populations. Groups or populations which do not occur together, which exclude each other geographically, are termed *allopatric*. Populations which occur together, whose areas of distribution overlap or coincide, are termed *sympatric*. Man is essentially a member of a sympatric polytypic species. Partial reproductive separation of small populations maintained by geographic barriers is a necessary condition in the production of the observed differences. As Dobzhansky says, "Racial differences cannot persist if races come to inhabit the same territory, for in such a case the races, lacking reproductive isolation, would exchange genes, the differences between them would gradually be erased, and finally they would fuse into a single variable population." Now that the world has, indeed, become "the same territory" the amalgamation of all varieties of man into a single variable population is but a matter of time. If, then, we are to understand the manner in which these geographic races came into being before this process is completed we cannot too long delay the initiation of the necessary investigations.

Definition of an Ethnic Group and Division

Thus far our discussion of the mechanism of ethnic group differentiation has been principally in genetic terms. We have seen that the manner in which groups of mankind are formed may best be understood in terms of the processes whereby certain genes acquire different frequencies in different isolates whether or not they are derived from the same ancestral population. A species, we saw, may be regarded as a more or less genetically closed system because it does not regularly exchange genes with other species, while subspecies or geographic races are genetically open systems, since they do exchange genes with other races within the species. Mankind was defined as a single sympatric polytypic species. The basis of that definition was geographic variation. The varying types of which mankind is comprised are seen to be the more or less geographically separated representatives of a single species. Such geographically separated groups were called *geographic races.* But in our own time we observe that the geographic barriers between such races are increasingly breaking down with the result, particularly in Europe, America, and latterly in the Pacific, that there has been much intermixture between all sorts of types. Gene exchanges between numerous formerly separated types are now occurring with great rapidity. It is no longer possible to distinguish a large number of these groups as geographic races. Hence, in order to avoid the confusion which otherwise inevitably results we need some term by which to distinguish recognizable groups of man that are not reproductively isolated from one another. The genetical definition of a race is a population which differs in the frequency of some gene or genes, which is actually exchanging or capable of exchanging genes across whatever boundaries separate it from other populations of the species. Such a definition as an analytic tool is invaluable, but its usefulness for the practical purposes of classification waits upon the analysis of data which have for the most part yet to be accumulated. Races in this sense have yet to be delimited in man.

The pre-genetical physical anthropologist has used purely morphological criteria for his classificatory purposes. For example, all black-skinned people with kinky head hair were distinguished as belonging to the Negroid division, all white-skinned people as belonging to the White or Caucasoid division, and yellow-skinned peoples as belonging to the Mongoloid division. Within these divisions populations were recognized which differed from one another in virtue of a more or less statistically distinguishable assemblage of physical traits. Such populations were and are still called races. Unfortunately for this form of "race" classification people who look alike may be genetically quite unlike in certain significant traits, while people who look unlike may be genetically very like. Furthermore, by arbitrarily selecting certain traits and treating them as criteria of "race" it is possible to create any number of artificial taxonomic "races," and even to sort these out of a single population. As Huxley says, "So-called 'racial types' may be mere recombinational segregants, thrown up from a highly mixed population, without any continuity of descent through the same phenotype or genotype from the original stock which they are held to represent." The so-called "Nordic" racial type is almost certainly such an artificial "race." If we add to these considerations the political and highly emotional distortions which the term has undergone during the last hundred years, it becomes more than ever necessary to distinguish between the *scientific* usage of the term race and its *unscientific* usage. It is perhaps no exaggeration to say that no term in the English language has been so consistently misused as the word "race." In view of all these facts it were better to use some noncommittal term which leaves the matter of rigorous definition and classification open till such time as the necessary data have been secured. For this purpose the phrase *ethnic group* has been suggested.

Since, in the next chapter, we shall be giving an account of the principal ethnic groups of mankind we may here define the terms which are there to be used.

All living mankind comprises the single species *Homo sapiens,* a species which consists of a number of populations which individually maintain certain differences from one another by means of isolating mechanisms such as geographical and social barriers. In addition to the effects of other influences these differences will vary as the power of the isolating mechanisms vary. Where these barriers are of low power neighboring isolates will intergrade or hybridise with one another. Where these barriers are of high power, such isolates will tend to remain distinct or replace each other geographically or ecologically.

Such isolates constitute *ethnic groups,* which anthropologically are defined as arbitrarily recognized groups which in virtue of the possession of a more or less distinctive assemblage of physical traits, through a common heredity, are statistically distinguishable from other groups within the species.

It is observed that most of these ethnic groups tend to form certain clusters, according to their resemblances in certain characters. For example, black skin yields a whole cluster of Negroid groups; white skin yields another cluster of White or Caucasoid ethnic groups, and yellowish skin the cluster of Mongoloids; while chocolate-brown to brownish-white skin associated with abundant wavy head hair yields the Australoid or Archaic White cluster. These clusters of characters suggest that some of the ethnic groups exhibiting them may be, in respect of these characters, more closely related than they are to the members of other clusters. As we shall see for this suggestion there is a fair amount of factual support.

It is customary to call such clusters "stocks." This term is, however, objectionable because it suggests an ancestral group from which other populations arose. It is, therefore, preferable to use a term which suggests its purely arbitrary character, namely, *division.*

A division is comprised of a number of ethnic groups classified together on the basis of their possession of certain common characters which serve to distinguish that division from others. For example, the black skin color, tightly curled hair, and everted lips of the Negroids together constitute a combination of characters which serves to distinguish the arbitrarily recognized cluster of ethnic groups they represent from all other ethnic groups.

It should be clearly understood that a division is a purely working device, a classificatory convenience arbitrarily created as a working hypothesis. In some cases it does not work, in many others it does. When and if it ceases to be useful it should be dropped.

Ethnic group and divisional differences simply represent more or less temporary expressions of variations in the relative frequencies of genes in different parts of the whole species. Such a conception rejects altogether the all-or-none conception of "race" as a static condition of fixed differences. It, of course, denies the unwarranted assumption that there exist any hard and fast genetic boundaries between any groups of mankind and asserts their common genetic unity in diversity. Such a conception of the variety of man cuts across national, linguistic, religious, and cultural boundaries, and thus asserts their essential independence of genetic factors.

FOR FURTHER READING, CONSULT:

ALLEE, W. C.: Where angels fear to tread: A contribution from general sociology to human ethics. *Science, 97*:518-525, 1943.

An important discussion of the principle of co-operation and the part which it has played and could play in the future evolution and development of mankind.

——— *et al.*: *Principles of Animal Ecology.* Philadelphia, Saunders, 1949.

The fundamental treatise on the interrelation between living organisms and their environment.

BEADLE, G. W.: Genes and biological enigmas. In G. A. Baitsell (editor) *Science in Progress,* Sixth Series, Yale University Press, 1949.

A superb account of the nature of the gene.

BOYD, W. C.: Critique of methods of classifying mankind, *Am. J. Phys. Anthropol., 27*:333-364, 1940.

A valuable and very clear exposition of the case for the blood groups in the classification of mankind.

———: Blood groups. *Tabulae Biologicae, 17*:111-240, 1939.

The standard work on the anthropology of the blood groups, listing the gene frequencies and percentage distribution of the blood groups for all peoples on whom such tests had been made up to the year 1939.

———: *Genetics and the Races of Man.* Boston, Little, Brown & Co., 1950.

A very readable book on the application of genetical methods of analysis to the problems of human raciation.

CANDELA, P. B.: The introduction of blood-group B into Europe. *Human Biol., 14*:413-443, 1942.

An admirable study illustrative of the manner in which the gene frequency method of analysis, together with a study of the historical data, may throw light on ethnic origins and relationships.

COLIN, E. C.: *Elements of Genetics.* Philadelphia, Blakiston, 2nd ed., 1946.

An excellent exposition of the laws of heredity with particular reference to man.

DAHLBERG, G.: An analysis of the conception of race and a new method of distinguishing races. *Human Biol., 14*:372-385, 1942.

A criticism of the existing anthropological conception of race, with an interesting proposal for the proper handling of the problem.

———: *Race, Reason and Rubbish.* New York, Columbia University Press, 1942.
An excellent introduction to the principles of heredity with especial reference to the problems of human variation, and an equally excellent discussion of the problem of race, by a leading authority.

DAVIS, A.: The distribution of the blood-groups and its bearing on the concept of race. *Political Arithmetic* (edited by L. Hogben), New York, Macmillan, 1938, p. 503-531.
A very clear and important discussion.

DOBZHANSKY, T.: *Genetics and the Origin of Species.* New York, Columbia Univ. Press, 3rd edition, 1951.
One of the most important analyses of the species problem in the light of genetics to be published in our time.

———: The genetic basis of evolution. *Scientific American, 122:*32-41, 1950.
An admirably clear discussion.

DUNN, L. C. and DOBZHANSKY, T. H.: *Heredity, Race, and Society.* New York, Pelican Books, 1946.
An excellent elementary introduction to genetic anthropology.

EVANS, R. D.: Quantitative inferences concerning the genetic effects of radiation on human beings. *Science, 109:* 299-304, 1949.
An important paper on, among other things, the probable number of genes in man.

FISHER, R. A.: *The Genetical Theory of Natural Selection.* The Clarendon Press, Oxford, 1937.
A fundamental work on the theory of natural selection, with a discussion of biological problems relating to man, and the rise and fall of civilizations.

——— FORD, E. B. and HUXLEY, J. S.: Taste-testing the anthropoid apes. *Nature, 144:*750, 1939.
On the genetics of the taste reactions of the anthropoid apes to PTC (phenyl-thio-carbamide).

GRÜNEBERG, H.: *Animal Genetics and Medicine.* London, Hamish Hamilton, 1947.
A survey of inherited diseases in laboratory rodents, valuable for its discussion of the physiological channels through which genes produce their physiological effects.

HALDANE, J. B. S.: *Heredity and Politics.* New York, Norton, 1938.
A brilliant series of papers on human biology.

———: The blood-group frequencies of European peoples, and racial origins. *Human Biol., 12:*457-480, 1940.
An important study, somewhat technical, but admirably demonstrative of the manner in which blood-group frequencies are studied in relation to the problem of varietal and ethnic group origins.

———: *New Paths in Genetics.* New York, Harper, 1942.
On the genetics and biochemistry of development.

HOGBEN, L.: The concept of race. *Genetic Principles in Medicine and Social Science.* New York, Knopf, 1932, p. 122-144.
The best critical analysis of the anthropological conception of race yet written.

Huxley, J. S. and Haddon, A. C.: *We Europeans: A Survey of Racial Problems.* New York, Harper, 1936.
An admirably clear survey written in collaboration by a distinguished biologist and a distinguished anthropologst.

Huxley, J. S.: *Evolution: The Modern Synthesis* New York Harper, 1942.
A magnificent synthesis of modern knowledge expository of the processes of evolution. With Dobzhansky's and Mayr's books, indispensable reading.

Kropotkin, P.: *Mutual Aid.* London, Penguin Books, 1939 (First published between 1890 and 1896 in the *Fortnightly Review,* and as a book in 1902).
The classic work on cooperation. Indispensable reading. To be regarded as a continuation rather than as the corrective of Darwin's *Origin of Species.*

Krzywicki, L.: *Primitive Society and Its Vital Statistics.* London, Macmillan, 1934.
A valuable pioneering study of the primitive community, its size, and vital statistics.

Longhem, Jr., J. J. van.: Nomenclature of the rhesus typing sera. *Bull. World Health Organization, 2:* 215-225, 1949.
An invaluable study.

Mayr, E.: *Systematics and the Origin of Species.* New York, Columbia Univ. Press. 1942
A most valuable discussion of taxonomical principles in the light of modern genetics, in relation to the old and the new systematics.

Montagu, M. F. Ashley: *Man's Most Dangerous Myth: The Fallacy of Race,* 2nd edition, New York, Columbia Univ. Press, 1945.
An examination and criticism of existing conceptions of race both anthropological and popular in the light of history, biology, genetics, sociology, and psychology.

———: The origin and nature of social life and the biological basis of cooperation. *J. Soc. Psychol., 29:*267-283, 1949.
A theory of the origin and nature of social life and an exposition of the principle of cooperation.

———: *On Being Human.* New York, Schuman, 1950.
A study in the meaning of cooperation.

———: *Statement on Race.* New York, Schuman, 1951.
An extended exposition and discussion of the UNESCO Statement on Race.

Muller, H. J., Little, C. C. and Snyder, L. H.: *Genetics, Medicine, and Man.* Ithaca, New York, Cornell Univ. Press, 1947.
An admirable work on the principles of heredity and their application to man in health and disease.

Nasmyth, G.: *Social Progress and the Darwinian Theory.* New York, Putnam, 1916.
An extremely important book in the tradition of Kropotkin, on cooperation versus disoperation.

Patten, W.: *The Grand Strategy of Evolution.* Boston, Badger, 1920.
One of the truly great books of our century. An eminent biologist's analysis of the nature of life and of evolution in the light of the principle of cooperation.

ROBERTS, J. A. FRASER: *An Introduction to Medical Genetics.* New York, Oxford University Press, 1940.

The best and most lucid work of its kind.

SCHEINFELD, A.: *The New You and Heredity.* Philadelphia, Lippincott, 1950. By far and away the best popularly written account of heredity, covering a vast territory including race. Beautifully, clearly illustrated by the author.

SCHIFF, F. and BOYD, W. C.: *Blood Grouping Technic.* New York, Interscience, 1942.

A manual for clinicians, serologists, anthropologists, and students of legal and military medicine. An indispensable work of great practical value. Specially constructed tables and nomographs greatly simplify the task of computing gene frequencies.

SIMPSON, G. G.: *Tempo and Mode in Evolution.* New York, Columbia Univ. Press, 1944.

A brilliant discussion of the rates of evolutionary processes, and of the manner in which populations become genetically and morphologically differentiated.

———: *The Meaning of Evolution.* New Haven, Yale University Press, 1949.

The best of all books on the history of life and its significance for man.

SPUHLER, J. N.: On the number of genes in man. *Science, 108:*279, 1948.

STERN, C.: *Principles of Human Genetics.* San Francisco, W. H. Freeman & Co., 1949.

An able, conservatively written, text covering the whole field of human genetics.

WIENER, A. S.: The Rh factor and racial origins. *Science, 96:*407-408, 1942. An excellent paper illustrating the manner in which conclusions may be arrived at as to ethnic origins, from a study of the present distribution of *Rh* and *rh* genes.

———: *Blood Groups and Transfusion.* Springfield, Ill., Thomas, 1943.

A standard work on the subject, very readable, and containing an exhaustive account of the anthropology of the blood groups.

———: Recent developments in the knowledge of the Rh-Hr blood types; tests for Rh sensitization. *Am. J. Clin. Path., 16:* 1946, (Reprinted with additions in *This Month in American Medicine,* January 1947, p. 1-12. Probably the best short account of Rh published to date.

———: Rh Glossary. *Laboratory Digest,* May 1949, p. 1-6.

Extremely useful.

Chapter VI

THE DIVISIONS AND ETHNIC GROUPS OF MAN

IN THE preceding chapter we saw that the divisions and ethnic groups of man must be regarded as more or less temporary isolates, which may be arbitrarily delimited and distinguished as such. We saw, too, something of the manner in which such isolates have been produced. In the present chapter a brief account will be given of the divisions and more prominent ethnic groups of man which have been recognized by physical anthropologists.

It should, however, be clearly understood that the classification here offered is both a tentative and a temporary one, and is merely calculated to give the reader little more than the names by which he may refer to certain arbitrarily distinguished groups of mankind. It must always be remembered that such names are only labels for convenient abstractions which help us to appreciate broad facts, and that a division or ethnic group is, in most cases, an abstraction which exists in our own minds alone.

The truth is that we know far too little about mankind to be able to make any efficient classification of it. The older school of physical anthropologists utilized a purely arbitrary selection of external or phenotypical characters in order to make their classifications. They could hardly have done otherwise, but their classifications have never been satisfactory for the simple reason that it is impossible to define most populations in terms of external characters alone. I have no desire to perpetuate this type of classification here or to perpetrate another along similar lines. It is, however, the duty of an expositor to present the conventional anthropological view of the divisions and principal ethnic groups of mankind, before it finally bows gracefully out of existence to make way for the genetical analysis of mankind.

The classifier of the "races" of man has hoped to be able to reduce the great variety presented by mankind to some sort of comprehensible system. This he has attempted to do by arbitrarily recognizing certain physical distinctions between groups of mankind, distinctions based on external characters such as the shape of the head, stature, hair form, hair color, hair distribution, eye form, eye color, skin color, and the like. The classifier has always tried to select characters which remained *constant,* and which he thought to be largely uninfluenced by the environment. By this means the classifier of mankind has generally been led to a definition of "race" which typically takes the following form: "A race is a group of individuals or a population with the same or similar external characters, which have been determined by their common heredity or descent."

Apart from the fact that such a definition would logically lead to the recognition of a red-headed race, a color-blind race, and a deaf-mute race, it makes possible the arbitrary creation of any number of "races" on the basis of any physical characters the classifier chooses to select. Furthermore, it obscures basic facts, and does not actually achieve what the classifier sets out to do, for such a definition does not delimit his "races" from either species or even genera. Finally, the notion of common heredity or descent seems inevitably to lead to the utterly erroneous idea of "pure races," the like of which there never were. The realities of the situation are that human groups represent not static but fluid aggregates characterized by very variable characters in process of undergoing more or less constant change. For this reason it has been difficult for the practical demand of the classifier to be met that the "races" of man be well limited and well defined units. The approach to the problem of raciation in man has, in the past, been unsound, for unfortunately the description of external characters can tell us very little concerning either the genetic history or present relationships of the groups described. Hence, the real interest of the physical anthropologist must be in those dynamic processes whereby human groups come to exhibit the kind of variability or changes they now display. Classification regarded as a preliminary step in the service of this interest is to be welcomed.

The reason why systematic exercises in the classification of external characters can never succeed in elucidating the relationships of different groups of mankind to one another is, as we have already more than once pointed out, that it is not assemblages of characters which undergo change in the formation of the individual and of the group, but single units which determine those characters, the genes. The fact is that there is no such thing as a "race" in the older conventional sense or in the popular sense. We have already seen that geographic races of mankind do exist, and that genetically the process of raciation may best be understood in terms of the frequencies with which genes in interaction with the total environment, express themselves in varying distributions of phenotypical characters, the degree of significant association of which is best assessed by statistical methods.

In the genetic sense a race may be defined as a breeding population differing in the incidence of certain genes from other populations within the species. Such a population is actually or potentially capable of exchanging genes across whatever boundaries separate it from other populations.

Since the same types of physical characters may have very different origins, the only way in which their origin can be traced is by tracing the distribution of the genes determining them, that is to say, by the very opposite method by which the classification below has been arrived at. This classification represents an attempt to reduce the classificatory schemes of the older school of anthropologists to a single simple scheme, combining both the vices and the virtues of most of them. It is based on certain external physical characters which are specified below, and which are very roughly capable of distinguishing the groups described. The reader should bear in mind that this, together with most other classifications, based on external characters alone, is a highly debatable one, and will very probably eventually turn out to be more or less nonsensical. Finally, the reader should remember that description is not analysis.

Bearing these cautions in mind we may now proceed with the attempt to give some of these abstractions some semblance of form.

THE DIVISIONS OF MANKIND

Three main divisions of mankind may be distinguished: The *Negroid,* the *Caucasoid,* and the *Mongoloid.* As a subdivision of the Caucasoid larger than an ethnic group may be distinguished the *Australoid* or *Archaic Caucasoid* sub-complex. This classification is based upon the common possession by each of these groups of a few physical characters which, in general, serve to distinguish them from one another. These characters are: Skin color, form and character of the hair and its distribution, form of the head and proportions of the body.

The Negroid Division

Among the Negroids the skin is typically dark brown, but is often black, and even yellowish-brown in some groups. The head hair varies from tightly curled to pepper-corn in form (sparsely distributed tufts), and as a rule there is a marked paucity of hair over the rest of the body (glabrousness). The head is long, the nose is broad and flat with wide nostrils, the ears small, there is some prognathism (forward projection of the upper jaw), and the lips are thick and everted.

The development of a deeply pigmented skin was probably early diffused throughout the group, for it is highly probable that the black skin has proven of distinct survival value to peoples living in hot humid climates. In association with this type of skin there occurs a large number of sweat glands which, by their excretion, serve to reduce the temperature of the body, and which in addition serve to maintain a salty film of moisture over the skin which assists to keep it cool.

There are a fairly large number of Negroid groups which are anthropologically known, but a still larger number which are anthropologically unknown. In general Negroids may be classified as African and Oceanic. Under African Negroids may crudely be distinguished the following ethnic groups:

The True Negroes
The Forest Negroes
The Nilotic Negroes or Nilotes
The Half-Hamites
The Bantu-Speaking Negroes
The Bushman-Hottentot
The Negrillos

Geographic Distribution of African Negroids

A line drawn from the mouth of the Senegal River on the West Coast of Africa through Timbuktu to Khartoum in the Anglo-Egyptian Sudan, and from thence down to the western borders of

Abyssinia around to the south-east, and finally from the Juba River to the Indian Ocean, divides Africa into a northern light-skinned third inhabited by Hamitic and Semitic speaking Caucasoids, and a southern two-thirds essentially Negroid.

Admixture among the peoples and cultures of these two great regions has been more or less continuous for many generations.

The influence of the Hamitic-speaking peoples has been considerable, much more so than the more recent influences of the Semitic-speaking peoples. A few words are therefore necessary concerning the Basic Mediterranean Hamitic-speaking peoples, usually called Hamites, though "Hamitic" is a linguistic and not a physical category. The so-called Hamites are divided into two major branches, the Eastern and the Northern.

The Eastern Hamites are composed of the ancient and modern Egyptians, the Beja, Nubians, Somali, Danakil, and most Abyssinians.

The Northern Hamites include the Berbers of Tripoli, Tunis and Algeria (the Libyans), the Berbers of Morocco, the Tuareg and Tibu of the Sahara, the Fula of Nigeria, and the extinct Guanche of the Canary Islands.

Among the Hamites skin color varies all the way from white to black; head hair varies from straight to frizzly; the face is never prognathous; the lips vary from thick to thin, but are almost never everted as in the Negro; there is, in general, a paucity of body hair. The head is mesocephalic (cephalic index 76.0), and stature is medium, about 1.65 m. (five feet five inches).

The True Negroes

The home of the so-called True Negroes is West Africa, from the mouth of the Senegal River to the eastern boundary of Nigeria, with the French Sudan, some part of the Cameroons and the Congo representing the central and southern extensions of the type. (The remainder of Negro Africa consists of Negroes hamiticized to a greater or lesser degree, namely, the Bantu, the Nilotic Negroes, and the Half-Hamites.)

The physical characters of the true Negroes may be summarized as follows: Skin black, hair woolly, nose broad and flat, average height 1.73 m. (five feet eight inches), thick often everted lips, moderately long head (cephalic index 73-75), considerable prognathism, body-build burly, relatively long-legged, long-armed.

The New World Negroes for the most part represent the somewhat mixed descendants of true Negroes of West African origin, and some northwestern Bantu. In general the New World Negro differs from the Old World Negro in the following observable features: Greater height, larger ears, lighter pigmentation, and a narrower nose. These differences, and others, are due to admixture with whites.

The Forest Negro

Over a wide area of tropical Africa, extending from the Senegal River in the west to the Sudan, Uganda, and Northern Rhodesia in the east, and in the south to Lower Angola, there occurs a rather barrel-chested, short-legged, long-armed, stocky type of Negro characterized by a markedly protrusive lower face, retreating chin, prominent cheek-bones, and a somewhat sloping forehead. The head is generally long (dolichocephalic), the root of the nose low, and the bridge flat. The lips are markedly everted. Stature varies considerably, averaging between 1.65 m. (five feet five inches) to 1.75 m. (five feet nine inches). It is supposed that the forest Negro is closely related to the pygmies who live within part of the range of the former in the equatorial forests of Africa, especially in the Congo region.

The Nilotic Negroes or Nilotes

The long-legged, slim, tall, very dark inhabitants of the Anglo-Egyptian Sudan and the Upper Nile Valley are long-headed (cephalic index 71-74), and the face is not as protrusive nor the forehead as sloping as in the forest or true Negroes. Average height is 1.78 m. (five feet ten inches) or slightly more. The nose is generally broad, but in some groups narrow, as among the Somalis and the Shilluk, and though the hair remains woolly, the evidence of Hamitic admixture is clear. The probabilities are that the Nilotes represent the result of admixture between true Negroes or Negroes of the forest type and some early Hamitic or Ethiopian stock. The Hamitic type is best seen in the Shilluk of the west bank of the Nile of the eastern Sudan, and also among

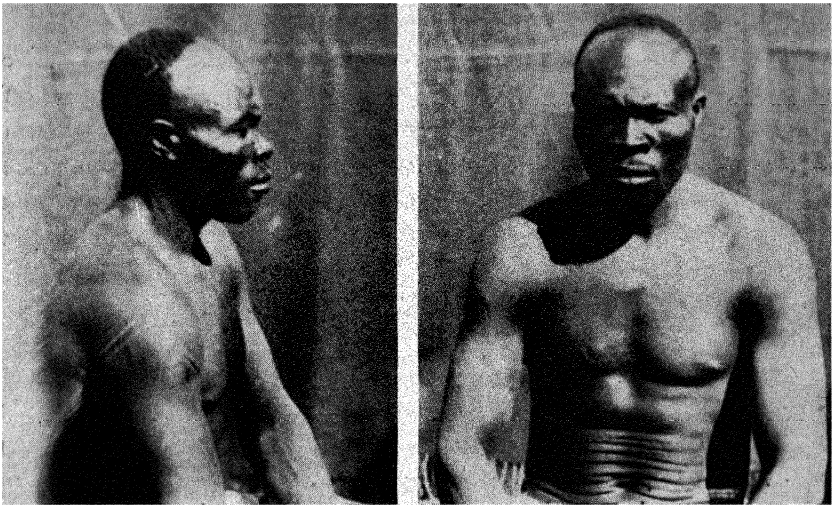


Fig. 119. A Nilotic Negro of the Tagala People of the Anglo-Egyptian Sudan. (Courtesy, Musée de l'Homme, Paris.)

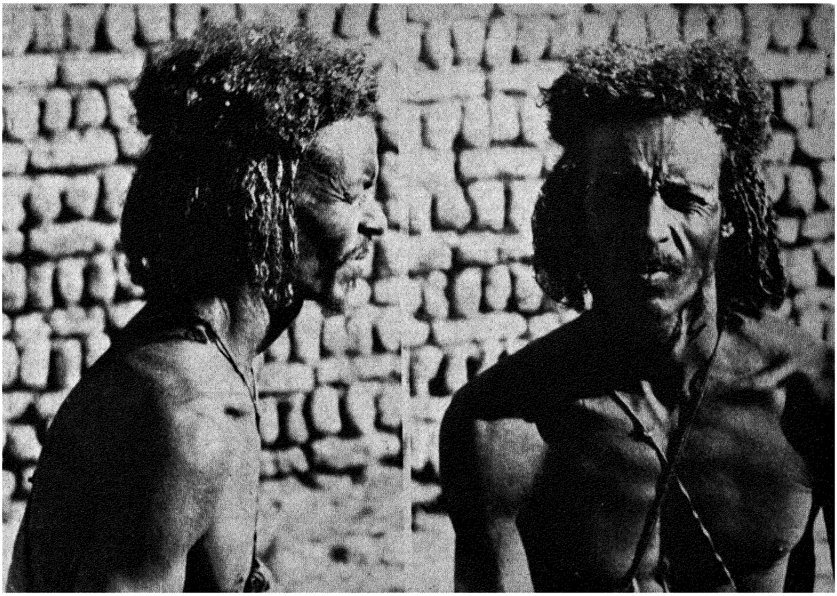


Fig. 120. Hamiticized Nilote of Assouan, Anglo-Egyptian Sudan. (Courtesy, Musée de l'Homme, Paris.)

the Dinka, the Kavirondo, Jaluo, and others. In view of their appreciable Hamitic admixture the Nilotes are properly spoken of as Negroids.

The Half-Hamites

The Half-Hamites are limited to East Africa and East Central Africa. They occupy the greater part of Kenya Colony, that part of the Uganda which runs northwards to the Sudan boundary, as well as much of the northern portion of Tanganyika Territory. The Half-Hamites are the result of mixture of Hamite with Negro. Typical Half-Hamite tribes are the Masai, Nandi, and Suk. Other tribes are the Turkana, Karamojong, Didinga, Topotha, and Ieso.

Skin color varies from light chocolate to very dark brown. Sometimes the skin is described as having a reddish tinge. The hair is woolly, the nose varies from broad and flat to moderately narrow, the lips are usually full but not everted, the cheek-bones high, prognathism slight, average stature is about 1.70 m. (five feet seven inches), while the Ba-Hima of the Uganda are extremely tall. The head among the Masai, Nandi, and Turkana is long (cephalic index 73-74), but the cephalic index among the Suk is about 77 (mesocephalic).

The Bantu-Speaking Negroes

"The Bantu-Speaking Negroes" is a phrase which embraces a great conglomeration of peoples inhabiting the enormous expanse of territory which includes central and southern Africa. A line drawn from the mouth of the Rio del Rey a little south of 4° N. lat., on the west coast to the mouth of the Juba River a little below the equator 43° long., demarcates the upper limits of the distribution of the Bantus or Bantu-Speaking Negroes. The phrase describing these peoples is a very crude, purely temporary one, and is merely used for convenience in order to refer to a fairly large number of African peoples of differing physical type who have thus far been insufficiently studied by physical anthropologists, and of whom it is at the present time not possible to give a satisfactory account, nor even to say of how many ethnic groups they may be constituted. As a whole they are customarily described as follows: Hair of usual Negro type, skin color varies from yellowish-brown to black, though dark chocolate is the prevalent hue, average height is 1.67

m. (five feet six inches), the head is typically dolichocephalic, though mesocephalic groups occur, some with lower stature. In the "typical Bantu" the skin is usually less dark, stature shorter, head less elongated, forehead flatter, prognathism less marked, nose generally more prominent and narrower than in the true Negro.

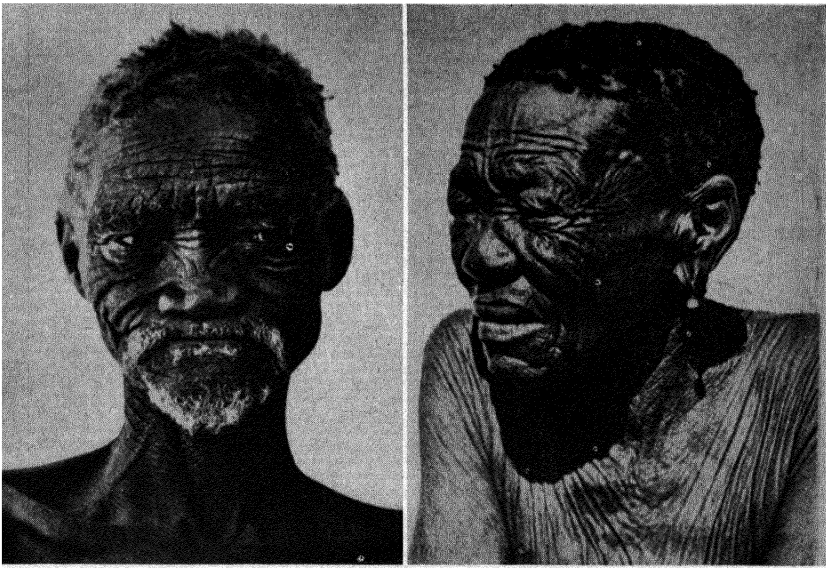


FIG. 121. Old Hottentot Man and Woman, South-West Africa. (From L. Schultz, *Aus Namaland und Kalahari,* 1907. Courtesy, Gustav Fischer, Jena.)

The Bantu-speaking peoples of central and southern Africa present a great variety of types. They are essentially Negro peoples mixed with Hamitic, Negrillo and in the south, with Bushman-Hottentot elements.

Bushman-Hottentot

In earlier times extending over the greater part of South Africa, but now mainly confined to the Kalahari desert live the Bushmen. The Bushman is so distinctive in appearance as to be distinguishable at a glance from all other Africans, save the Hottentot. The average height of the Bushman is 1.52 m. (five feet), but there are a large proportion of definitely pygmoid individuals, and also many tall ones. They are slightly built, with well-shaped limbs and small hands and feet; head hair is tightly coiled into spiral knots termed "pepper-corn," the body is almost completely devoid of hair, though a sparse growth on the face is generally present; the head is mesocephalic, the face broad and flat and somewhat pentagonal. There is generally no or only a very slight protrusion of the lower face, and the lips while showing a full exposure of mucous membrane are not usually thick or everted. The nose is short and very broad, seen in profile it appears concave, the root of the nose is depressed. The cheekbones are broad, the forehead vertical but narrow, and the chin pointed. The eyes are set rather wide apart and the opening between the eyelids is narrow, often appearing slightly oblique owing to the remarkable fulness of the upper lid,

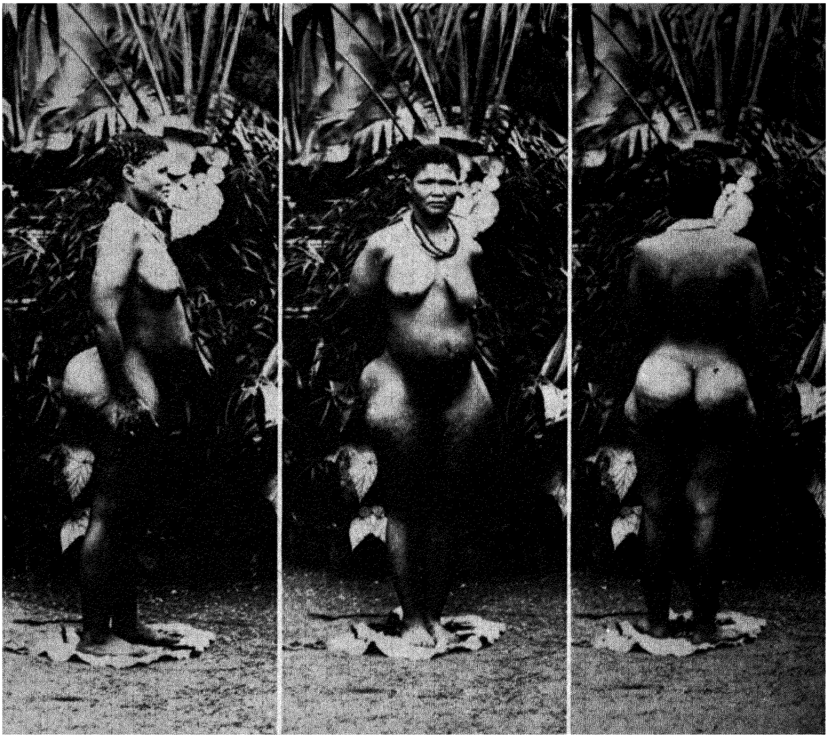


FIG. 122. Hottentot Woman showing steatopygia. (Courtesy, Musée de l'Homme, Paris.)

Bushman-Hottentot is more correctly described as an epicanthic fold. The bluish-gray so-called Mongoloid sacral spot occurs in 90 per cent of Negro infants, and is found in some whites and American Indians. In short, there is really no reason whatever to assume a Mongoloid component in the ancestry of this perfectly clear-cut geographic race. The flat root of the nose, the resulting epicanthic fold, the regional deposition of fat, and the general characters of the skull, are all pedomorphic traits (see pp. 211-213).

Attempts to distinguish the Bushman from the Hottentot on physical grounds have failed. They are physically the same people, differing only somewhat in culture. Because of their more or less physical and cultural identity they are becoming better known by the term *Khoisan,* the first half of the term (actually *Khoi-Khoin*) being derived from the Hottentot's own name for themselves, the second half (*San*) from their name for the Bushman.

The Pygmies

At one time some anthropologists regarded the pygmies as the most primitive surviving branch of mankind; others, with even less justification, inclined to assign that rank to the Australian aborigines, but whatever the truth may be the fact is that we know of no early types of man which in any way resemble the pygmies, and there certainly seems to be insufficient reason to regard them as primitive simply because they inhabit either marginal, island, or central areas. The evidence suggests that they are best regarded as relatively early variants of the Negroid division, from which they differ in a number of important features.

Average stature is 1.42 m. (four feet eight inches), hair is black and woolly, skin color varies from yellowish-brown to black, the nose varies from broad and flat to straight and moderately broad with the tip upwardly directed, the upper lip tends to be deep and convex, the lips in general are moderately thick, eyes rather large and prominent, face short, the body is often covered with a light downy hair, the head normally varies between meso- and brachycephaly, but dolichocephalic types occur both in Africa and New Guinea; markedly prognathous and slightly prognathous types are known to occur.

The pygmies have an interesting distribution, being found in the interior of the Malay Peninsula and East Sumatra, in the Andaman Islands in the east of the Bay of Bengal, in the Philippine Islands, in Netherlands New Guinea, and in the Congo region of Equatorial Africa. On the basis of this geographic distribution together with certain associated physical differences the pygmies have been distinguished as falling into three groups, namely, the African, the Asiatic, and Oceanic groups. The African pygmies are known as *Negrillos,* the Asiatic and Oceanic pygmies being known as *Negritos.* Several distinct ethnic groups may be recognized.

The African Pygmy or Negrillo

The shortest of all the pygmies with an average height of 1.36 m. (four feet six inches), the African pygmy is a native of the equatorial forests of the Congo, typically he has a short trunk, short legs, and long arms, woolly dark rusty-brown head hair, yellowish downy hair on the body, ordinarily black hair in arm-pits and on pubes; the skin though frequently very dark includes reddish-yellow and yellowish-brown shades. The head is mesocephalic (cephalic index 79.0). The nose is very flat and broad, the wings of the nostrils being both broad and high; the eyes tend to be protuberant, the upper jaw prognathic. Cranial capacity is 1,300 c.c.

The Asiatic Pygmies or Negritos

Andamanese

Inhabitants of the Andaman Islands in the east of the Bay of Bengal, the Andamanese or Mincopies are a well-proportioned people of an average height of 1.48 m. (four feet ten inches); the woolly hair is black in color, with a reddish tinge, body hair is very scanty, skin color varies from bronze to sooty-black, the head is brachycephalic (cephalic index 82.5), the face is broad at the cheek-bones, the lips are full but not everted, the jaws do not project, the nose is straight, and not flat. Cranial capacity is 1,269 c.c.

Semang

Inhabitants of the central region of the Malay Peninsula and of East Sumatra, the Semang are of an average height of 1.52 m. (five

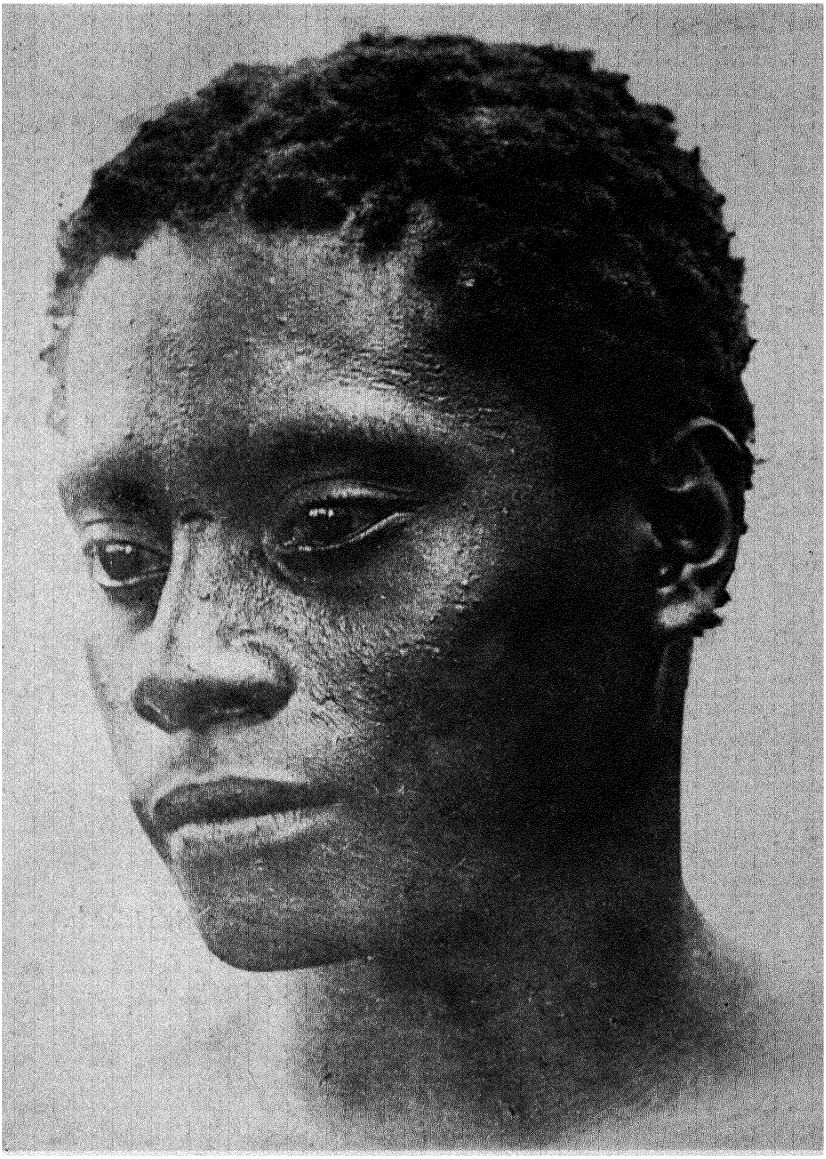


FIG. 124. A young Andaman male. (Courtesy, Musée de l'Homme.)

feet), well-proportioned, mesocephalic (cephalic index 79.0), the black head hair is woolly or frizzly with a reddish tinge, body hair is scanty, skin color dark chocolate brown, the face round, the lips not thick, the nose flat and broad, the upper jaw slightly projecting. This is the type which has been described as "infantile"; the adult type is long-faced, relatively thin-lipped with a narrower-looking nose, short torso, and longer extremities. Cranial capacity is 1,338 c.c.

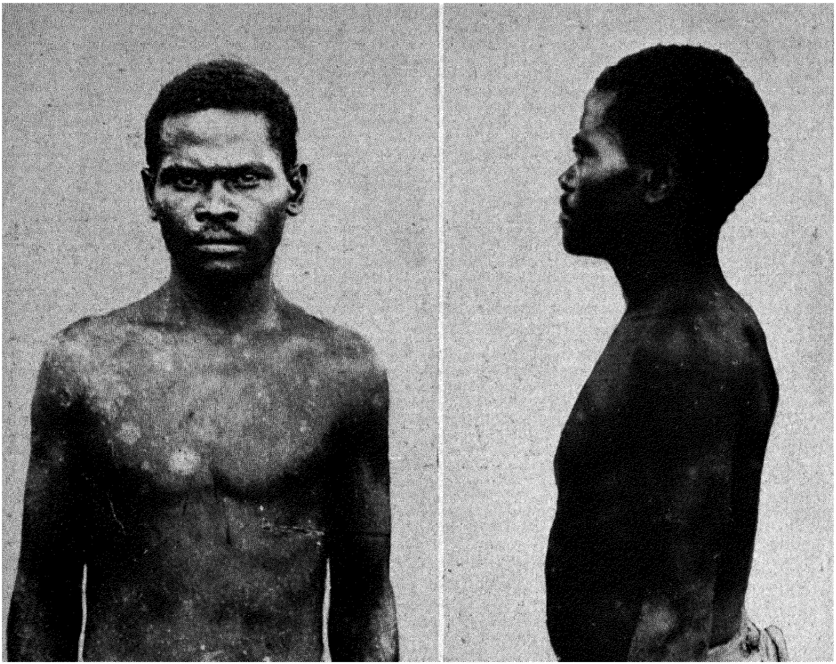


FIG. 125. Young Negrito male, from Zambales, Philippine Islands. (Courtesy, Musée de l'Homme, Paris.)

Aeta

Inhabitants of the Philippine Islands, the Aeta have an average height of 1.42 m. (four feet eight inches), the frizzly head hair is dark brown to black in color, and is frequently abundant on face and body; skin color is sooty brown; the head is brachycephalic (cephalic index 82.0), the nose short, flat, and broad, the lips moderately thick. Cranial capacity is 1,415 c.c.

It is of interest to note that the Aeta are inhabitants of the northernmost part of the larger Philippine Islands, namely, Luzón.

The Oceanic Pygmies or Negritos

New Guinea Pygmies

Inhabitants of the central range, through almost the whole length of New Guinea, the average height of the New Guinea pygmies is 1.45 m. (four feet nine inches), the head hair is black and woolly, and is abundant on face and body, skin color is yellowish-brown, the nose is short, broad, and flat, the upper lip is deep and convex, the head varies from dolichocephalic to mesocephalic.

The superficial resemblances of the pygmies have inclined many students to consider them as closely related. Their peculiar distribution would tend to support this view. The significant differences which now characterizes each of the known pygmy groups may be due to isolation and some admixture with the peoples in the regions in which they have lived, and in which they now live.

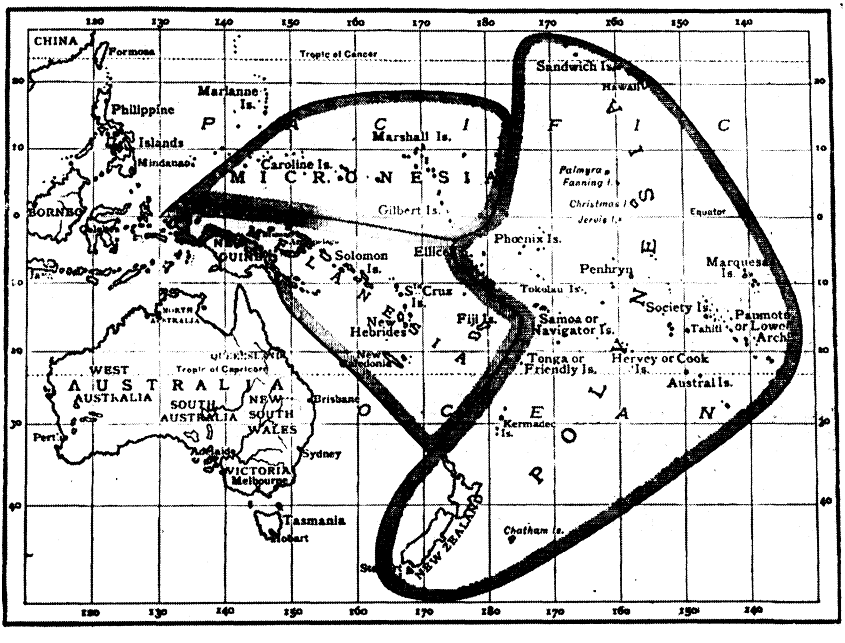


FIG. 126. Map showing the Ethnological Divisions of Oceania.

There is a certain amount of evidence which indicates that the representatives of a widespread pygmoid stock formed the earliest populations of Malaysia and the Pacific Islands. The peculiar distribution of the pygmies, in marginal areas, at the extremities of continents, as the Bushman-Hottentot in South Africa, and the Andamanese on the islands of the southern extremity of India; in central areas, as the Semang of Malaysia, the New Guinea, and Congo Pygmies; the Philippine Pygmies in the extreme north of Luzón, is very suggestive. It looks as if these are the "refuge areas" left to peoples that at one time had a much wider distribution.

Oceanic Negroids

The Oceanic Negroids are inhabitants of the territory of New Guinea and the great group of islands extending to the east all the way to the Fiji Islands. The natives of the New Guinea region are known as Papuans, and are said to be more strikingly Negroid than those who inhabit the numerous islands extending to the east, the Melanesians. The distinction, however, is perhaps rather more geographic than physical. Strictly speaking the terms Papuan and Melanesian refer to two linguistic families rather than to physical types. Though very similar in their general characters to their presumed African relatives, the Oceanic Negroes differ from the former in several particulars. They are, on the whole, less pedomorphic than the African Negroes. Hair tends to be more abundant and less tightly coiled, the lips less thick and everted, the jaws less protrusive, and the chin less receding. The forehead is rounded and not so sloping, and the nose is often strongly hooked.

Papuans

The Papuans are said to be the more Negroid of the Oceanic Negroids. There is, however, no evidence at all that they differ in any significant manner from the Melanesians, and it is best to recognize them as a geographic rather than as a physical group. They cannot be treated as linguistic groups since Melanesian is spoken on the south-east and parts of the north-east coast of New Guinea. If the term "Papuan" be retained it must be on the strict understanding that it refers to Melanesians who are natives of New Guinea. Many distinct local types are recognizable, such as the pale-skinned Hula, the stalwart brown Huon Gulf people, the pygmy Buangs, the black New Georgians, the tall dark Kiwai, the stocky yellow-brown Hagen people, the slightly taller Chimbu, and the slender Bena-Bena.

Hair is black, somewhat frizzly, and abundant on the face; the nose is broad, often prominent and convex, with tip frequently turned down, skin color is dark chocolate or sooty brown, average height is about 1.68 m. (five feet six inches). Long-headed and broad-headed types occur, the forehead sloping with fairly marked brow ridges, the lips are of medium thickness.

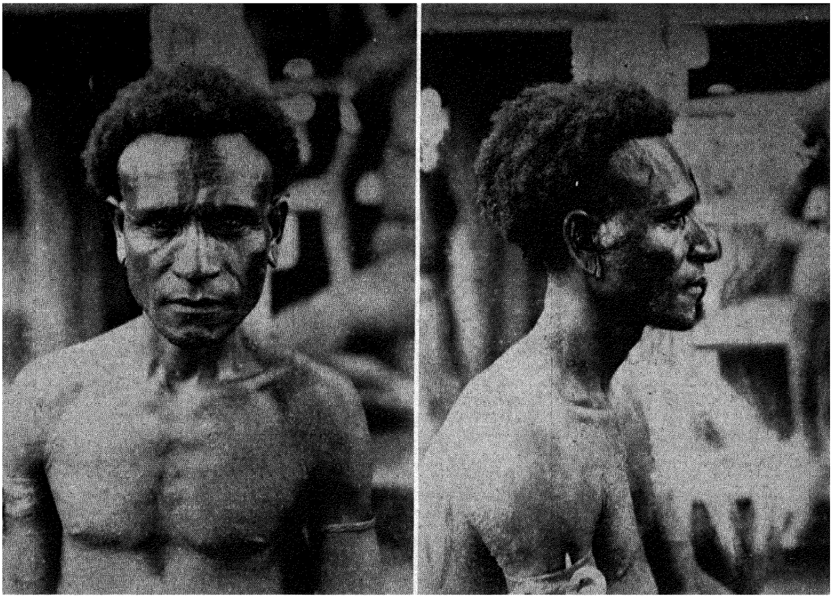


FIG. 127. Frontal and right lateral views of Papuan male, aged 35 years, from New Guinea. (Courtesy, Musée de l'Homme, Paris.)

Melanesians

Hair usually frizzly, but sometimes curly and even wavy, usually slight on face and body; skin color is dark chocolate, sometimes very dark, sometimes copper-colored; stature is short to medium; longheadedness prevails generally, forehead rounded, and brow ridges usually not prominent; nose somewhat broad, sometimes straight with less fleshy tip.

The Distribution of the Negroids

The markedly discontinuous distribution of the Negroids presents an interesting problem. Africa and southeastern Asia and Oceania are quite a long way from one another. The Negroids of today are, generally, poor seafarers; were their ancestors so, too? It is difficult to say. Melanesians often make voyages by sea in small outrigger craft of 50 miles or more. There is no reason to suppose that their ancestors could not do likewise. It is quite possible that the Oceanic Negroids are the result of Negrito and Archaic White admixture.

Evidences of a very ancient Negroid substratum in the existing peoples of India, Burma, Assam, Persia, and Arabia are not wanting. The persistence of Negroid types among these populations suggests the possibility that a Negroid population once inhabited continental Asia, and that migrant groups from this population eventually populated the areas to the east and west, while in the continental homeland the Negroid population was absorbed by other groups in intermixture.

The Australoid or Archaic Caucasoid Sub-Division

Into this sub-division fall four of the most interesting groups of mankind, the Australian aborigines, the Veddahs of Ceylon, the Pre-Dravidian peoples of India, and the Ainu of Japan. These four groups bear a close resemblance to one another, and to the so-called "white" or Caucasoid peoples. The evidence of their physical characters, of their geographic distribution, and of prehistory, suggests a considerable antiquity for these four groups, while from their physical characters alone it seems clear that their nearest affinities are with the Caucasoids, and that they are best regarded as a Caucasoid sub-division.

The Australian Aborigines

The Australian aborigines are frequently regarded as physically the most primitive of the surviving ethnic groups of man. This belief is based largely upon the fact that the skull is considered to present certain "primitive" features, such as the relatively large size of the palate and teeth, the fairly pronounced brow-ridges,

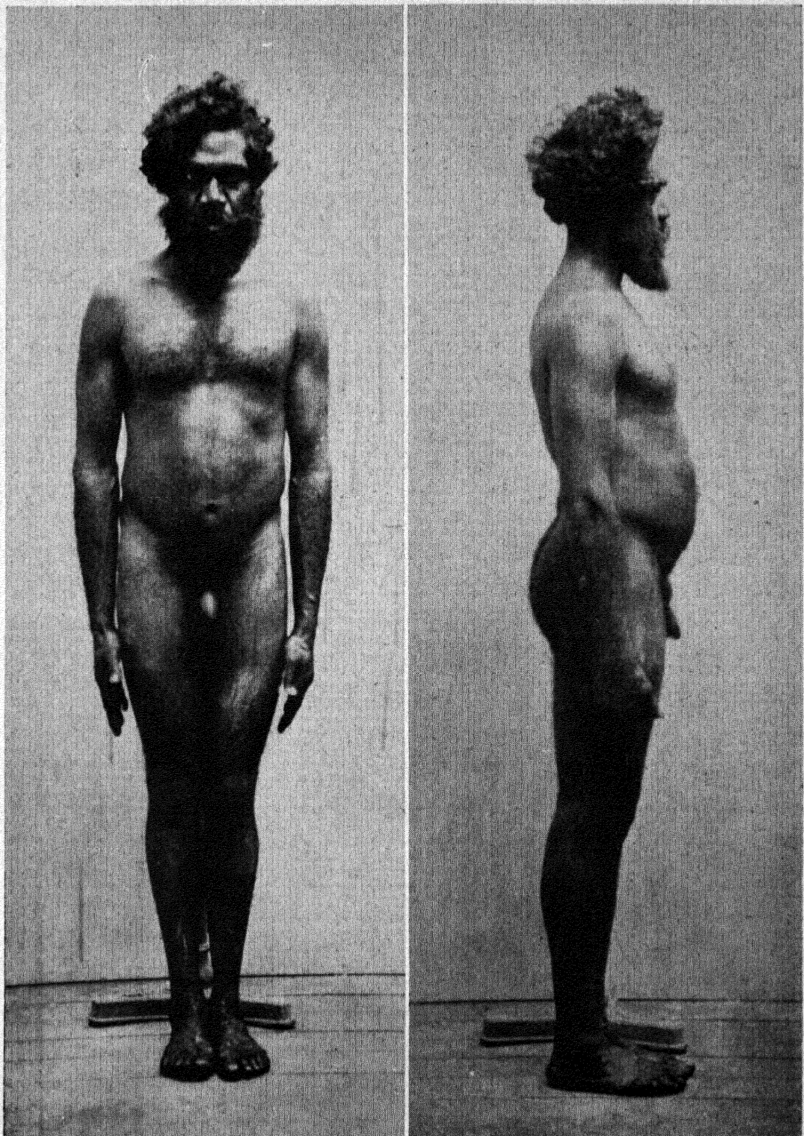


FIG. 128. Frontal and lateral views of an Australian aboriginal male, aged 30 years, height 5 feet 6 inches. (Courtesy, Musée de l'Homme, Paris.)

small cranial capacity, sloping forehead, and receding chin. The Australoid skulls found at Wadjak in Java, and the Wadjak-like skull found at Keilor in south-eastern Australia, suggest that Asiatic origins of the Australian aborigines. Unfortunately, there is neither archeological nor any other kind of evidence which tells us how long the aborigines have been in Australia. The highly mineralized Talgai skull found in Queensland in 1884 is of doubtful age. The Keilor skull thought to be of Middle Pleistocene age is now believed by some to be of more recent age. The same is true of the Cohunna skull, found in 1925 some 10 miles south of the Murray river in Victoria. Save for the great cranial capacity of Keilor (1,590 c.c.) none of these skulls differ in any way from that of the modern Australian aboriginal. The question of the antiquity of the aboriginal in Australia is quite open, and no one at the present time knows the answer to it.

In his external features the Australian aboriginal presents the following characters: Head hair is wavy and sometimes quite straight, varying from light brown to black in color. In children the hair is sometimes very light brown, and occasionally quite fair, but it invariably darkens before adult age is reached. Facial and body hair is abundant. The head is dolichocephalic (cephalic index 73.0), the vault is gable-shaped, and the cranial capacity about 1,280 c.c. The forehead is sloping and the brow-ridges extremely well developed. The nose is broad, depressed at the root, fleshy at the tip, but otherwise not flat but quite prominent; the ears are large and long; the face is rather short, the lips full but not Negroid; there is a moderate degree of prognathism, the chin is weak. Skin color varies from a reddish to a chocolate brown. Stature is very variable, averaging about 1.65 (five feet five inches).

Several morphological types have been distinguished, the (Caucasoid) Murrian type of southeastern Australia, the (Melanesian-Papuan) Carpentarian type of the Gulf of Carpentaria, the Desert type of Central Australia, said to be a blend of the Murrian and Carpentarian types, and the Negrito-like Tasmanoid type of the rain forest refuge areas in the Cairns and Atherton districts.

The Australian aborigines may be explained as an archaic Caucasoid group modified in the Negroid direction by admixture with some Negroid group on the one hand, and some Oceanic admix-

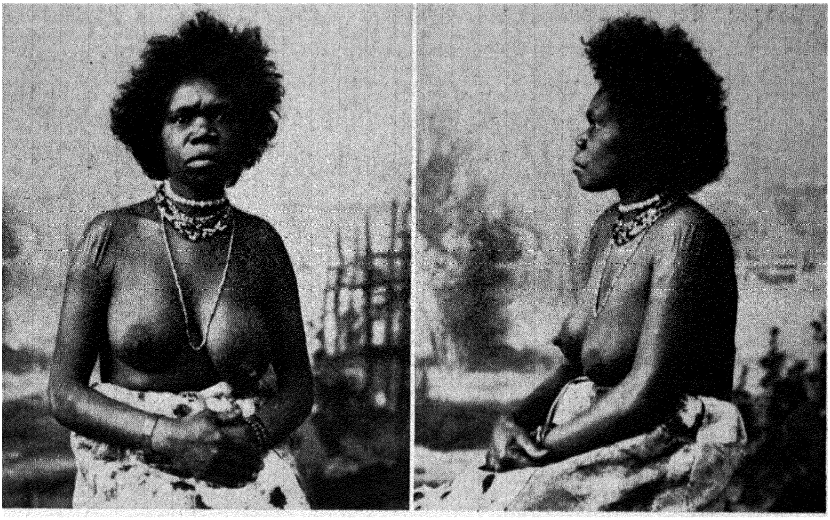


FIG. 129. Frontal and left lateral views of young Australian aboriginal female. (Courtesy, Musée de l'Homme, Paris.)

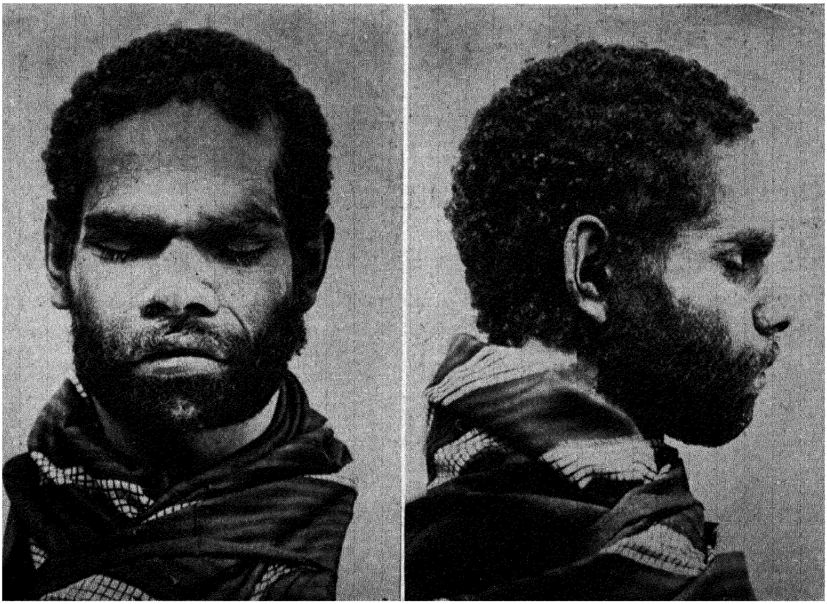


FIG. 130. Frontal and right lateral views of Tasmanian male. (Courtesy, Musée de l'Homme, Paris.)

ture on the other. Thus, possibly trihybrid in origin, the Australians remain dominantly Caucasoid, a view abundantly supported by the fact that when Australian aboriginal and white are crossed the hybrid loses most of the typically "primitive" characters of the aboriginal. That the earliest Australoids were of Asiatic origin is rendered probable by the existence of groups bearing a striking resemblance to the Australian aborigines both in their physical and blood group characters in central and southern India (Pre-Dravidians), in Ceylon (the Veddahs), and in Japan (the Ainu).

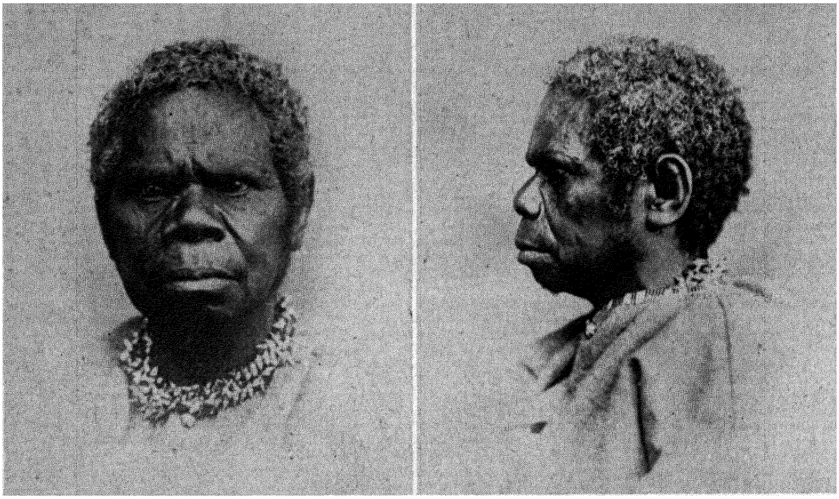


FIG. 131. Truganini, female Tasmanian aboriginal. She was the last Tasmanian to survive, dying May 8, 1876. Frontal and lateral views. (Courtesy, Tasmanian Museum, Hobart, Tasmania.)

The extinct Tasmanians, the last of whom (see Fig. 131) died in 1876, were physically chiefly distinguishable from the Australian aborigines by virtue of their rather woolly Negroid hair. The Bass Straits, between Australia and Tasmania represents a distance of 120 miles.

The Veddahs

The Veddahs of Ceylon are a people of small body size, the average stature being just 1.52 m. (five feet). Head hair is black with a reddish tinge in some cases, fine and wavy or slightly spirally coiled, except for a sparsely distributed growth of hair in the chin region, and an even more sparse attempt at growth on the upper lip, the rest of the body is totally devoid of the adult type of hair, except at the pubes and the arm-pits. If any hair is present it is of the infantile type, known as lanugo. Eyebrows are feebly developed, and eyelashes are sparsely represented. Skin color is chocolate brown, and is very "matt" in appearance; the head is the smallest to be found in any living hominid group, the average cranial capacity being 1,250 c.c. in the male, is very dolichocephalic (cephalic index 70.5), the forehead is slightly sloping, and the brow ridges are only moderately developed, though they may be quite prominent in some individuals, there is no protrusion of the lower face except occasionally; the lips are of medium thickness, and the chin generally somewhat receding; the nose is depressed at the root, but below this rises to form a squat triangular eminence, with expanded wings with rounded nostrils, opening forwards as much as downwards, the tip is often depressed, the face is short and broad. The characters of the skull bear very striking resemblances to that of the Australian aboriginal, and interestingly enough, to that of the Bushman, but as in so many other characters the closest affinities of the Veddahs are with the Pre-Dravidian peoples of central and southern India; craniologically there seems to be no difference between them whatever. In this connection it should be recalled that the island of Ceylon is merely a detached portion of the southern mainland of India.

The Pre-Dravidians

The Pre-Dravidians of central and southern India constitute the oldest and most primitive populations of that land, and comprise many local types which differ in some degree from one another. While now mainly limited to the Deccan (southern India) and to Central India, there is reason to believe that the Pre-Dravidians formerly extended their range over the greater part of India. At the present time the Pre-Dravidians make their homes, for the most part, in the jungles. Typical tribes are the Kadir (who are somewhat Negroid in appearance), the Kurumba, Paniyan, and Irula of the Deccan, the Bhil, Gond, and Kandh, of northern central India, and the Oraon and Kolarian of Chota Nagpur. Like the

Veddah the Pre-Dravidians are rather short, the average stature being 1.57 m. (five feet two inches), the hair is very dark brown to black in color, varying from wavy to very curly; hair on the rest of the body is very scanty, though facial hair may provide a moderate beard; skin color is black, the head is dolichocephalic

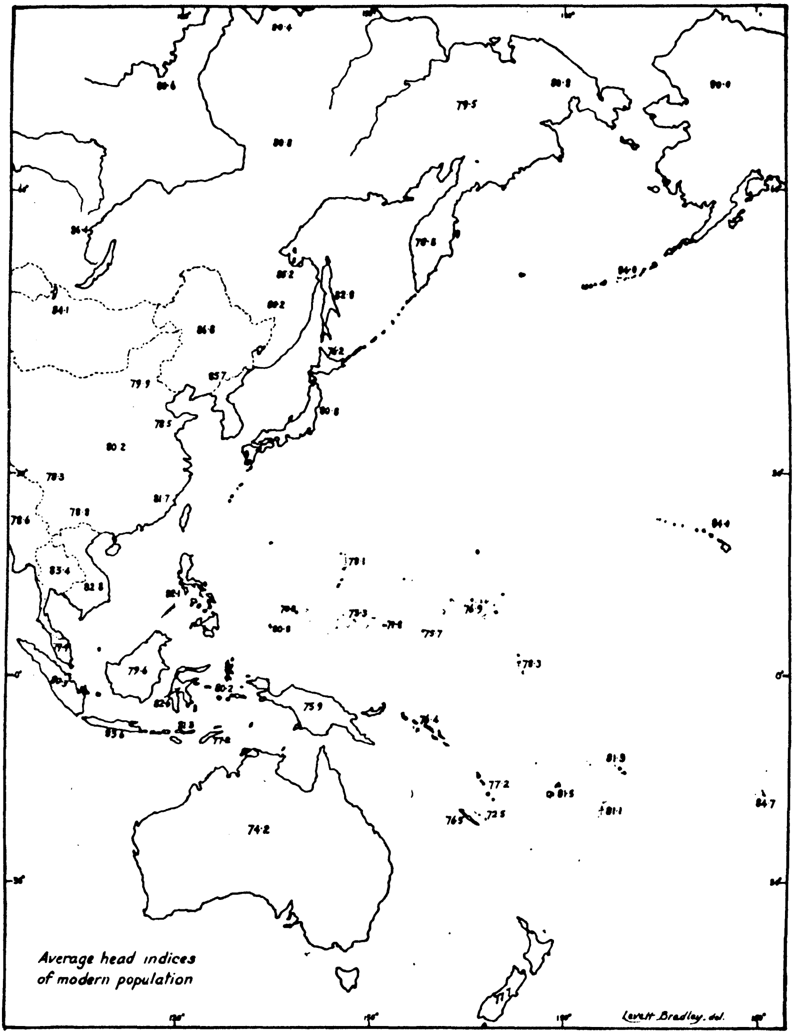


FIG. 132. Map showing the average head indices of the recent populations of Eastern Asia, Australia, and Oceania. (From Weidenreich. Courtesy, University of Chicago Press.)

(cephalic index 73.0), the nose very broad, depressed at the root, and flat, the forehead is somewhat sloping, the brow-ridges but slightly or moderately prominent, some protrusion of the lower face is present, and the lips are often quite thick, while the chin is generally somewhat receding.

The physical characters of the Pre-Dravidians strongly suggest admixture of a Negrito with a Proto-Australoid type at some early period in their development.

A very closely related Pre-Dravidian type is to be found in the southern portion of the Malay Peninsula, this is the Sakai or Senoi, a people who live mainly in southern Perak and northern Selangor. Head hair is long, wavy or curly, while some individuals have hair which very closely approaches frizzly, the hair is black with a reddish tinge, skin color varies from yellowish-brown to dark brown, the head is mesocephalic (cephalic index 78.0), the nose broad and flat, prognathism is slight, the chin somewhat receding, the lips moderately thick but not everted; the average height falls just short of 1.48 m. (five feet). The Sakai, on the whole, support the suggestion of a Negrito-Proto-Australoid ancestry.

The Ainu

Known generally as the "Hairy Ainu" because the men are characterized by the heaviest growth of facial and body hair to be found in any form of man, the Ainus have a brownish-white skin, wavy dark-brown or black hair, a short moderately broad nose, thin lips, well-developed jaws and chin, a short broad face, and a mesocephalic head (cephalic index 76.6). Average height is 1.58 m. (five feet two inches), and body build is thick-set. The Ainu represent the indigenous population of Japan, but are now confined to parts of the northern island of Yezo (Hokkaido), and Sakhalin Island further north.

A resemblance of the Ainu to the Australian aboriginal has often been remarked. A large proportion of Ainus show some evidences of Mongoloid admixture, but the Caucasoid types with a good hair-cut and a shave would pass unnoticed on a European street. The characters of the Australian would appear to be those of an Ainu-like type that had been mixed with a Negroid. The resemblance of Ainu and Australian may be quite fortuitous or it may not. It is possible that the Ainus represent a fairly ancient stock, and that some early Ainu-like population after a history of intermixture with Negroid groups became the inhabitants of Australia.

In view of the fact that the Ainu type is found represented in more or less appreciable numbers throughout almost every European population—two famous men who show a superficial, though quite fortuitous, resemblance to the type are Charles Darwin and Tolstoy—it seems probable that the Ainu were once a very widespread people or else that they made very strong contributions to some of the peoples who later wandered into Europe; the former seems the more likely hypothesis, and it may be that the future will reveal that the long-neglected Ainu played a far greater part in the prehistoric settlement of Europe than is at present suspected.

The Caucasoid Division

This division of mankind is often called "white." The term is not an altogether accurate one for the reason that it includes many peoples of dark skin color. The reason for giving this division the name "Caucasoid" originates in the choice made by Blumenbach, the Father of Physical Anthropology, who in the late eighteenth century described and named the type from a female skull, whose beauty had much impressed him, which came from Georgia in the Caucasus and which seemed typical of the cranial characters of the group. Blumenbach was of the opinion that the type originated in the Caucasus, but as a matter of fact no one knows where the type did originate. Our knowledge upon this point is too weak even to warrant speculation. These facts clearly understood, the term may be retained for the division called Caucasoid.

Head hair is usually wavy, but ranges from silky straight to various degrees of curliness. It is almost never woolly, rarely frizzly, and is never as coarse or as sparsely distributed as in Mongoloids. The hair on the face and over the rest of the body in males is usually well developed. Skin color varies from white to dark brown. All forms of head shape occur, but the general tendency is towards broad-headedness. The nose is comparatively narrow and projecting, being relatively high at both root and bridge, the cheek-bones are generally not prominent, and the lips tend to be thin. The face is orthognathic or straight, the palate and teeth smaller than in most other peoples, the forehead comparatively high, and the chin well developed.

There are a great number of Caucasoid ethnic groups, here again we can mention only the most representative of them.

Mediterranean

The various groups embraced under the term Mediterranean comprise a number of local types which may be regarded as sub-groups within the Mediterranean ethnic group. The reason for giving these various groups the common name "Mediterranean" is that the type it describes, and which these groups comprise, is actually constituted by the populations which fringe the Mediterranean sea, and radiate outwards in all directions from that region as far as Northern India. Thus, Portuguese, Spaniards, Frenchmen, Italians, Greeks, Turks, North Africans of many kinds, many Arabians, Iranians, Afghans, and Indians are all peoples having physically much in common with one another.

Skin color varies all the way from tawny white to light or medium dark-brown, the predominant complexion is best described as dark brunet white or olive skinned; hair is dark brown or black, and varies from a very light wavy form to a loose curl; hair on the face and remainder of the body is moderately well developed. The head is generally long, the face generally oval and orthognathic, there being little or no protrusion of the jaws, the lips are moderately full, the chin is either weakly or moderately developed. The forehead vertical, and the nose high-bridged and generally narrow. The average height is 1.62 m. (five feet four inches).

While the Mediterranean ethnic group is remarkably homogeneous, it is convenient to recognize three sub-groups as follows:

Basic Mediterranean

This type is best seen in Portuguese, Spaniards, Italians, and in some English and Welsh; in North Africa among the ancient and modern Egyptians; in Arabia, and among the Berbers of Morocco. To this type belonged the basic Jewish population of Palestine. According to Coon the purest present day nucleus of this type is to be found in Arabia.

Average height is about 1.65 m. (five feet five inches), head dolicho- and meso-cephalic, straight narrow nose, slender and somewhat delicate build, and light brown complexion.

Atlanto-Mediterranean

This type forms the principal element in the population of North Africa, and is strongly represented in Iraq, Palestine, parts of Arabia, and the eastern Balkans. It also forms the principal element, in varying degrees of mixture with Negroids, throughout the whole of East Africa, and is represented in small numbers in Portugal, Spain, and the British isles. Tall, long-headed, straight to convex-nosed, white-skinned, and rather more robustly built than the Basic Mediterranean.

Irano-Afghan Mediterranean

The principal element in the population of Iran, Afghanistan, and the Turkoman country, occurring also in parts of India, Arabia, and North Africa.

Tall, long-faced, high-headed, hook-nosed; complexion is brunet with some blondism.

The "Nordic"

The so-called "Nordic" is a Mediterranean with very light skin, fair hair, and blue or gray eyes. The conventional description of the type is as follows:

The hair may be either blond, yellow, very light brown, or reddish, and is slightly wavy to curly in form; facial and body hair is sparse. Skin is florid or pinkish-white, eyes blue or gray; the head is long but of medium breadth in relation to its length (mesocephalic 76-79), the face is long and its bones strongly developed; the nose is fairly prominent, straight and narrow. The chin is well developed and prominent. The average height is 1.72 m. (five feet eight inches). The average cranial capacity is about 1,350 c.c. to 1,400 c.c.

The "Nordic" is often said to be the characteristic type of Scandinavia, but the same type occurs in varying frequencies in Iceland, the Frisian Islands, the British Isles, Belgium, the Netherlands, and in the north central European plain, embracing Russia on the East, and Poland and Northern Germany on the west. There has been much speculation as to where this alleged racial type originated, the most favored argument being that which suggests that the elements which entered into its formation came together in the early Neolithic somewhere in north central Europe. It has been further suggested that the depigmentation of the "Nordic" represents a mutation from the Mediterranean stock, but since these characters, the white skin and lightly pigmented eyes, are well known to occur quite frequently in true Mediterraneans, the appeal to mutation is quite unnecessary. It is possible that the action of natural selection, isolation, and such factors as random variability in favor of blondism, the action of sexual and social selection have been involved in the development of the "Nordic" type, but it seems quite as, if not more, likely that the type represents a mere recombinational segregant thrown up from a highly mixed population. This is a matter upon which certainty is not at present possible, but it does seem likely that the type originated within the populations of various parts of Europe not once but several times, and that there never was at any time in the history of man a distinct "Nordic" race. In short, it is likely that the "Nordic" type is nothing but a color segregant of Mediterranean stock, its strongest affinities being with the Atlanto-Mediterranean subgroup of that stock. Certainly, the practice of arbitrarily extracting such individuals from the populations in which they occur and lumping them together in an artificially created group called "Nordic" would scarcely seem to be a defensible procedure.

The recent cult of the "Nordic" in Germany, where the type occurs less frequently than in any of the other lands of its distribution, can only be regarded as an unfortunate perversion of thought, for there are no anthropological grounds whatever upon which the notion of a "superior" Nordic race could be sustained. The discussion of such matters must, however, be deferred for consideration to the next chapter.

Alpine

One of the most round-headed members of the Caucasoid division of man is the Alpine, the breadth of the head generally being over 85 per cent of its length. It is possible that brachycephalization

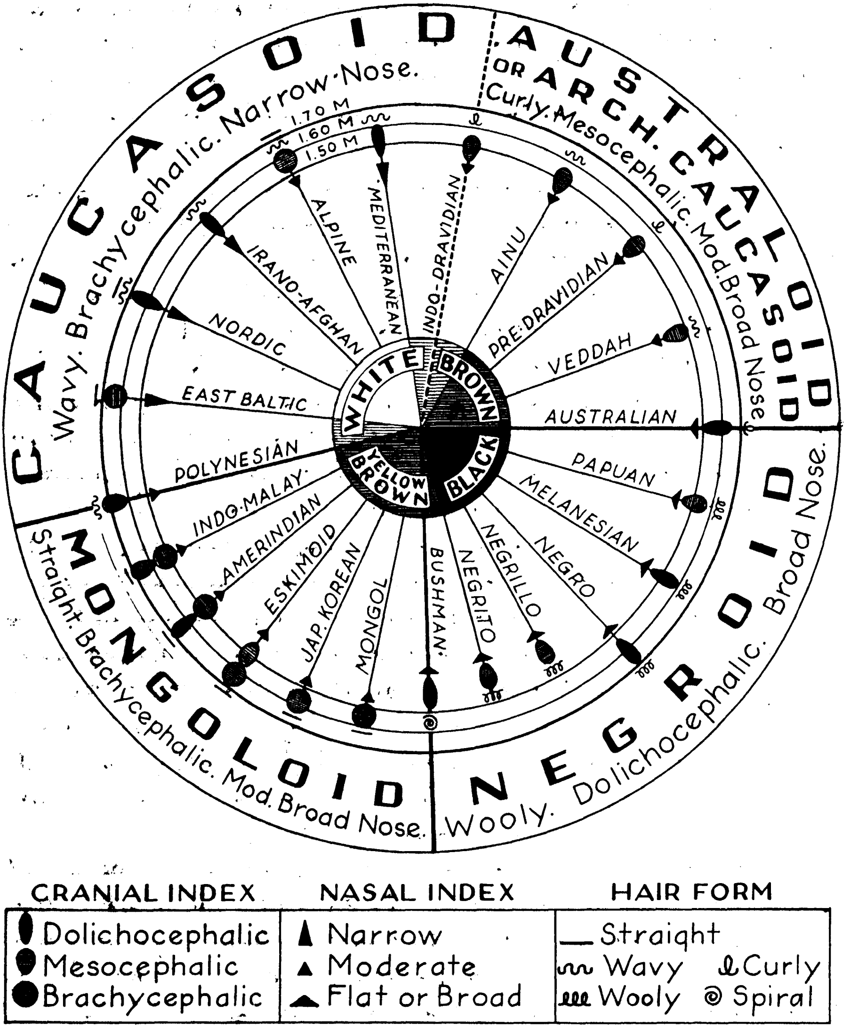


FIG. 133. Diagram showing the divisions and ethnic types of man usually recognized, together with certain of their physical characters. This diagram is simply intended to provide a useful approximation to facts which are at present not capable of accurate description.

was introduced into European populations by the Alpines, though it will be recalled that it was already encountered among the mesolithic Neanderthaloids of Krapina.

The Alpine stock receives its name from the fact that the type tends to be concentrated along a line extending from France eastwards along the Alps, down through the Balkans, east into the mountains of Asia Minor, and from thence north-west into Russia and Siberia. The type, however, occurs sporadically throughout Europe.

Situated as they are between Nordics to the north and Mediterraneans to the south there has been, as would be expected, a great deal of admixture with these ethnic types, so that the Alpine has taken on many of the characters of his neighbors, the only two more or less consistently associated characters remaining to him being brachycephaly and a sallow complexion.

The typical Alpine is broad- and high-headed, with somewhat high curved occiput, vertical forehead, moderately to strongly developed brow-ridges, more or less roundish face, with prominent nose which has a tendency to broadness, and "blobbiness" at the tip; the face is orthognathic, there being no protrusion of the jaws, and the chin is well-developed. Skin color is sallow, and not quite as dark as in Mediterraneans, hair color is chestnut-brown to black, frequently blond, and generally straight though sometimes wavy in form, hair is very abundantly distributed over the body, being especially heavy on the face. Average height is about 1.65 m. (five feet five inches), and the build tends to be sturdy rather than stocky. The popular conception of the Frenchman's appearance provides a good example of the type.

The origin of the Alpines is unknown, and in the present state of our knowledge speculation is not of much help. Some think that they originated in Asia, while Coon believes that they may represent a west European upper paleolithic survival, somewhat reduced in head and face size. What's the truth 'tis hard to say!

Dinarics and Armenoids

The Dinarics and the Armenoids as customarily classified by the physical anthropologist afford good illustrations of the kind of error into which the investigator may fall when he relies upon external characters for the criteria of his classifications. The principal character by which these two types have been distinguished from related types is the extreme flattening of the occiput (planoccipitaly) which is associated with extreme round-headedness (hyperbrachycephaly) and high-headedness (hypsicephaly). It has recently been shown that these traits are largely, probably entirely, due to the cradling habits of these peoples. It appears that planoccipitaly is due to the length of time that the infant's head has remained relatively immobile. Ewing, Ehrich, and Coon have independently shown that, in most cases at least, the occipital flattening is due to local cradling practices (tying the infant down, flat on its back, for a year or so). Ewing found that in Lebanon-born Maronites the average cephalic index was 88.3, while in American born Maronites the index was 79.4. The conclusion that the Lebanese custom of cradling was responsible for the hyperbrachycephaly of the Lebanon-born Maronites was inescapable.

Ehrich tested a series of 851 subjects almost entirely from Montenegro, and found that except for the independent variable of artificially deformed heads, the so-called Dinaric type proved to be in no way different from the rugged Atlanto-Mediterranean type. Coon subsequently arrived at the same conclusions with regard to Albanians with deformed and undeformed heads.

These findings render invalid the three major diagnostic characters upon which the recognition of distinct Dinaric and Armenoid types was based. They also illustrate the dangers involved in relying upon certain external characters which by tradition are believed to have some stability. It is today known that bones are among the most plastic of living tissues, the bones of the head being no exception (as witness the ease with which orthodontists are able to move teeth within the jaws).

Ewing, Ehrich and Coon conclude that while one cannot exclude the possibility of planoccipitaly occurring genetically, it is no longer possible to apply the names Dinaric and Armenoid, as hitherto defined, to races in the genetic sense. The terms, if they may be used at all, can only be applied to types having a certain appearance (phenotypes *not* genotypes). In this sense the Dinaric and Armenoid *types* may be described as follows:

Dinaric

The so-called Dinaric type, sometimes called the Adriatic or Illyrian occurs in a range from east Switzerland through the Aus-

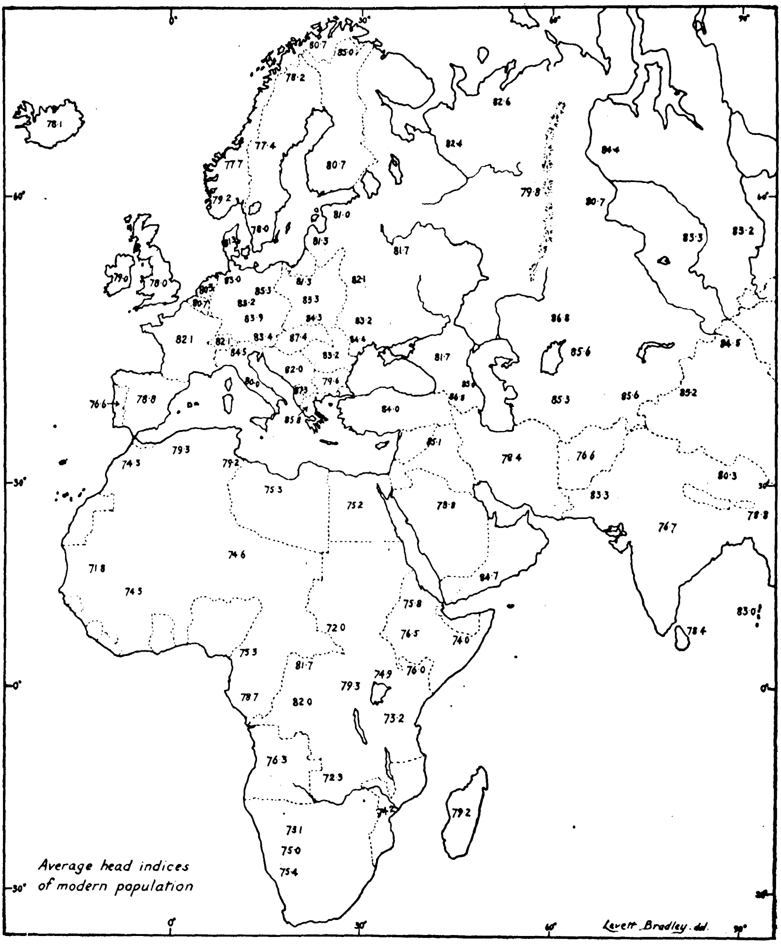


FIG. 134. Map showing the average head indices of the recent populations of Europe, Africa, and Western and Central Asia. (From Weidenreich. Courtesy, University of Chicago Press.)

trian Tyrol, and south through Yugoslavia to Albania. The head ranges from high mesocephaly to moderate brachycephaly, the forehead runs all the way from strongly sloping to high and vertical, with well-developed brow-ridges. A remarkable feature of the Dinaric face, which is long and deep, is the long prominent, generally convex nose usually with a fleshy tip. The lips are of medium fulness, and the chin well-developed. Hair color varies from brown to black, and hair form from straight to wavy and sometimes curly, but lighter hair, skin, and eye colors are very frequent. The Dinarics are remarkably tall having an average height of 1.72 m. or five feet eight inches.

The Dinarics have undoubtedly a considerable Atlanto-Mediterranean component, an Alpine, and probably also an appreciable Irano-Afghanian one. Beyond the mountains they extend to the north-east, being found in some numbers in the Hungarian region, while to the south they are a major element in the Po Valley where, with the Alpines proper, they have introduced a considerable brachycephalic strain into Italy as a whole. Unquestioned Dinaricized types are also to be found in the dominantly brown and round-headed population of Asia Minor and Syria.

Armenoid

In Asia Minor to the east and the south-east of the Black Sea, that is in Armenia and north-eastern Turkey, is found the highest concentration of a type closely resembling the Dinaric, namely, the Armenoid. It occurs with varying frequency throughout Asia Minor.

The Armenoid head ranges from high mesocephaly to moderate brachycephaly. The nose is prominent and convex, and is remarkable for the length and fleshiness of its tip—a characteristic which occurs more frequently among the females than the males. The cheekbones are rather well developed, the lips moderately full, hair abundant and dark brown to black in color, and slightly wavy to straight in form, eyebrows and beard in the males are especially thick, the former often meeting over the root of the nose. The average height is 1.67 m. or (five feet six inches) and body-build somewhat stocky tending towards corpulence in middle and old age.

That the Armenoid represents a blend, but possibly in different proportions, of the same ethnic groups and sub-groups as have entered into the composition of the Dinarics would seem probable. The difference may lie in the lesser Atlanto-Mediterranean component, and the greater Irano-Afghanian element which, with some Nordic and Alpine elements, has entered into the composition of the Armenoid type.

East Baltic

In northeastern Germany, Poland, the Baltic States, and Finland, there occurs a rather variable though well-differentiated type which, from the region in which it is chiefly concentrated, is known as the East Baltic type. While there is some variation in the pigmentary factors and in other characters, the type is characterized by its feeble pigmentation of hair, skin, and eyes. The straight head-hair is best described as tow-colored, having reached the maximum degree of depigmentation—outside albinos—known in the human species; facial hair is moderately developed but body hair is usually sparse; skin color is generally a tawny white; the eyes are very gray or light blue. The head is very brachycephalic, rather flat at the back, the forehead is broad and high, the cheekbones fairly prominent, and the angles of the lower jaw rather widely separated; all these characters give the head and face a rather squarish appearance, hence the name "Square-heads" for the type. The chin is well developed, the brow ridges moderately well developed; the nose, while quite prominent, is generally broad at the wings, somewhat short at the tip, so that the roundish nostrils are directed forward, and in profile is characteristically concave. The German Junker class of East Prussia, as represented in particular by the German general von Hindenburg, is a good example of the type. It is the type which is often miscalled "Nordic" by the Germans.

The composite nature of the East Baltic type is obvious, but the ethnic elements which have entered into that composition and produced it have thus far escaped anthropological analysis. Alpine, Atlanto-Mediterranean, Lapp, and some Nordic strains have been suggested, but these are merely speculations.

The Lapps

The Lapps live in Northern Scandinavia, in the highlands of Sweden, the tundra of northern Finland, the Norwegian coastal provinces of Troms and Finnmark, and occupy a great part of the Russian Kola Peninsula. With other ethnic groups of the circumpolar zone they share many features in common. The Reindeer Lapps live in the forests and mountains, the Sedentary Lapps live

Table 19. Average Cranial Capacities in Anthropoids and Man. Males

Group	Reference	Method	Cubic Capacity
Gibbon	Schultz 1933	m	97
Siamang	Schultz 1933	m	125
Chimpanzee	Hooton 1942	m	400
Orang-Utan	Hooton 1942	m	416
Gorilla	Hooton 1942	m	549
Plesianthropus	Broom 1946	e	560
Australopithecus africanus	Broom 1946	e	600
Paranthropus robustus	Broom 1946	e	650
Australopithecus prometheus	Broom 1950	e	*715*
Pithecanthropus II	Weidenreich 1945	e	775
Pithecanthropus I	Weidenreich 1945	e	940
Paranthropus crassidens	Broom 1950	e	1000
Sinanthropus	Weidenreich 1945	mc	1043
Solo	Weidenreich 1945	mc	1100
Steinheim	Berckhemer 1934	c	*1177*
Cape Flats	Drennan 1929	mw	1230
Baining	von Bonin 1934	c	1243
Australian aborigines Northern Territory	von Bonin 1934	c	1256
Tasmanians	Morant 1927	c	1264
Andamanese	Morant 1924; von Bonin 1931	m	1264
Australian aborigines Southern Australia	von Bonin 1934	c	1278
New Guinea	Hambly 1947	c	1280
Veddas	Morant 1924	m	1285
Rhodesian man	Keith 1925	mc	1305
Talgai	Smith 1918	c	1300
Melanesians	Hambly 1947	m	1323
Bushmen	von Bonin 1934	mc	1329
Hindu and Tamil	Hambly 1947	m	1335
Australian aborigines Victoria	Wunderly 1943	m	1338
African Negroes	Hambly 1947	m	1346
American Negroes	Todd 1923	mw	1350
Piltdown	Keith 1925	e	1358
Tyrolese	Frizzi 1912	m	1359
Ainu	Hambly 1947	mc	1383
London (Lloyds)	Keith 1931	e	*1386*
Galla and Somali	von Bonin 1934	c	1388
Galley Hill	Keith 1925	m	1400
Dayaks	von Bonin 1934	c	1403
Burmese	Tildesley 1921	m	1406
Hottentots	von Bonin 1934	c	1408
Aetas	von Bonin 1931	c	1415

Capacities in *italics* indicate that 10 per cent has been added to the capacity of the female skull which is the presumed sex from which this particular type is known. Female capacities may generally be approximated by deducting 10 per cent from the male capacity. In the human species the cranial capacity is about 200 cc. larger than the volume of the brain.

m = measured with seed; mc = measured and calculated; mw = measured with water; c = calculated; e = estimated.

TABLE 19—(*continued*)

Group	Reference	Method	Cubic Capacity
Châtelperron	Montagu 1950	mc	1425
Malayans	Morant 1924	m	1424
Marquesans	von Luschan 1907	m	1427
Moriori	von Bonin 1934	c	1434
1st to 2nd Dynasty Egyptians	von Bonin 1934	c	1435
Czechs	Morant 1928	m	1438
Fijians and Loyalty Islanders	Hambly 1947	m	1439
Combe Capelle	Keith 1925	e	1440
S. Amer. Indians	Hambly 1947	c	1442
Modern Europeans	von Bonin 1934	c	1446
Neanderthal	Keith 1925	mc	1450
Ingwavuma	Cooke *et al* 1940	e	1450
Polynesians	Hambly 1947	m	1451
Sandwich Islands	Wagner 1937	m	1456
Swanscombe	Keith 1939	c	*1457*
"Kaffirs"	Shrubshall	m	1460
Chinese	Morant 1924	m	1467
Swiss	Morant 1928	m	1468
Fontéchevade	Vallois 1949	mc	1470
Western Eskimo	Hambly 1947	m	1473
Japanese	von Bonin 1931	m	1475
Bury St. Edmunds	Keith 1925	e	*1474*
Maoris	von Bonin 1934	c	1476
Ehringsdorf	Weidenreich 1928	e	1480
Modern English	Keith 1931	m	1480
Tahitian	von Luschan 1907	m	1487
Buriats	Woo & Morant 1932	m	1490
Koreans	Morant 1924	m	1490
E. Centr. Amerinds	von Bonin & Morant 1938	c	1495
Kalmucks	Woo & Morant 1924	m	1498
Springbok Flats	Keith 1931	e	1500
Ancient Europeans	von Bonin 1934	c	1501
Upper Paleolithic	von Bonin 1934	c	1505
Central Eskimo	Hambly 1947	c	1516
Iroquois	von Bonin 1934	c	1519
Chancelade	Keith 1925	c	1530
Algonkin	von Bonin 1934	c	1532
Matjes River	Keith 1934	c	1532
Galilee	Keith 1931	e	*1540*
Tepexpan	Romero 1949	mw	1540
Mount Carmel	Keith & McCown 1939	c	1552
Mongols	Woo & Morant 1924	m	1573
Předmost	Keith 1925	c	1590
Keilor	Wunderly 1943	m	1593
Fish Hoek	Keith 1931	c	1600
La Chapelle aux Saints	Keith 1931	mc	1625
Wadjak	Dubois 1920	c	1650
Gibraltar	Keith 1931	e	1650
Cro-Magnon	Keith 1925	c	1660
Elementeita	Keith 1931	c	1680
Boskop	Broom 1914	e	1700
Zitzikama	Keith 1931	c	*1925*

along the coast and rivers. At one time the Lapps were classified with the Mongoloids. As they have become better known anthropologically it has become clear that they are, from a classificatory point of view at any rate, more dominantly Caucasoid than Mongoloid. Some anthropologists believe that the original ancestral Lapps may represent a stage in the evolution of both the Upper Paleolithic Europeans and the Mongoloids (Schreiner, Coon).

The head form tends to be brachycephalic, with an average cephalic index of 84.0. The forehead is usually narrow and steep and often exhibits bilateral frontal eminences; supraorbital ridges are usually absent. A remarkably short face, with an average nasion-menton height of 112.0 mm (as compared with 125.0 mm for Norwegians and Finns), is a characteristic Lapp feature. The shortness of the face is largely due to the feeble development of the upper and lower jaws and the small teeth, there is little or no prognathism. The face is moderately broad (140.0 mm) and well within the Caucasoid range; flaring Mongoloid cheek-bones are rarely encountered, though they tend to project forward prominently. The nose is moderately broad, with a concave bridge, and a peculiar snubbed or pointed up-turned tip; the lips tend to be moderately thin. The eyes are widely separated, set in low orbits, and rarely overhung by a Mongoloid fold. In about two-thirds of Lapps skin color varies from grayish yellow to yellowish brown, and in these the hair is mostly dark brown or black and the eyes dark; in those with light hair and eyes (about a third) skin color is as light as that of any Scandinavian. Hair color is most frequently dark brown or black, and usually straight or slightly wavy, it is rarely of Mongoloid type; facial and body hair is sparse. The Lapps are a short people, average height being 1.59m (5 feet 3 inches).

The Lapps have undoubtedly mixed to some extent with Swedes, Finns, Norwegians, East Baltics, Russians, and Samoyedes, nevertheless they remain a distinctively recognizable ethnic group.

Indo-Dravidians

Distributed very widely throughout India and Ceylon is a basically Mediterranean people who exhibit some evidences of Negritoid, and possibly proto-Australoid, admixture. The head form varies from dolicho- to brachycephalic, the cephalic index averaging 74.3; the forehead is usually rounded, the supraorbital ridges moderately developed, the face narrow and of medium length, with little or no prognathism. The nose is of moderate breadth, fairly prominent and straight in profile, somewhat depressed at the root, and the wings somewhat flaring; the lips are moderately full, but not Negroid. Stature averages 1.64 m. (five feet four inches). Skin color varies from light to dark brown; hair is usually black and slightly wavy, though straight hair is quite frequent and frizzly hair also occurs; facial and body hair is sparse.

Here, too, the basic Mediterranean character of the Indo-Dravidians is brought out by the fact that the hybrids of crosses between Europeans and Indo-Dravidians, are indistinguishable from basic Mediterraneans, except in skin color, which may be a little darker than is customarily found in the latter.

A familiar offshoot of the Mediterranean Indo-Dravidians are the gypsies or Romanies. These peculiar people are descended from outcast groups who wandered westward into every corner of Europe, where they have in the last thousand years remained a foreign population in the midst of western peoples and customs. Fundamentally Indo-Dravidian Mediterraneans, they have to a certain extent been modified in physical type by admixture with western peoples. Their language basically remains a modification of Sanskrit, with many incorporations from western languages.

Polynesians

A line drawn from Hawaii in the north to the Fiji Islands in the Southwest, and thence to New Zealand, then to the Paumoto Archipelago in the east, and finally back to Hawaii, will embrace the whole of the vast area of Polynesia. In this area of the Pacific lives a far-flung branch of the Mediterranean stock, the tall, handsome peoples called Polynesians.

The Polynesians are predominantly brachycephalic, high-headed, with slightly sloping forehead, flattish occiput, and with long broad faces, fairly prominent cheek bones, a prominent nose somewhat broad at the wings of the nostrils, lips of moderate fullness, and chin well developed. Skin color is generally light brown, hair color dark brown to black, and head hair is slightly wavy, occasionally straight, rarely curly, and in some individuals frizzly. Body hair is very sparse. Very rarely a Mongoloid fold over the medial angle of the eye is present. The average height is about 1.78 m. or five feet eight inches; body build is muscular with a strong tendency to corpulence towards middle age.

Essentially Mediterraneans, the Polynesians would appear to have undergone some admixture both with a Negroid and a Mongoloid stock, the former may have been Melanesians, the latter possibly already much mixed Mongoloids or people with only slightly developed Mongoloid characters.

At this point we may appropriately turn to an account of the Mongoloid division of man.

The Mongoloid Division

The skin has a yellowish tinge but is really a yellowish light brown, head hair is generally black and straight, each hair is very large in cross-section. There are fewer hairs per square centimeter of skin and face, and body hair is less developed than in any other variety of man. The head is generally brachycephalic, the average cephalic index being 85.0, but meso- and dolichocephalic groups occur, the forehead is of medium height and rounded, and the occiput projecting. The nose is flat or low at the root, the bridge is low, and the wings of the nostrils of medium spread; lips are of medium fulness, and the chin well developed. The face tends to be remarkably flattened in most groups, and the gonial angles of the lower jaw everted in some. The cheek bones are very strongly developed, projecting forwards and laterally. The incisor teeth tend to be shovel-shaped, scooped out behind like a scoop shovel; the tooth-bearing portion of the upper jaw has a marked tendency to project slightly upwards and forwards, to give the appearance in many individuals of "buck teeth." This is seen in its most extreme form in the Japanese, and is also very frequent in the Chinese. But the trait which above all others gives the typical Mongoloid his characteristic appearance is the fold of skin from the upper eyelid which lies over the inner angle (canthus) of the eye or extends over the whole of the upper eyelid, the internal epicanthic or complete so-called Mongoloid fold, a character which gives the eye its slit-like appearance (Fig. 150, p. 459). Stature averages about 1.66 m. (five feet five inches).

The skeleton of the classic Mongoloid type is very delicately made, even down to the character of the sutures of the skull which, like those of the infant skull, are relatively smooth and untortuous. In fact the Mongoloid presents so many physical traits which are associated with the late fetus or young infant that he has been called a fetalized, infantilized or pedomorphic type. Those who have carefully observed young babies may recall that the root of the nose is frequently flat or low as in Mongoloids, and that an internal epicanthic fold in such instances is usually present. The smaller number of individual head hairs and the marked hairlessness of the remainder of the body are infantile traits, as are likewise the small mastoid processes, the shallow fossa into which the jawbone fits (the mandibular fossa), the rather stocky build, the large brain-pan and brain, lack of brow ridges, and quite a number of other characters. Since fetalization seems to be the

FIG. 135. Young Javanese male from Bautam. (Courtesy, Musée de l'Homme, Paris.)

process by which man has attained many of his unique characters there is reason for regarding the Mongoloids as a rather highly evolved type.

Inhabitants chiefly of northern, central, and south-eastern Asia, embracing the Philippines, Malaysia, the East Indies, and the Americas, the Mongoloids are anthropologically perhaps the least known of the varieties of man. There have been no really adequate studies on any Mongoloid group, including the American Indian. The following account of the Mongoloids is therefore deliberately brief.

Many anthropologists believe that the Mongoloid was the last great variety of man to become differentiated. Weidenreich, on the other hand, believes that the Mongoloid was probably derived from a Sinanthropoid stock; others see in the Eskimo-like characters of the paleolithic skull found at Chancelade, a possible ancestral type of the Mongoloids, but these are all speculations which arise out of the paucity of our knowledge of prehistoric Asia. When future expeditions and researches in the field have brought in more abundant material finds we may be in a position to speak with some authority on the origin of the Mongoloids. Until then it were better to record our ignorance than to conceal it with poorly founded speculation.

Among the Mongoloids there are probably as many, if not more, ethnic groups and sub-groups as there are among the Caucasoids, but the satisfactory recognition and description of most of these awaits future research.

The Mongoloids have been subdivided into four great geographic subdivisions, as follows: (1) The central or classical Mongoloid, (2) the northern or Arctic, which we shall call Eskimoid, (3) The American Indian or Amerindian from North to South America, and (4) the Southern or Indo-Malayan.

The Central or Classical Mongoloid

The central or classical Mongoloid type is found sporadically distributed in Northern China, Mongolia, and Tibet. The cephalic index averages about 85.0, and the Mongoloid fold is always present. For the remainder the classical Mongoloid's traits are as already described. The type is well seen in such tribes as the Gilyak, Koryak, Goldi, Buriats, and Kalmucks.

The Arctic Mongoloids or Eskimoids

The northern or Arctic subdivision includes peoples living in north-east Asia, the arctic coast of North America, Greenland, Labrador, and western Alaska including the Aleutian Islands. This subdivision is typically represented by the Eskimos, and like the classical Mongoloids tends to be brachycephalic. In addition to the Eskimos it includes such paleoasiatic peoples as the reindeer and coastal Chukchee, the Kamtchadales, and such neoasiatics as the Tunguses, Samoyedes, and Yakuts.

The Eskimos represent a single continuous breeding population, with their center in western Alaska, where they are brachycephalic and low headed, becoming increasingly so from north to south.

The Eastern Aleutian Eskimo has an average height of 1.62 m. (five feet four inches) and is brachycephalic (c.i. 84.6). The lower Kuskokwim Eskimo has an average height of 1.62 m. (five feet two inches) and is brachycephalic (c.i. 81.5). The Asiatic Eskimo has an average height of 1.62 m. and is brachycephalic (c.i. 80.8). The Arctic Eskimo has an average height of 1.65 m. and is mesocephalic (c.i. 78.6). The Greenland Eskimo is mesocephalic (c.i. 76.8) and has a stature of 1.62 m. The arctic Eskimos have a high gabled head. In less extreme form this gabling or keel is also present in the western Eskimos.

Eskimos as a group are characterized by large broad faces, markedly flaring cheek bones, narrow noses, high incidence of the complete Mongoloid fold, straight black hair, small hands and feet, large trunks and relatively short legs, and large amounts of blood, group A, and small amounts of blood, group B.

The Kamtchadales and eastern Tungus belong to the mesocephalic group (c.i. 78.3 to 80.8), the western Tungus, Chukchee, Gilyak, and Samoyedes, belong to the brachycephalic group (c.i. 83.0 to 85.6).

The migrations of peoples of this stock into Europe has resulted in much admixture, evidences of which are still recognizable in such peoples as the Baltic Finns, Esths, Livonians, Finlanders, Magyars (Hungarians), and others. This latter group of peoples is usually termed Finno-Ugrian or Uralic, a term which also defines a family of languages spoken by these peoples.

The American Indian or Amerindian

Physically among the least known groups of Mongoloids are the Indians of North, Middle, and South America. Research on the physical anthropology of the American Indian has been extremely slow in getting started. The little we know indicates that not all those who at different times migrated into the Americas were of predominantly Mongoloid stock, that, indeed, judging from their physical characters, such as the absence of shovel shaped incisiors in many Indians, the shape of the nose, and the high frequencies of blood group A (50 per cent among the Blackfeet) some of these immigrants were possibly dominantly Caucasoid with some Mongoloid admixture.

The American Indians exhibit a certain basic homogeneity but at the same time are evidently characterized by an equally certain diversity of types. Owing to the lack of the necessary data it is impossible to say quite how many diverse types there may be. General impressions based on sporadically measured and photographed individuals from various groups provide an insufficient basis upon which to erect a satisfactory account of the American Indian.

The basic traits which American Indians have in common are yellow-brown to red-brown skin color; hair, black, straight, coarse, sometimes slightly wavy, very sparse on body and face, and usually entirely absent on the sides of the face. Eye color varies from medium to dark brown. A completely Mongoloid fold is rarely present, though the internal epicanthic fold is frequently seen in women and children, but very rarely in males in whom an external epicanthic fold is commonly present. The face is broad, with large flaring cheek bones, the lips vary from thin to average thickness, the chin is fairly well developed, shovel-shaped incisors are common, and the bite (of the teeth) is edge to edge.

The character gradients, as might have been expected, follow the geographic gradients. For example, the Indians of the northwest coast, the Tlingit, Haida, Tsimshian (c.i. 82.5, stature 1.68 m., five feet six inches), and the Kwakiutl (c.i. 84.5, stature 1.64 m., five feet four and a half inches) look more like the Arctic Mongoloids than do the Indians east of the Rockies. The latter extending through the great Plains into the northern and eastern Woodlands area, range from brachycephaly, through mesocephaly to dolichocephaly, with the northeast predominantly dolichocephalic. In the Plateau area brachycephaly prevails, and stature tends to be somewhat shorter, and noses somewhat straighter.

In Mexico, Middle and South America it is known that every form of head shape is encountered. Eastern Brazil shows a very large proportion of mesocephalic types.

It has already been pointed out that these different waves of migrants entered North America from Siberia across the Bering Straits by way of Alaska. The Asiatic origin of the American Indians is now beyond dispute. In Tibet there are to be found types which closely resemble the Fuegians of southernmost South America; the Chukchee of Siberia closely resemble the whole Eskimo population, furthermore, in many aspects of their culture these populations are very much alike.

Indonesian-Malay

Throughout southeastern Asia flourishes a large number of Mongoloid peoples most of whom look as if in the past they had experienced an appreciable Caucasoid, and probably Negroid, admixture. This is the Indonesian-Malay or Oceanic Mongoloid strain.

The Indonesian is slenderer and slightly shorter (1.55 m. or five feet one inch) than the stockily built Malay (1.58 m., five feet two inches); he is longer-headed (c.i. 78.5) while the Malay is usually brachycephalic (c.i. 85.0); the head hair tends to be slightly wavy, and for the rest is very sparse in both groups; in the Malay head hair is straight. In the Indonesian the nose is narrower and higher, and the internal epicanthic fold less frequent. The Mongoloid influence, indeed, seems to be less strongly marked in the Indonesians than in the Malays. In the Malay Archipelago the Indonesian type, generally speaking, occurs more frequently inland, while the Malays are the coastal peoples. The Japanese largely belong to the Malay type.

The Indonesian type is found in southern China, Indo-China, Burma, Thailand, the interior of the Malay Archipelago, while the Malay type in addition occurs in the Malay Peninsula, the Dutch East Indies, the Philippines, Japan, Okinawa, and adjacent islands.

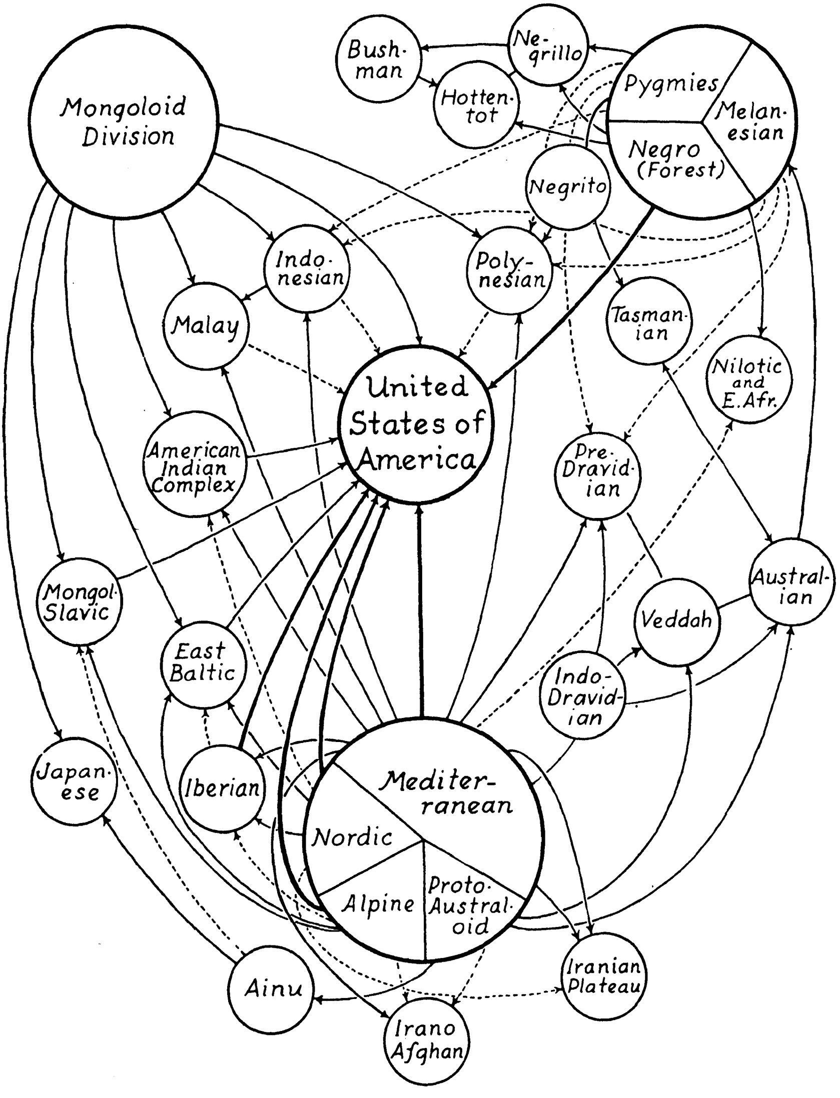


FIG. 136. Some relationships of the varieties of mankind to one another, and those which have entered into the formation of the population of the United States.

CONCLUSION

In this chapter an attempt has been made to give an account of the principal varieties and ethnic groups of man, and we have seen that far from pursuing a completely independent course of development it is probable that all of them have at one time or another met and contributed their genes to produce new modifications of older types. Through these modifications something of the older types can sometimes be seen more or less clearly shining through, but this is not always the case, for the new made pattern is usually an harmonic one, and unless there are certain striking features such as skin color, hair form or Mongoloid fold, very refined methods of analysis are required in the not always successful attempt to discover the components which have entered into the formation of a particular type.

It is clear that there are no "pure races" in existence, and it is greatly to be doubted that there ever were any. The ethnic groups of mankind are not, and never have been, so many separate streams and tributaries flowing within well-defined banks, but currents and eddies in one great river, in which there has been a constant interchange of what each has carried.

In Fig. 136 is reproduced a diagram showing some of the relationships of the divisions and principal ethnic groups of man, and the contribution of all these to the population of the United States. This diagram may perhaps serve to suggest the probable truth that the United States stands out in high relief as the example of what, upon a lesser scale, has occurred throughout the history of man, the mingling of peoples to produce greater strength in almost every way, to illustrate the truth that diversity of genes as well as of culture is the basis of collective achievement.

The reader will have read the significance of this chapter correctly if he understands that the arrangement of the divisions and ethnic groups of man here listed is quite arbitrary, tentative and temporary, being a classification based upon a few characters statistically averaged for an appallingly small number of the world's peoples. It must always be remembered that the concept of a human group characterized by a certain uniformity of physical characters is a statistical concept which applies only to groups and not to individuals. So real are the transitions between one group and another, and so great the variability of almost all human groups that any individual taken at random from some such groups could, in many cases, fit into the framework of variability of almost any other. Thus, for example, there are many Caucasoids who could easily fit into a Negroid group, and *vice versa,* and the same holds true for the relationships of many Mongoloids with both these groups.

The error most commonly committed in this connection is to think in terms of a genetically independent development of each of the varieties and even ethnic groups of man, and to regard them as clear cut types which are readily contrasted with one another. As we have seen, this is a very great fallacy for the good reason that no human groups have ever undergone completely independent development, that all are much mixed, and that temporary stabilization of their more or less distinctive characters has been due to the action of isolating factors, not merely of a geographic kind, upon a mixed population. This mixing of all peoples is evident in their resemblances to one another, and in the imperceptible transitions in physical characters which exist between all ethnic groups. The differences between them are due to the differences in the proportions of the ethnic elements which have entered into the composition of each group, and the action of the primary and secondary factors upon them. When these differences are considered and evaluated they are seen to be relatively few in number compared to the overwhelming number of likenesses, and they are seen to be of a nature which does not render any one of the groups concerned either biologically superior or inferior to the other. The physical differences are merely expressive of a somewhat different biological history, differences for which we should be extremely grateful since, among other things, they assist us to demonstrate the essential unity—not difference—of mankind, and will enable us eventually to trace a good part of the history of that unity and differentiation. Our classificatory schemes must be regarded as nothing more than convenient devices calculated to assist us toward the achievement of such a desirable end.

The Divisions and Ethnic Groups of Man

Division: NEGROID

African Negroes

Ethnic Group: a. **The True Negro:** West Africa, Cameroons and Congo.
b. **The Half-Hamites:** East Africa and East Central Africa.
c. **Forest Negro:** Equatorial and Tropical Africa.
d. **"Bantu-Speaking Negroids:"** Central and Southern Africa.
e. **Nilotic Negro:** Eastern Sudan and Upper Nile Valley.
f. **Bushman-Hottentot:** South Africa.

Oceanic Negroids

Ethnic Group: a. **Papuans:** New Guinea.
b. **Melanesians:** Melanesia.

African Pygmies or Negrillos

Ethnic Group: a. **African Pygmies or Negrillos:** Equatorial Africa.

Asiatic Pygmies or Negritos

Ethnic Group: a. **Andamanese:** Andaman Islands.
b. **Semang:** Central region of Malay Peninsula, and **East Sumatra.**
c. **Aeta:** Philippine Islands.

Oceanic Pygmies or Negritos

Ethnic Group: a. **New Guinea Pygmies:** New Guinea.

Division: CAUCASOID

Ethnic Group: a. **Basic Mediterranean:** Borderlands of the Mediterranean Basin.
b. **Nordic:** Central Europe, Scandinavia and neighboring regions.
c. **East Baltic:** East Baltic regions.
d. **Lapps:** Northern Scandinavia, Kola Peninsula.
e. **Alpine:** France along the Alps to Russia.
f. **Dinaric:** Eastern Alps from Switzerland to Albania, Asia Minor, and Syria.
g. **Armenoids:** Asia Minor.

h. **Indo-Dravidians:** India and Ceylon.
i. **Polynesians:** Polynesia.

Sub-Division: AUSTRALOID or ARCHAIC CAUCASOID

Ethnic Group: a. **Australian:** Australia.
b. **Veddah:** Ceylon.
c. **Pre-Dravidian:** India.
d. **Ainu:** Japan, Hokkaido (Yezo) and Sakhalin Islands.

Division: MONGOLOID

Classical Mongoloids

Ethnic Group: a. An undetermined number of ethnic groups in the older populations of Tibet, Mongolia, China, Korea, Japan, and Siberia, including such tribes as the **Buriats** east and west of Lake Baikal, the **Koryak** of northern Siberia, the **Gilyak** of northernmost Sakhalin and the mainland north of the Amur estuary (who appear to have mixed with the Ainu), and the **Goldi** on the Lower Amur and Ussuri.

Arctic Mongoloids

Ethnic Group: a. **Eskimo:** extreme northeast of Asia, Arctic coast of North America, Greenland. The type includes the **Aleuts** of the Aleutian Islands, and the Reindeer and **costal Chukchee** of northeastern Siberia.
b. **Evenki or true Tungus (Americanoids):** Mongolia, Siberia, Asiatic highlands north of the Himalayas.
c. **Kamtchadales:** Kamchatka.
d. **Samoyedes:** Kola Peninsula, White Sea and Yenisei regions.

American Indians

Ethnic Group: a. An undetermined number of ethnic groups of North, Middle, Central, and South America.

Indo-Malay

Ethnic Group: a. **Indonesian:** Southern China, Indo-China, Burma, Thailand, interior of Malay Archipelago.

b. **Malay: in addition to Indonesian distribution Malay Peninsula, Dutch East Indies, Philippines, Okinawa, and adjacent islands.**

FOR FURTHER READING, CONSULT:

COON, C. S.: *The Races of Europe,* New York, Macmillan, 1939.

A book rich in basic materials following the conventional methods of classification, but entirely without reference to the data of genetics.

———, GARN, S. M. and BIRDSELL, J. B.: *Races: A Study of the Problems of Race Formation in Man.* Springfield, Illinois, Thomas, 1950.

An interesting and suggestive volume, containing a new classification of the races of man. Particularly good on the adaptive characters of man.

EHRICH, R. W., and COON, C. S.: Occipital flattening among the Dinarics. *Am. J. Phys. Anthropol., 6:*181-186, 1947.

A discussion of the part played by cradling practices in determining what was at one time assumed to be a "racial" set of characters.

EWING, J. F.: Hyperbrachycephaly as influenced by cultural conditioning. *Papers Peabody Museum, Harvard University, 23:*10-99, 1950.

An important piece of research showing the influence of cradling practices upon the form of the skull.

HADDON, A. C.: *The Wanderings of Peoples,* New York Macmillan, 1911.

An excellent little book on the migrations of different peoples throughout the world.

———: *The Races of Man.* New York, Cambridge University Press, 1924.

An authoritative and well-balanced little book.

HOOTON, E. A.: *Up From the Ape,* 2nd edition, New York, Macmillan, 1946. pp. 423-661.

Containing a very interesting discussion of raciation and the classification of human races with which, however, no genetically minded physical anthropologist could possibly agree.

MORANT, C. G.: *The Races of Central Europe,* London, Allen & Unwin, 1939.

An invaluable little book.

SELIGMAN, C. G.: *The Races of Africa,* New York, Oxford University Press, 1930.

A small and excellent book dealing both with the physical and general cultural characters of the peoples of Africa.

Chapter VII

THE SIGNIFICANCE OF ISOLATE DIFFERENCES OR THE RELATION BETWEEN BODY, MIND, AND CULTURE

IN the preceding chapter we saw something of the significance which is to be attached to the physical differences existing between the ethnic groups of man, in the present chapter we shall chiefly consider the significance of the mental and cultural differences which exist between such isolates. Since the belief is often encountered that certain physical characters are invariably associated with certain mental ones, and that membership in a particular "race" generally means that one may expect certain mental and cultural traits to be exhibited by every member of that "race," we may profitably inquire to what extent such a belief is true, and what significance is to be attached to the association, which can so easily be observed in different groups, between physical, mental, and cultural traits. Our purpose in this chapter will be to inquire into the nature of this association.

The Racist View

A typical expression of the racist viewpoint runs as follows: A "something" called "race" or "blood" is the prime determiner of all the important traits of body and soul, of character and personality, of mind and thought. This "something" is a fixed and immutable part of the germ-plasm which, differing in each people, is transmitted from generation to generation, to unfold in each people in a typical expression of personality and culture. Hence, there must exist irreconcilable differences in mind, soul, and blood between the "races" of mankind. During the last hundred years this view has found supporters in many different lands, culminating finally in the Nazi doctrine of racism, the basis of the official viewpoint of the German government of 1933-1945.

The Genetic Facts

The parents contribute a set of genes to their children which combine to form the new individual, an individual who is unlike anyone who has ever lived before or who will ever live again. Since man possesses 24 pairs of chromosomes, the possible combination of hereditary factors which every parent can theoretically produce is 16,777,216. The chances of exactly the same combination occurring in any two individuals are, on the basis of the number of chromosomes alone, 1 in 300,000,000,000,000, or about once in every 300,000 generations, which, is, for all practical purposes, never. This tremendous range of variation is due to the fact that the carriers of the hereditary materials are particulate more or less independent structures, the genes, carried on the 24 pairs of chromosomes of each parent, and that these can combine in a practically infinite variety of relations. That is why no two persons ~~are ever alike.~~

We have seen that out of this inexhaustible reservoir of genetic materials certain combinations may be produced as the result of the action of a variety of factors, so that we find one group with white skin, another with brown, and still another with yellowish skin, and so on. Even so we never find any two individuals who are ever alike, and that is in essence what we mean by the term variation. The particulate and extra-chromosomal forms of inheritance and the consequent variability are facts which lend not the slightest support to any notion that a "something" which is a fixed and immutable part of the genetic system is responsible for any irreconcilable differences between the ethnic groups of mankind. These facts are, on the other hand, quite opposed to such a view. There are no fixed and immutable parts of the genetic system, and hence it is impossible to transmit them; there are merely temporary combinations of genes which under isolate conditions will tend to remain relatively stable. They are, of course, more or less constantly in process of undergoing change, and undergo very substantial modification as soon as the conditions relative to which the gene combinations have maintained their stability are changed.

Genes do not make their own conditions of expression, but have them made for them by the environment in which they develop. Hence, it is not only new combinations and mutations of genes which are responsible for the production of novelty, but the environment as well. It is not traits or characters which are inherited, but the potentialities to develop traits or characters, and the expression of these potentialities is to a large extent determined by the environment in which they undergo development.

Thus, for example, as has been mentioned in an earlier chapter, the head-shape of children born in the United States will differ from that of their European-born siblings and parents in a manner which can only be explained as due to the effect of the new environment. A poor socio-economic environment will almost invariably exert an untoward effect upon the growing individual, so that it is safe to say that practically the whole of his body is affected, and he grows up to be somewhat different from what he might have been under more favorable conditions. Even the shade of the skin will vary in different environments, appearing darker in an area of intense sunlight than it would in the same individual in a cloudy, foggy, climate. Physiological characteristics such as the onset of first menstruation (menarche), basal metabolism, and blood pressure, will vary very significantly in association with the climates in which these functions develop (see Chapter VIII).

The expression of a gene is, therefore, to a certain extent, dependent upon the environment to which it is exposed and to which it is in a very definite sense a response. The ultimate characters the genes produce will therefore tend to vary as the environment varies. The term "character" is itself an abstraction, but one which is unavoidable for descriptive purposes. As Dobzhansky points out, "Genes produce not characters but physiological states which, through interactions with the physiological states induced by all other genes of the organism and with the environmental influences, cause the development to assume a definite course and the individual to display certain characters at a given stage of the developmental process."[1]

There is nothing stable or immutable about the genetic system. Under varying conditions it will tend to vary. The essential divisional physical characters will be preserved only as long as genes from another division are excluded from the group. With

---

[1] Dobzhansky, Th., and Holz, A. M.: A re-examination of the problem of manifold effects of genes in Drosophila melanogaster. *Genetics, 28*:301, 1943.

the introduction of such genes the group tends to lose its former characters and to acquire new ones. Were there to exist any irreconcilable differences in the genetic structure between the members of different ethnic groups such processes could not occur or else they would exhibit themselves in disharmonic or undesirable effects in the hybrids. And this we know very definitely not to occur.

One of nature's favorite methods of producing new and better types of living forms, and strengthening old ones, is by hybridization. This is as true of man as of any other living creature.

The popular stereotype that interbreeding or crossing between different "races" results in inferior offspring and in ultimate degeneration of the stock is totally without scientific foundation, and, indeed, is quite contrary to the truth.

Studies on Polynesian-White crosses carried out by Shapiro, on Australian-White crosses by Tindale and others, by numerous investigators on crosses between Japanese, Filipinos, Koreans, Puerto Ricans, Europeans of all sorts, and Hawaiians, by Boas on Indians and whites, by Herskovits on the American Negro, by Davenport and Steggerda on the Jamaican offspring of Negro-White unions, by Fischer on Dutch-Hottentot crosses, by Lotsy and Goddijn on a great variety of crosses in South Africa between Bushmen, Basutoes, Fingoes, "Kaffirs," Zulus, Mongoloids, Indians, whites and many others, all these studies, and a great many more, prove the great value, from every possible unbiased point of view, of hybridization.

There have, however, been some writers who have concluded from their studies of "race-crossing" that the process results in neither good nor bad effects, while some have concluded that the crossing of ethnic groups does not, on the whole, result in desirable types. I do not read the evidence so.

The "half-caste" is, as his name implies, not fully accepted by either of the castes or ethnic groups with which his parents are associated, and though he tends to adhere to that group which is lower in the social scale, he tends also to be somewhat isolated, to be "outcast." In most instances the half-caste finds it extremely difficult to adjust himself to conditions which are themselves the cause of maladjustment in others. One of America's leading geneticists, Castle, has put the matter very cogently. He writes, "Since there are no biological obstacles to crossing between the most diverse human races, when such crossing does occur, it is in disregard of social conventions, race pride and race prejudice. Naturally therefore it occurs between antisocial and outcast specimens of the respective races, or else between conquerors and slaves. The social status of the children is thus bound to be low, their educational opportunities poor, their moral background bad. . . . Does the half-breed, in any community in the world in which he is numerous, have an equal chance to make a man of himself, as compared with the sons of the dominant race? I think not. Can we then fairly consider him racially inferior just because his racial attainments are less? Attainments imply opportunities as well as abilities."[2]

In the isolating factors which operate upon the half-caste we are dealing with a conspicuous example of the action of socially depressing conditions and not with the effects of biological ones. These facts are invariably overlooked by those who attribute the unfavorable effects of "race crossing" to biological factors.

At every point then, we see the enormous importance of the environmental factor, either physical or social, in conditioning what we so often misinterpret as biologically determined.

"Blood"

A very general belief, and one which has led to much serious misunderstanding of human relationships, is the prevailing popular conception of blood as the carrier of the heritable qualities of the family, "race," or nation. The term "blood-relationship," and its anglicised Latin equivalent "consanguinity," meaning the condition of being of the same "blood" or relationship by descent from a common ancestor, enshrines the belief that all biological relationships are reflected in, and are to a large extent, determined by the character of the blood. Such terms as "blue blood," "blood royal," "pure blood," "full-blood," "half-blood," and "good blood," further reflect that meaning.

---

[2] Castle, W. E.: Biological and social consequences of race crossing. *Am. J. Phys. Anthrop. 9:*147, 1926.

All these terms reflect the belief that "blood" is equivalent to "heredity," and that blood, therefore, is that part of the organism which determines the quality of the individual. By extension it is further generally believed that the social as well as the biological status of the individual is determined by the kind of "blood" he has inherited. Supposed national and "racial" differences are recognized in such terms as "German blood," "English blood," "Negro blood," and so forth; so that today the words "race" and "blood" are often used as synonyms.

The facts of science lend no support to the conception of blood thus implied. Blood is in no way connected with the transmission of hereditary characteristics. The carriers of the hereditary potentialities which, in interaction with the environment, express themselves in characters, are the particles which lie in the chromosomes and cytoplasm of the germ cells represented in the spermatazoön of the father and in the ovum of the mother. These particles have no connection whatever with blood, except insofar as they determine its serological properties. Blood has nothing whatever to do with determining the heredity of the individual or of the group, either biologically, culturally, or in any other manner.

The belief that the blood of the mother is transmitted to the child, and hence becomes a part of the child, is an ancient but erroneous one. Scientific investigation of the processes of pregnancy has long ago made it perfectly clear that there is normally no actual passage of blood from mother to child. The developing child manufactures its own blood, and the character of its various blood cells is demonstrably different from that of either of its parents. The mother does not contribute blood to the fetus, nor is her blood continuoús with that of the fetus. The placenta is a complex system of semi-permeable membranes which permits the passage only of molecules of very small size. Blood cells are too large to pass across the placental barrier. Save for the gases and chemical nutrients and wastes of small molecular size nothing else gets through. Such facts should completely dispose of the false idea of a "blood-tie" between any two individuals whether they be mother and child or even identical twins. Hence any claims to kinship based on the tie of "blood" can have no scientific foundation whatever. Nor can claims of group consciousness based on "blood" be anything but spurious, since the character of the blood of all human beings is determined not by their membership in any group or nation but by the fact that they are members of the single species *Homo sapiens.*

The serological traits which we have already discussed in a previous chapter are determined by the presence or absence of certain genes in combination with one another. It is these hereditary molecules which determine the character of the blood, and not the blood which determines heredity. The frequencies of these genes vary from population to population, as do the genes for other characters. In short, the serological characters of the blood are the expression of certain gene combinations, not the cause of them.

SPIRITUAL QUALITIES, GENES, AND CULTURE

By the "soul" may, apparently, be understood many strange things. The principal Nazi "anthropologist," Hans Günther, as long ago as 1922 classified the "souls" of different "races" according to their alleged colors and stated, for example, that the soul of the Dinaric "race" seems to be dark green ("Als 'seelische Farbe' der dinarischen Rasse scheint sich ein dunkles Grün zu ergeben").

Scientists cannot presume to speak on the nature of the soul since it has never been the subject of serious investigation, but if one may make an approximation to what is generally meant by the word and suggest that it is the spiritual principle which appears to inform a person's conduct, there are several important things which a scientist can say about the "soul." He can say with some degree of assurance that the spiritual quality of a normal man's mind or conduct is not produced so much by anything inborn, by anything which he inherits in his genes, as by the influence of cultural factors upon the organization of his mind. The genes provide the necessary factors for the development of a nervous system and a mind, but the potentialities of that nervous system and its functioning as mind can never be realized in the absence of the human social stimuli which serve to organize that system to function as a human mind.

The fact that an infant ever develops into a human being is almost entirely due to the influence upon its genetic endowment of the human environment in which it is brought up. Genes alone cannot create a human being. They largely create the physical characters which we associate with individuals who are human, and they create the potentialities for the development of human behavior. Behavior which becomes human only because a suitable environment has organized such gene potentialities in a human way. Children who are brought up in solitary confinement, isolated from the socializing influence of human contacts, have no resemblance but a physical one to human beings. There is no such thing as a human mind, apart from a human socializing influence. The human mind as an entity is not so much inherited as socially produced, and it will depend, to the largest extent, upon the nature of the socializing influences which are brought to bear upon it, what the nature of that mind will be.

If it is true that genes alone cannot create a human being, it is equally true that environment cannot do so. However powerful the socializing influences might be, they would be powerless to create a human mind if the necessary gene potentialities were wanting. There can be no human mind without the unique gene potentialities with which every member of mankind is endowed. This is a point which cannot be too greatly stressed in view of the fact that in recent years the reaction to the extreme claims of the racists has caused the pendulum to swing in the opposite direction, and there has been a tendency to deny any relation between the biological make-up of the individual and his mental characteristics. Such a connection undoubtedly exists in every individual and it is an important one. Differences in temperament, special abilities, and in intelligence, are to a certain extent undoubtedly determined by the genetic structure of the individual, but only in interaction with the total environment of the individual.

Were it possible to expose every person to the same total environment—social, economic, climatic, geographic, and so on—persons would still differ from each other, and these differences would express the effect of the genetic factor in the assimilation of the external factors, and that is all. Biologically determined differences in mental characteristics exist between all *individuals,* but this is a very different thing from saying that such differences exist between all ethnic *groups,* or that the mental differences between individuals are biologically determined.

In pure breeds of dogs or birds differences in mental behavior are very closely associated with each breed, but human ethnic groups are not pure breeds, but are, on the other hand, very much mixed. Human groups do not in the least approach the type of genetic uniformity which one encounters among breeds of domesticated animals. Hence, any comparison between them is quite unsound since these domestic breeds are genetically relatively uniform, whereas man, in almost every group in which he may be considered, is characterized by considerable genetic diversity. The evidence indicates that from the earliest times to the present day ethnic intermixture has been the rule, evidence of such intermixture is found in the most inbred ethnic groups. Study of hereditary traits in family lines in most human populations which have thus far been investigated shows that each family line differs from every other, that the diversity in family lines is so great as to render it impossible to speak, in such a population, of hereditary traits common to the whole group.

The history of mankind would lead us to expect such a result, for that history is one of migration and mixture of group with group, again and again. In view of the tremendous diversity of genetic lines which have entered into the formation of each group of mankind such a thing as a pure breed of mankind cannot be said to exist anywhere on this earth. The claim, therefore, that any group of mankind represents a pure group different from all others, all of whose members are distinguished by the same characteristics, is quite untenable.

We must recognize, and be properly grateful for, the fact that all individuals are biologically determined to be unlike, but we must also recognize the fact that when such individuals are evaluated collectively in terms of the groups which they compose, each group seems to average up to about much the same level as every other. At any rate, science has not been able to discover that there exist any fundamental biologically determined mental differences between groups that would outweigh the influence of culture. As Boas has put it: "Our conclusion is that the claim to biologically determined mental qualities of races is not tenable. Much less have we a right to speak of biologically determined superiority of one race over another. Every race contains so many genetically distinct strains, and the social behavior is so entirely dependent upon the life experience to which every individual is exposed, that individuals of the same type when exposed to different surroundings will react quite differently, while individuals of different types when exposed to the same environment may react the same way."

We can be perfectly certain that whatever genetic differences exist between individuals or groups, genes do not and cannot make a mind or produce a "soul." It is the environmentally conditioned experiences acting upon a relatively undifferentiated variety of nervous tissues, formed by the genes, which serve to differentiate and organize those tissues into a bioneurological system which creates mind, and it is a particular history of interaction between those genes and environmental or cultural experience which determines the exact spiritual quality of a mind. As that history differs so will the quality of the mind. To a large extent every human being is culturally or spiritually the product of the society into which he is born. His thoughts, his ideas, his habits are all socially acquired. He is not born with any of these things. Individuals born and brought up in the same society will nevertheless differ from one another because however like their experience may have been it can never have been quite the same, and because of certain individual differences in genetic endowment.

When we consider the great differences in the cultural experience of persons not of the same family, economic or class group, nation, or ethnic group, we can readily see why great mental and spiritual differences may exist between them. The differences are primarily due to differences in culture and cultural experience. These differences have no known or demonstrable connection with the genetic system, although it would be unjustified to assume that they are entirely unconnected. Whatever that connection may be, it is insignificant when compared with the cultural factor.

Now, since the cultural factor is extremely variable for individuals, and even more so for social isolates, it is obvious, even apart from such differential action as the genes may exercise, that individuals and groups will differ from one another as their cultural experience varies. The very fact that cultural and spiritual differences exist between individuals and between groups is proof positive of the fact that there is nothing fixed or immutable about or irreconcilable between such differences, for if such differences were fixed then we should observe no cultural development or change of the most substantial kind within a culture or a people. The inhabitants of the British Isles today would still be in a Stone Age phase of cultural development, for the population of those isles has not significantly changed during the last few thousand or more years; the various non-literate peoples of Tsarist Russia would still be non-literates instead of the westernized peoples of the U.S.S.R. who have adapted themselves with amazing rapidity to the new cultural demands which have been made upon them. The Japanese could hardly have become "westernized," nor the Mexican Indians Hispanicized. In those parts of Africa in which an enlightened administrative policy has been followed, particularly in West Africa, there are many thousands of native Africans who have never left their own land who have come most capably abreast of the novel Western culture with which they have been confronted. In India, after two centuries of British rule, a great number of Indians have made British culture a part of their own.

The example of the Jews, who constitute not an ethnic group but a cultural isolate wherever they are found, is well known. The Jews carry certain kinds of historically conditioned cultural traits with them wherever they go. These are often stated to be biologically determined, but that this is false is proven by the fact that when Jews completely adopt the culture of the land in which they happen to live they frequently become completely indistinguishable from the non-Jewish population of that land. Such "Jews," of course, pass unnoticed, but those who retain Jewish cultural traits are easily recognized, *principally by virtue of their retention of certain cultural traits which have no connection whatever with biological factors.*

The American Negro is another case in point. So far as he has been permitted he has acquired the cultural traits of the white populations among which he lives, while the white populations have acquired some of his traits. This is not due to a physical intermixture but to a cultural intermixture. If the physical intermixture were responsible then we should observe a blending of Negro and white cultural traits, but we observe nothing of the sort. The original cultures of the African Negro ancestors of the American Negro survive in Africa but have been to a large extent lost among many Negro groups in America, having been practically completely eroded by the dominant white culture. This could not have occurred had the genes been responsible for the development of either "soul" or culture.

It may, however, be argued that culturally the American Negro, after being exposed to western culture for some 250 years, is still not culturally indistinguishable from the white. This is, of course, true in precisely the same way that it is true of any social isolate. The American Negro has never been allowed to become socially or culturally indistinguishable from the white. On the other hand, distinctions have been deliberately created and maintained, barriers have been erected across which the Negro has not been permitted to pass; he has been segregated, culturally isolated. Is it any wonder then that he should exhibit certain differences in culture and behavior which distinguish him from the populations from which he is excluded? Having been excluded he has been forced to create a more or less parallel culture, and under conditions of the most difficult kind he has succeeded in doing so. Since the Negroes as a group are hardly ever given the opportunity to realize their potentialities on an equal social footing with whites, it is as unfair as it is unscientific to count the effects of the lack of such social equality against them. Were they given such an opportunity it is more than likely that the Negro average of achievement would turn out to be quite as high as that of the average white.

Another example of interest is provided by the gypsies. In spite of a certain amount of physical and cultural amalgamation with the peoples among whom they have lived the gypsies have, on the whole, successfully resisted complete assimilation. They have retained a substantial part of their original language, and culturally they have remained a foreign element in the midst of every population in which they have lived. This is obviously not because their genes have prevented them from adopting the cultural manners of their hosts, for many of them have made the change, but because they have consciously preferred to retain their own spiritual and cultural integrity.

"Changes in personality without change in heredity," writes Boas, "may be observed in the history of many peoples. The impoverished Indian who has become a laborer is the descendant of his daring, warlike ancestors. The terrorized Germans of our time are in part the same individuals, in part the direct descendants, of the fine citizens of twenty years ago; the Europeanized Japanese of our time are by heredity the same as their ancestors who closed the door to all foreign influence."

Thus, at every point we see that individuals and groups will or will not undergo spiritual or cultural change not for any genetic reasons but for purely cultural ones, without themselves necessarily undergoing any genetic change.

The racist assertion of the biological inheritance of spiritual and mental qualities peculiar to each "race" is, therefore, negated by the facts of science.

Relationship of Body, Mind, and Behavior. The material structures which are ultimately to subserve mental functions are to a large extent inherited precisely as are all other structures of the body. This assumption is supported by at least some sporadic investigations of the brains of near relatives, in addition to certain observational considerations of a like nature. The qualification "to a large extent" is a very necessary one since, in man, the nervous system continues to undergo structural differentiation and development long after birth, and is therefore appreciably influenced by the post-natal experience of the individual. In every part of the nervous system new connections can always be established through education. As a leading neuro-anatomist, S. W. Ranson, has put it, "The neurons which make up the nervous system of an adult man are therefore arranged in a system the larger outlines of which follow an hereditary pattern, but many of the details of which have been shaped by the experiences of the individual."[3]

It is evident that experience must play a considerable rôle in

---

[3] Ranson, S. W.: *The Anatomy of the Nervous System.* Philadelphia, 1943, p. 41.

the development of the *structure* of the nervous system, hence in the manner in which it functions. It should also be clear that the aspect of the nervous system which we know as *mind*, behavior, is dependent upon the interaction of several factors. These are, primarily, the inherited, *incompletely developed*, structure of the nervous system, and the character of the external developing influences. Coghill's fundamental studies on the development of the nervous system in relation to behavior in the spotted salamander *Amblystoma punctatum* has demonstrated that the conditioning processes of experience are registered in the nervous system in such a way that the neural structures involved acquire functional specificity with reference to the experience. Specificity of function is established by interaction of growth and excitation, that is to say, the excitation fixes upon the growing terminals of neurones its own mode of activation. As Coghill writes when discussing the mammalian cortex, "cortical cells, beginning their function with the beginning of experience, grow as experience progresses till all of the essential behaviour and conditioning processes are registered in them. Every pyramidal cell as a growing unit may be conceived as blending, so to speak, the experience of the individual from the beginning to the end of stimulation and response. . . . As a result of this, although the behaviour at any moment may be dominated by some particular phase of experience, it cannot be utterly disconnected from any part of the whole. Only with the retrogressive changes of senescence or with arrested development in pathological cases does experience cease to register in a progressive manner."[4]

The mind of man, in the sense above indicated, is a social product. It reflects the pattern of the culture in which it is conditioned. The functional specificities thus determined when expressed in behavior can clearly only be expressed according to the pattern of the culture in which they have been organized. The hereditary determinants of the morphological potentialities from which a mind may be organized are what is given. It is the cultural organization of such nervous morphological potentialities that *creates* mind. Genes do not create mind, but they do provide

---

[4] Coghill, G. E.: *Anatomy and the Problem of Behaviour.* New York, Cambridge University Press, 1929, pp. 105-107.

every individual with a somewhat different morphological pattern of cellular tissues; so that if it were possible to keep all other factors constant, differences in behavior, that is in mind, would still serve to distinguish every person. Such differences would express the action of the genetic differential and nothing else. Put in another way what we have been saying is that the genetic potentialities are organized by the socially structured field to which they are exposed.

There is every reason to believe that in any human population the genetically determined nervous structure is at least as variable as any of its other physical characters. But once this has been granted, it must be said that there is equally good reason to believe, and this is the important point, that the observable differences in the behavior between different individuals are to a far larger extent determined by cultural factors than by the total number of biological factors which operate from within the individual. Chief among these biological factors are the functional capacities of the nervous system itself, and it cannot here be too often emphasized that those functional capacities, to the most important extent, are organized by the action, from birth to maturity, of cultural influences. Again, it cannot be too often repeated that all the evidence indicates that it is principally due to this unique plasticity that the species *Homo sapiens* owes most of those qualities which are implied in the words "human being."

The principal fact which all those who are in any way interested in human behavior must continually hold before their minds is that man, alone among the members of the animal kingdom, is a creature influenced more prominently by his cultural history than by his ancestral or individual biological history. In the meaning of this fact lies the uniqueness of man.

Are There Any Mental Differences between the Divisions and Ethnic Groups of Mankind?

It may be that in some different ethnic groups the nervous system differs in some of its hidden or undiscovered characters, but if this is so all attempts to demonstrate such differences have thus far failed. What seems to be quite clear is that if such differences exist then they are of the most insignificant kind. The measurable mental characters of different ethnic groups strongly suggest that so far as the average member of the group is concerned no significant mental differences exist between such groups which may be attributed to the inherited character of the nervous system alone. Furthermore, the mental differences which exist between human groups would appear to be much less than those which are found to exist between individuals of the same group. In the light of our present knowledge, the evidence shows that within the limits of the normal, brain weight, cranial capacity, head size, or the *gross structure* and form of the brain bear no relation whatsoever to the characters of the mind, as between individuals of the same or different ethnic groups. Nor is there any necessary association between certain divisional characters and certain kinds of mentality. Since mental functions are so largely dependent upon experience, upon cultural conditions, it is impossible to make any inferences as to the equivalence or non-equivalence of mental potentialities as between ethnic groups or isolates among whom the cultural conditions are not strictly comparable. In short, no statement concerning the mentality of an individual, an ethnic group or other isolate, is of any value without a specification of the conditions of the environment in which that mentality has developed. No discussion of ethnic mental characters can be countenanced which neglects a full consideration of the associated cultural variables, for it is evident that it is precisely those cultural variables which play the most significant part in producing mental differences between ethnic groups and other isolates.

It is perfectly clear that genetically determined mental differences do exist between individuals of the same and of different ethnic groups, but there is absolutely no evidence that significant mental differences which are determined by the genetic characters of the nervous system exist between any two ethnic groups. It would appear to be chiefly because of differences in cultural experience that individuals and groups differ from one another mentally and culturally, and it is for this reason that, where the cultural experience has appreciably differed, cultural achievement alone is an exceedingly poor measure of the mental value of an individual or of a group.

It is quite probable that in a non-isolated, heterogeneous, hybridizing population, the range of variability in the genetic determination of mental potentialities is greater than it is in a relatively isolated, homogeneous, inbreeding population. This is true of physical characters, and it may be true of mental potentialities, and eventually it may, in part, provide the explanation for the more frequent occurrence of individuals of genius in much mixed groups as compared with relatively less mixed or inbred groups. The average member of both groups would, however, have about the same potential mental range.

Thus far scientific investigation has been unable to demonstrate any ethnic mental differences due to hereditary differences. As Klineberg, one of the leading students of the subject, has put it, "We have the right to say that the results obtained by the use of intelligence tests have not proved the existence of racial and national differences in innate mental capacity; and also that as the social and economic environments of the two ethnic groups become more alike, so do their test scores tend to approximate each other. We have no right to conclude that there are no racial differences in mental ability, since it is conceivable that new techniques may some day be developed which will indicate that such differences do exist. This is unlikely, however, and we may state with some degree of assurance that in all probability the range of inherited capacities in two different ethnic groups is just about identical."[5]

THE EVOLUTION OF THE MENTAL CHARACTERS OF MANKIND

From the standpoint of the student of human evolution man's distinctive mental character is the product of mutation, selection, genetic drift, and hybridization—and something more. A narrow biologism usually stops before reaching the "something more," and treats man as if he were no more than a purely biological entity. He is, however, something more, a great deal more. The specific human features of the evolutionary pattern of man cannot be ignored. Man is a unique product of evolution in that he,

---

[5] KLINEBERG, Otto: Mental testing of racial and national groups, in *Scientific Aspects of the Race Problem.* New York, Longmans, 1941, p. 283-284.

far more than any other creature, has escaped from the bondage of the physical and the biological into the multiform social environment. This remarkable development introduces a third dimension in addition to those of the external and internal environments, a dimension which many biologists, in considering the evolution of man, tend to neglect. The most important setting of human evolution is the human social environment. A biologist approaching the problems of human evolution must never lose sight of the truth stated more than 2,000 years ago by Aristotle: "Man is by nature a political animal."

In the words of Fisher, "For rational systems of evolution, that is, for theories which make at least the most familiar facts intelligible to the reason, we must turn to those that make progressive adaptation the driving force of the process." It is evident that man by means of his reasoning abilities, by becoming a "political animal," has achieved a mastery of the world's varying environments quite unprecedented in the history of organic evolution. The system of genes which has permitted the development of the specifically human mental capacities has thus become the foundation of and the paramount influence in all subsequent evolution of the human stock. An animal becomes adapted to its environment by evolving certain genetically determined physical and behavioral traits; the adaptation of man consists chiefly in developing his inventiveness, a quality to which his physical heredity predisposes him and which his social heredity provides him with the means of realizing. To the degree to which this is so, man is unique. As far as his physical responses to the world are concerned, he is almost wholly emancipated from dependence upon inherited biological dispositions, uniquely improving upon the latter by the process of learning that which his social heredity (culture) makes available to him. Man possesses much more efficient means of achieving immediate or long-term adaptation than any other biological species; namely, through learned responses or novel inventions and improvisations.

In general, two types of biological adaptation in evolution can be distinguished. One is genetic specialization and genetically controlled fixity of traits. The second consists in the ability to respond to a given range of environmental situations by evolving traits favorable in these particular situations; this presupposes genetically controlled plasticity of traits. It is known, for example, that the composition of the blood which is most favorable for life at high altitudes is somewhat different from that which suffices at sea level. A species which ranges from sea level to high altitudes on a mountain range may become differentiated into several altitudinal races, each having a fixed blood composition favored by natural selection at the particular altitude at which it lives; or a genotype may be selected which permits an individual to respond to changes in atmospheric pressure by definite alterations in the composition of the blood. It is well known that heredity determines in its possessor not the presence or absence of certain traits but, rather, the responses of the organisms to its environments. The responses may be more or less rigidly fixed, so that approximately the same traits develop in all environments in which life is possible. On the other hand, the responses may differ in different environments. Fixity or plasticity of a trait is therefore genetically controlled.

Whether the evolutionary adaptation in a given phyletic line will occur chiefly by way of genetically controlled plasticity of traits will depend on circumstances. In the first place, evolutionary changes are compounded of mutational steps, and consequently the kind of change that takes place is always determined by the composition of the store of mutational variability which happens to be available in the species populations. Secondly, fixity or plasticity of traits is controlled by natural selection. Having a trait fixed by heredity and hence appearing in the development of an individual regardless of environmental variations is, in general, of benefit to organisms whose milieu remains uniform and static except for rare and freakish deviations. Conversely, organisms which inhabit changeable environments are benefited by having their traits plastic and modified by each recurrent configuration of environmental agents in a way most favorable for the survival of the carrier of the trait in question.

Comparative anatomy and embryology show that a fairly general trend in organic evolution seems to be from environmental dependence toward fixation of the basic features of the bodily structure and function. The appearance of these structural features in the embryonic development of higher organisms is, in general, more nearly autonomous and independent of the environment than in lower forms. The development becomes "buffered" against environmental and genetic shocks. If, however, the mode of life of a species happens to be such that it is, of necessity, exposed to a wide range of environments, it becomes desirable to vary some structures and functions in accordance with the circumstances that confront an individual or a strain at a given time and place. Genetic structures which permit adaptive plasticity of traits become, then, obviously advantageous for survival and so are fostered by natural selection.

The social environments that human beings have created everywhere are notable not only for their extreme complexity but also for the rapid changes to which immediate adjustment is demanded. Adjustment occurs chiefly in the psychical realm and has little or nothing to do with physical traits. In view of the fact that from the very beginning of human evolution the changes in the human environment have been not only rapid but diverse and manifold, genetic fixation of behavioral traits in man would have been decidedly unfavorable for survival of individuals as well as the species as a whole. Success of the individual in most human societies has depended and continues to depend upon his ability rapidly to evolve behavior patterns which fit him to the kaleidoscope of the conditions he encounters. He is best off if he submits to some, rebels against others, compromises with some, and escapes from still other situations. Individuals who display a relatively greater fixity of response than their fellows suffer under most forms of human society and tend to fall by the way. Suppleness, plasticity, and, most important of all, ability to profit by experience and education are required. No other species is comparable to man in its capacity to acquire new behavior patterns and discard old ones in consequence of training. Considered socially as well as biologically, man's outstanding capacity is his educability. The survival value of this capacity is manifest, and therefore the possibility of its development through natural selection is evident. Natural selection on the human level favors gene complexes which enable their possessors to adjust their behavior to any condition in the light of previous experience. In short, it favors educability.

It should be made clear at this point that the replacement of fixity of behavior by genetically controlled plasticity is not a necessary consequence of all forms of social organization. The quaint attempts to glorify insect societies as examples deserving emulation on the part of man ignore the fact that the behavior of an individual among social insects is remarkable precisely because of the rigidity of its genetic fixation. The perfection of the organized societies of ants, termites, bees, and other insects is indeed wonderful, and the activities of their members may strike an observer very forcibly by their objective purposefulness. This purposefulness is retained, however, only in environments in which the species normally lives. The ability of an ant to adjust its activities to situations not encountered in the normal habitats of its species is very limited. On the other hand, social organizations on the human level are built on the principle that an individual is able to alter his behavior to fit any situation, whether previously experienced or new.

This difference between human and insect societies is, of course, not surprising. Adaptive plasticity of behavior can develop only on the basis of a rather more complex nervous system than is sufficient for adaptive fixity. The genetic differences between human and insect societies furnish a striking illustration of the two types of evolutionary adaptations—those achieved through genetically controlled plasticity of behavioral traits and those attained through genetic specialization and fixation of behavior.

The genetically controlled plasticity of mental traits is, biologically speaking, the most typical and uniquely human characteristic. It is very probable that the survival value of this characteristic in human evolution has been considerable for a long time, as measured in terms of human historical scales. Just when this characteristic first appeared is, of course, conjectural. Here it is of interest to note that the most marked phylogenetic trend in the evolution of man has been the special development of the brain, and that the characteristic human plasticity of mental traits seems to be associated with the exceptionally large brain size. The brain, for example, of the Lower or Middle Pleistocene fossil forms of man was, grossly at least, scarcely distinguishable from that of modern man. The average Neanderthaloid brain was somewhat larger than that of modern man, though slightly different in shape. More important than the evidence derived from brain size is the testimony of cultural development. The Middle Acheulian handiwork of Swanscombe man of several hundred thousand years ago and the beautiful Mousterian cultural artifacts associated with Neanderthal man indicate the existence of minds of a high order of development. The cultural evidence thus suggests that the essentially human organization of the mental capacities emerged quite early in the evolution of man. However that may be, the possession of a gene system which conditions educability rather than behavioral fixity is a common property of all living mankind. In other words, educability is truly a species character of man. This does not mean that the evolutionary process has run its course and that natural selection has introduced no changes in the genetic structure of the human species since the attainment of human status. Nor is there any implication that no genetic variations in mental equipment exist at our time level. On the contrary, it seems likely that with the attainment of human status that that part of man's genetic system which is related to mental potentialities did not cease to be labile and subject to change.

This brings us once more face to face with the old problem whether significant genetic differences in the mental capacities of the various ethnic groups of mankind exist. The physical and, even more, the social environments of men who live in different countries are quite diversified. Therefore, it has often been argued, natural selection would be expected to differentiate the human species into local races differing in psychic traits. Populations of different countries may differ in skin color, head shape, and other somatic characters. Why, then, should they be alike in mental traits?

It will be through investigation rather than speculation that the problem of the possible existence of average differences in mental make-up of human populations of different geographical origins will eventually be settled. Arguments based on analogies are precarious, especially where evolutionary patterns are concerned. If ethnic groups differ in structural traits, it does not necessarily follow that they must also differ in mental ones. Ethnic group differences arise chiefly because of the differential action of natural selection on geographically separated populations. In the case of man, however, the structural and mental traits are quite likely to be influenced by selection in different ways.

We have seen that ethnic differences in traits such as the blood groups may conceivably have been brought about by genetic drift in populations of limited effective size. Other ethnic traits are genetically too complex and too consistently present in populations of some large territories and absent in other territories to be accounted for by genetic drift alone. Differences in skin color, hair form, nose shape, etc., are almost certainly products of natural selection. The lack of reliable knowledge of the adaptive significance of these traits is perhaps the greatest gap in our understanding of the evolutionary biology of man. Nevertheless, it is at least a plausible working hypothesis that these and similar traits have, or at any rate had in the past, differential survival values in the environments of different parts of the world.

By contrast, the survival value of a higher development of mental capacities in man is obvious. Furthermore, natural selection seemingly favors such a development everywhere. In the ordinary course of events in almost all societies those persons are likely to be favored who show wisdom, maturity of judgment, and ability to get along with people—qualities which may assume different forms in different cultures. Those are the qualities of the plastic personality, not a single trait but a general condition, and this is the condition which appears to have been at a premium in practically all human societies.

In human societies conditions have been neither rigid nor stable enough to permit the selective breeding of genetic types adapted to different statuses or forms of social organization. On the other hand, the outstanding fact about human societies is that they do change and do so more or less rapidly. The rate of change was possibly comparatively slow in earlier societies, as the rate of change in present-day non-literate societies may be, when compared to the rate characterizing occidental societies. In any event, rapid changes in behavior are demanded of the person at all levels of social organization even when the society is at its most stable. Life at any level of social development is a pretty complex business, and it is met and handled most efficiently by those who exhibit the greatest capacity for adaptability, plasticity.

It is this very plasticity of his mental traits which confers upon man the unique position which he occupies in the animal kingdom. Its acquisition freed him from the constraint of a limited range of biologically predetermined responses. He became capable of acting in a more or less regulative manner upon his physical environment instead of being largely regulated by it. The processes of natural selection in all climes and at all times have favored genotypes which permit greater and greater educability and plasticity of mental traits under the influence of the uniquely social environments to which man has been continuously exposed.

As Muller has pointed out "racial genetic differences . . . may well be insignificant in comparison with the individual ones, owing to the lack of any substantial difference in the manner of selection of most of these characters in the major part of the past history of the various human races." Whether or not we are reasonably justified in assuming that there has been little if any significant change in man's mental potentialities during the major part of his past history, this does seem to be reasonably clear, namely, that the effect of natural selection in man has probably been to render genotypic differences in mental traits, as between individuals and particularly as between ethnic groups, relatively unimportant compared to their phenotypic plasticity. Instead of having his responses genetically fixed as in other animal species, man is a species that invents its own responses, and it is out of this unique ability to invent, to improvise, his responses that his cultures are born.

Hence, we should expect to find the range of inherited capacities in all human groups "just about identical."

The Isolate Effect in Cultural Differentiation

A question often asked is: Why do the cultures of different ethnic groups frequently differ so considerably from our own? If the members of all ethnic groups are characterized by a range of inherited capacities which are about identical, why have not all ethnic groups arrived at a stage of cultural development which is about identical?

Very briefly, the answer is: Because culture is not a function of inherited capacities alone but of inherited capacities *plus* experience, and that in so far as the experience of ethnic groups has been different in so far will their cultures be different. By experience is meant anything that an individual or group of individuals, has undergone or lived, perceived or sensed. The reason why the cultures of different ethnic groups differ so much from our own is that these groups have been exposed to experiences which differ as considerably from our own as do the cultures in question.

Had the reader and the author of the present volume, with their present genetic backgrounds, been born and brought up among a group of Australian aborigines they would now be, culturally and mentally, Australian aborigines, though physically they would each remain members of their own ethnic group; for experience is determined by the place and culture in which groups and individuals live, and it is for this reason that groups and individuals belonging to different cultures will differ mentally from one another. Our physical structure would not have varied substantially from our parental ethnic type because it was genetically determined by our present parents, but our cultural equipment would have been that of an Australian aboriginal. Why? Because culture, and by culture is to be understood socially transmitted social behavior and all its products, is something one acquires by experience, unlike one's physical characters, which one acquires through the action, for the most part, of inherited genes; and the culture of individuals, as of groups, will differ according to the kind of experience which they have undergone. We have every reason to believe that the culture of different peoples, as of different individuals, is practically entirely a reflection of their past history or experience.

If this is true then it constitutes a very hopeful discovery for mankind, for we have not had much success in controlling the genes, and there is no great prospect that we shall be able to do so very much better in the future, nor can we change those of individuals now alive. But we can change the cultural organization of a group or of an individual, and by this means bring about the changes we desire.

All learned activities are culturally, and not biologically, determined, whether those activities are based upon basic needs or traditional practices. The generalized urges which all human beings in common inherit continue to be present in all human beings in all cultures, but how these urges are permitted to operate, and how they are satisfied, is something which is determined by tradition, and varies not only in different cultures but in different groups within the same culture. For example, one of the fundamental urges which we all inherit is the urge to eat. Now, different human groups, to whom the same foodstuffs may, or may not, be available, not only eat different foods, but prepare them in ways peculiar to themselves, and consume them with or without implements in a variety of different styles, usually for no better reason than that it is the customary practice to do so. The potentiality of speech is genetically determined, but what language we shall speak and how we shall speak it, is determined entirely by what we hear in the culture in which we have been conditioned or culturalized. Human beings everywhere, when they are tired, experience a desire to rest, to sit down or to sleep, but the manner in which they do all these things is culturally determined by the custom of the group in which they live. Many other instances will doubtless occur to the reader's mind. The important point to grasp here is that even our fundamental biological urges are culturally controlled and regulated or culturalized, and their very form and expression, not to mention their satisfaction, molded according to the dictates of tradition.

Different cultures are really the expression of different isolate effects, differences in experience determined by limiting factors such as physical, geographic, and social barriers. Since this is so, the concept of cultural relativity applies here, that is to say, all cultures, and cultural achievements, must be judged in relation to their own cultural history, and definitely not by the arbitrary standard of any single culture such, for example, as our own.

Judged in relation to its own history each culture is seen as the resultant of the responses to the conditions which that history may or may not record. If these conditions have been many and complex in character, then so will the culture be. Culture is essentially a relation which is the product of the interaction of two correlates, the one a plastic, sensitive biological being, the other simply—experience. If we agree that mankind is everywhere plastic, adaptable, and sensitive, then the mental and cultural differences which exist between different groups of mankind can be accounted for on the basis of a difference in experience. And this, when everything is taken into consideration, seems to be a perfectly satisfactory explanation of the mental and cultural differences which exist between the ethnic groups of man.

One or two examples of the isolate effect and of cultural relativity, as it were, in action, may be given here.

Five thousand years ago the ancestors of the present highly cultured peoples of western Europe were primitive food gatherers. The ancestors of the modern Englishman were living in a Stone Age phase of culture but little more advanced than that of the Australian aboriginal. At this time in the East many highly organized cities were flourishing in the alluvial plains of the Tigris, the Euphrates, and the Nile valley. The peoples of Upper and Lower Egypt (Dynasties I-II, c. 3200-2780 B.C.) were members of great civilizations at a time when the Europeans of the West had not yet discovered the use of metal or of the plough. But 5,000 years ago and less the peoples of these great cultures could have looked upon the Europeans as savages comparable to beasts and by nature completely incapable of civilization—and hence, better exterminated lest they pollute the blood of their superiors! Whatever sins the Europeans have since committed, they have at least shown that given a sufficient amount of time and experience they were capable of cultural development not less than that to which the early kingdoms of Egypt attained.

Here we have an example of cultural relativity. If we use time as our framework of reference and say "The Egyptians have had a much longer time than we in which to develop as far as we have culturally—why haven't they?" the answer is that time is not a proper measure to apply to the development of culture or cultural events; it is only a convenient framework from which to observe their development. Cultural changes which, among some peoples, have taken centuries to produce, are among other peoples often produced within a few years. The rate of cultural change is dependent upon a multiplicity of different conditions, but the one indispensable and necessary condition for the production of cultural change is the irritation produced by the stimulus of new experiences. Without the irritation of such new experience cultural change is exceedingly slow. Hence, if new experience is the chief determinant of cultural change, then the yardstick by which we may most efficiently judge cultures is that of the history of the experience which has fallen to the lot of the cultures observed. In other words, to evaluate cultural events properly one must judge them by the measure of experience viewed through the framework of time. We, of the Western world, have packed more varieties of experience into the past two thousand years than has probably fallen to the lot of the Australian aborigines, and other peoples, throughout their entire history. Hence, any judgments of value we may attempt to make as between our own culture and that of other peoples will be quite invalid unless those judgments are made in terms of experience.

If, then, the essential physical differences between the ethnic groups of mankind are largely limited to adaptive characters such as skin color, hair form, and nose form, while the cultural and mental differences are due principally to differences in experience, then from the socio-biological standpoint all the ethnic groups of mankind must be adjudged as, at least, potentially more or less equal.

All normal human beings are everywhere born as culturally indifferent animals, and they become culturally differentiated according to the social group into which they happen to be born. Some of the culturally differentiating media are neither as complex nor as advanced as others; the individuals developed within them will be culturally the products of their cultural group. As individuals they can no more be blamed or praised for belonging to their particular cultural group than a fish can either be blamed or praised for belonging to his particular class in the vertebrate series. Culture, the culture of any group, is more or less determined by accidental factors which the group, as a group, has usually done little to bring about. The more advanced cultures have merely been luckier in the breadth and variety of their experience, in their contacts, than the less advanced cultures. By the pure accident of geographical locality, rather than by the amount of time they have had at their disposal, and by the accidents of history, the peoples of Europe have found themselves in the very center of the maelstrom of cultural development. Experiencing the fertilizing effects of the various cross-currents of different seminal cultures to which they have been exposed, the cultures of Western Europe, for example, could hardly have avoided advancing beyond the state of development of many other cultures which have, in comparison, remained relatively isolated from such stimulating effects. Let it be remembered that man is the creature who transmutes accidents into opportunities, but that in order for him to be able to do so he must fall heir to a fair share of accidents.

Much as physical variability is limited and reduced by isolation, so is cultural variability limited and reduced by isolation, while the removal of the isolating barriers produces exactly the opposite effect.

FOR FURTHER READING, CONSULT:

Benedict, R.: *Race: Science and Politics.* New York, Viking, 1943.

A valuable analysis of racism.

Boas, F.: *The Mind of Primitive Man.* New York, Macmillan, 1938.

A book which covers almost the whole field of anthropology in brief compass, stimulating, sound, and indispensable.

———: Racial purity. *Asia, 40:*231-234, 1940.

Possibly the best demolition of the idea of "racial purity" ever written.

———: *Race, Language and Culture.* New York, Macmillan, 1940.

Containing most of Boas's fundamental papers. A treasure-house of unequalled value.

———, *Race and Democratic Society.* New York, Augustin, 1945.

An important selection of Boas's papers on race.

Kluckhohn, C. and Kelly, W. H.: The Concept of Culture, in (R. Linton, editor) *The Science of Man in the World Crisis,* New York, Columbia Univ. Press, 1945, p. 78-106.

An extremely clear and informative discussion of the concept of culture in its various meanings.

Turner, R.: *The Great Cultural Traditions.* 2 vols., New York, McGraw-Hill, 1941.

Two volumes which mark a new departure in the writing of ancient history, tracing the development of culture and civilization in a manner at once both learned and readable.

LINTON, R.: *The Cultural Background of Personality.* New York, 1945.

A brilliant work.

WALLIS, W. D., *Culture and Progress.* New York, Whittlesey House, 1930.

A valuable examination of the nature of culture and culture change, and the criteria of progress.

WHITE, L. A.: *The Science of Culture.* New York, Farrar, Straus & Co., 1949.

An original and provocative study of the concepts of culture.

Chapter VIII

HEREDITY AND THE INFLUENCE OF THE ENVIRONMENT UPON MAN

THUS far we have considered mankind in various groups and as a whole, in the present chapter we shall consider man as a person, and we shall seek to determine what relation exists between heredity and environment in determining his physical development. We have already discussed this relation with respect to the mental and cultural development of mankind.

THE TWIN METHOD OF STUDYING THE EFFECTS OF HEREDITY AND ENVIRONMENT

Twins have been used as a favorable means of investigating the relative effects of environment and of heredity upon the physical and mental development of the individual. It was Francis Galton who first pointed out the value of this method. "Twins" he wrote "have a special claim upon our attention; it is that their history affords a means of distinguishing between the effects of tendencies received at birth and of those that were imposed by the special circumstances of their after-lives."[1]

It was Galton, in fact, who first committed the error into which most students of twins have since regularly fallen, namely, the error of assuming that all likenesses exhibited by twins are genetically determined, while most of the differences which they exhibit are environmental in origin.

With respect to monozygotic twins, i.e., "identical twins," originating from the same ovum, there can be not the slightest doubt that the physical likenesses are due to a fundamental genetic likeness, and there can also be little doubt that many of the mental likenesses are due to the same cause. There can, however, be equally little doubt that many of the mental likenesses, as well as the differences, are due to environmental factors.

The cliché "identical twins" used as a synonym for monozygotic

---

[1] Francis Galton, *Inquiries Into Human Faculty and its Development*, London, 1883.

twins is an unsatisfactory one for the reason that monozygotic twins are rarely, if ever, identical. Prenatal differences in blood supply, position, pressure, etc., generally produce effects which in many ways serve to produce a differential effect upon each twin. As Newman, Freeman, and Holzinger write, "General biological facts suggest that . . . prenatal conditions produce differences of significant magnitude in the personal characteristics of identical twins and possibly, therefore, in the organic substrate of mental abilities and personality. For example, identical-twin embryos differ more in size than do fraternal-twin embryos, and identical twins differ as much as fraternal twins, i.e., dizygotic twins, derived from separate ova at birth. The prenatal mortality rate of identical twins is several times as high as that of fraternal twins, and very frequently one member of an identical-twin pair dies before birth, showing symptoms of injury from lack of nutrition. There is an exchange of blood supply between identical-twin fetuses which frequently produces an imbalance in blood exchange to the disadvantage of one twin. Conjoined twins (Siamese twins) show marked differences in height, weight, features, and intelligence. The differences between completely separated identical twins may have the same origin as these differences. These considerations predispose the biologist to attribute to prenatal factors the predominant share in the causation of differences between identical twins reared together."

From fertilization on, small changes may occur in the egg which will affect the development of various characters. The inner environment because of random variation may have different effects in different parts of the embryo. Indeed, as Dahlberg has pointed out, small purely accidental variations in the environment of the egg and in the embryo can have a decisive effect. The characteristics of a fully grown individual can therefore be said to depend not only on inheritance and environment, but also on pure chance.

Thus, it is seen that during prenatal development environmental factors are already producing different effects upon originally genetically identical organisms. It is therefore an error to assume that at birth monozygotic twins are "identical." The effects of prenatal environmental factors upon the operation of the genetic system in organizing indifferent tissue may be, and probably often is, considerable. Such differences not only express themselves in physical characteristics, but may also be expressed, as Newman and his co-workers suggest, in the organic substrate of mental abilities and personality. While some of the physical and mental differences between identical twins probably arise in this manner, there is reason to doubt the soundness of attributing "to prenatal factors the dominant share in the causation of differences between identical twins, reared together." Such a view betrays an extreme biologistic bias.

We may accept the important rôle played by prenatal factors in producing differences between monozygotic twins reared either apart or together, but it should be quite obvious that when we find that monozygotic twins reared apart exhibit greater differences than those reared together, the greater difference is most probably due to the difference in environment. This is abundantly proven by the findings of Newman, Freeman, and Holzinger, to the effect that "educational and social changes in environment are effective in producing variations in such traits as intelligence and school achievement. Some slight change is also suggested in the case of temperament. Variations in physical environment are responsible for changes in weight and, again, to some extent in temperament." They add, "The analysis indicates that the rôle of heredity and environment in producing twin differences is a function of the type of environment. . . . From the viewpoint of the educator it is important to note that extreme differences in educational and social environment are accompanied by significant changes in intelligence and educational achievement as measured by our tests."

The organism, which is always the solution of the heredity-environment equation, will vary as the terms of this equation vary. Where one of the terms, heredity, is relatively constant, as in monozygotic twins, while the other term, environment, is variable, the differences in the result of the equation must for the most part be attributed to the environmental factors, prenatal and postnatal.

Stated very simply, the individual is the expression of five interacting and interdependent fundamental factors: (1) a system of genetic relations, (2) a system of developmental relationships determined by the uterine environment, (3) family environment,

(4) general socio-economic environment, and (5) general physical environment. If, as is necessary, one is to evaluate the relative importance of these factors it can be laid down as a general principle that the environmental factors produce the most important effects upon the mentality of the organism. Whatever the action of the environmental factors may be the organism will always develop, in general, according to the basic "pattern" determined by the genetic system. But that basic structure can be taken very much for granted; what is important—and vastly more important—is the regulation and filling-in of the details of that "pattern." This is where the environmental factors play their important rôle. It may not be possible to make a silk purse out of a sow's ear, but by sufficiently depressing the quality of the environmental factors it is possible to make a sow's ear out of materials which, under the proper conditions, could have been woven into a silk purse.

The most recent investigation on the mentality of monozygotic twins has thus far been limited to a study of temperament. In this investigation Cattell and Molteno found that in the factors of temperament tested, such as fluency of association, perseveration, and surgency (quickness, cleverness, wit), environment played a more important part than heredity. For fluency of association and, they presume, surgency, "environment is about eight times as efficacious as heredity in the production of the mean differences between children of the same family and five times as important in accounting for variance within the family."

These conclusions are of the first importance because hitherto even the most extreme environmentalists were ready to admit that temperament was for the most part germinally determined. One may still believe that this is so, but in the light of recent psychodynamic studies an important modification in this belief must be made, namely, that environment plays a much more important part in determining temperament than has hitherto been supposed.

Monozygotic twins are in every respect more alike than are any other kinds of siblings, and it must be assumed that in the organic substrates of mind they are similarly more alike. Evidence in support of this is, in fact, to be found in the studies of the brain waves taken with the electroencephalograph on twins; in identical twins these waves follow an almost identical course. Nevertheless, whether they are reared together or apart, monozygotic twins are always characterized by mental differences of varying magnitudes, and these differences, recent researches indicate, are to a large extent to be attributed to environmental factors. As Newman and co-workers conclude, "We feel in sympathy with Professor H. S. Jenning's dictum that what heredity can do environment can also do."

Tests on identical twins reared apart from each other indicate that country life has a less stimulating effect upon intellectual development than urban life, the urban reared twin being invariably ahead in this respect of his rural bred twin. Such studies demonstrate that educational advantages have a marked effect on the qualities of intelligence which it is possible to measure. Such findings by no means underestimate the importance of heredity. They succeed rather in clarifying the important rôle which it plays, and at the same time bring out and emphasize the significance of appreciable differences in the environment for the development of the individual's innate potentialities. As Woodworth has recently pointed out, "When individuals of identical heredity are subjected to environments differing about as much as those of the children in an ordinary community, such identical twins differ much less than the children of such a community. Therefore the differences found among the children of an ordinary community are not accounted for, except in small measure, by differences in homes and schooling."

In other words, heredity would appear to play a considerable part in determining the individual's response to his environment. We arrive then, at the conclusion that *environment provides the opportunities for the development of innate potentialities which are limited by heredity.* For all practical purposes, however, it may be said that the limits of heredity can only be reached in an environment which is itself unlimited, in the sense of affording unrestricted opportunities for development to the individual. This, in fact, has rarely occurred. As Thorndike put it many years ago, "To the real work of man for man,—the increase of achievement through improvement of the environment,—the influence of heredity offers no barrier."

The study of "foster children" again serves to emphasize the importance of the rôle played by environment in shaping the intelligence, personality, and social qualities of the subject. The limiting factors of heredity are clearly brought out in these studies, but at the same time it is demonstrated that the environment is, all things considered, the most important factor in the development of the (limited) hereditary powers.

CRIMINALITY IN TWINS

If heredity has anything whatever to do with behavior, one-egg twins should be very much alike in behavior, at least significantly more so than two-egg twins. Several investigators have recently occupied themselves with the study of the concordance of criminal behavior in one-egg twins as compared with two-egg twins. When both members of a twin pair were found to be similar with respect to the commission of one or more crimes, they were termed "concordant"; when dissimilar, that is, when one was found to have committed a crime and the other not, they were termed "discordant." In Table 20 are summarized the findings of one American and four European investigators on such adult twins.

TABLE 20. CRIMINAL BEHAVIOR OF TWINS

Author	One-Egg Twins		Two-Egg Twins	
	Concordant	Discordant	Concordant	Discordant
Lange (1929)	10	3	2	15
Legras (1932)	4	0	0	5
Kranz (1936)	20	12	23	20
Stumpfl (1936)	11	7	7	12
Rosanoff (1934)	25	12	5	23
Total	70	34	37	75
Per Cent	67.3	32.7	33.0	67.0

From this table it will be seen that of 104 pairs of one-egg twins examined, 70 were concordant and 34 were discordant. The concordant were almost exactly twice as numerous as the discordant pairs. On the other hand, the two-egg twins showed a discordance almost exactly twice as great as the concordance shown in this group of 112 pairs. These are impressive figures, but what do they mean? Newman, the latest writer on this subject, and our leading authority on twinning, believes that these figures prove "beyond question that hereditary factors bulk large among the causes of criminal behavior." This is the opinion of all the investigators mentioned, but in reality such studies do not prove, but only suggest, a connection between hereditary factors and criminal behavior. The following comment by Newman, who has perhaps observed more twins than anyone else living, is to the point here, he writes:

"The only serious criticism I have known to be aimed at the twin method of studying the factors of crime is that one-egg twins far more than two-egg twins are close companions in their social activities and are therefore more likely to encounter together such social influences as might lead to criminal behavior. This is one more instance of lack of control features in nature's scientific experiments, for it can hardly be maintained that the social environment of two-egg pairs is as closely similar as that of one-egg pairs. Therefore, environmental similarities may to some extent account for the close concordance in crime of one-egg twins, while lack of any such similarity in environment may to an equal extent account for lack of concordance in crime of two-egg twins. Undoubtedly the study of crime by means of the twin method is less simple than it seemed at the outset."

This is, of course, the crucial point. The factor of environment has been virtually completely omitted from these studies of criminal behavior in twins. Hence, the attribution of the behavior of such twins to hereditary factors may possibly be written off as yet another illustration of the fallacy of *false cause.*

Since heredity is supposed to play no significant rôle in the case of the two-egg twins, if the hereditary theory is to be consistent, the proportion of two-egg twins who are both affected should be lower than the proportion of one-egg twins where only one is affected; for one would expect the hereditary factor to be so much stronger in the one-egg twins. The actual proportions, however, are almost identical, being 33.0 per cent for two-egg concordance, and 32.7 per cent for one-egg discordance. Furthermore, as Reckless has pointed out, "If biological determination of destiny is correct, a discordant monozygotic one-egg twin set should be impossible, whereas discordant dizygotic two-egg sets should be frequent." The actual findings, however, reveal that one-third of the one-egg pairs of twins investigated were discordant. Why did not the hereditary factor for crime declare itself in the other one of the pairs of this one-third of single-egg twins? If the answer is that an environmental factor was probably operative in these cases, a factor which was absent in the case of the criminal sibling, then the theory of the hereditary cause of crime collapses beyond repair; for it then becomes obvious that it was the absence of such environmental factors, or the presence of others, that was the one indispensable condition in the causation of the criminal behavior!

It appears then, that just as it takes environmental conditions to activate, to organize, and to produce a mind so, too, does it take environmental conditions to organize the hereditarily determined elements of the nervous system to develop and function, or not, in ways which society terms "criminal." There is not the slightest evidence which would lead one to believe that anyone ever inherits a tendency to commit criminal acts. On the other hand, the evidence points overwhelmingly to the fact that criminal acts, and crime as a whole, are largely determined by social conditions, and not by biological ones.

Suicide is, in all occidental societies, regarded as a crime, *felo de se* or self-murder. If the tendency to commit criminal acts is in any way inborn then this crime should occasionally occur in identical twins. A recent investigation by Kallman and Anastasio demonstrates, on the contrary, "that except for rare suicide pacts self-destruction does not seem to occur in both members of twin pairs, even if the twins are alike in type of personality, cultural setting, social frustration, and depressive features of a psychosis." Clearly the discordance of suicide in monozygotic twins is evidence of the preponderant influence of environmental rather than genetic factors in producing self-destruction.

CONSTITUTION AND CRIME

Professor E. A. Hooton has recently investigated the relation between crime and the physical characters exhibited by the individual. Hooton's findings lead him to assert that "whatever the crime may be, it ordinarily arises from a deteriorated organism. . . . You may say that this is tantamount to a declaration that the primary cause of crime is biological inferiority—and that is exactly what I mean."

This, it will be recalled, was the view of the Italian school of criminologists led by Cesare Lombroso. The errors committed by this school, and by the students of criminality in twins already discussed, have been committed by Hooton. Hooton's first report is based on the examination of 4,212 native white Old American prisoners, and 313 native white civilians. Unlike Lombroso, Hooton did not set out with any preconceived notions concerning the nature of physical marks of inferiority, but was content to allow the greater frequency with which certain physical characters occurred in his criminal series as compared with his civilian series to indicate these. Thus, he writes, "if we find felons to manifest physical differences from civilians, we are justified in adjudging as undesirable biological characters those which are associated in the organism with anti-social behavior. . . . It is the organic complex which must be estimated inferior or superior on the basis of the type of behavior emanating from such a combination of parts functioning as a unit."

An analysis of the characters studied by Hooton in the light of the biological standards of what are generally accepted to be "advanced," "indifferent," and "primitive," human characters, yields interesting results. By such standards we find that Hooton's criminal series show, for the combined anthropometric, indicial, and morphological characters, only 4 per cent of primitive, 15.8 per cent of indifferent, and the astonishing amount of 49.5 per cent of *advanced* characters, more frequently than the non-criminal sample.

By biological standards Hooton's criminal series would, on the whole, appear to be superior to his non-criminal series! Whatever such a finding may mean, the fact is that Hooton did not draw his criminal and non-criminal series from the same local, social, economic, and occupational levels of the population, and furthermore, almost half his check sample was drawn from 146 Nashville firemen; in an occupation for which, Hooton observes, "the physical qualifications are rather stringent."

In order to make any biological test of differential behavior, it is necessary that both the criminal series and the check non-criminal series be in every respect similar except in the one condition of behavior. The two series must be drawn from the same population or populations, from the same areas, and must come from the same social, economic, and occupational levels. When these requirements have been satisfied, and a significantly higher frequency of certain physical characters is found among the criminals than among the non-criminals, it may be legitimately inferred that there is some significant *association* between criminal behavior and the presence of a high frequency of such characters in an individual or in a group. But to infer from this that such characters reflect the cause of criminal behavior is to misunderstand the nature of causation.

In his investigation Hooton did not satisfy the requirement of equating the conditions of his two groups in all but those in which they were being compared, and he did fall into the error of taking a statistical association to be a cause.

Crime is the resultant of a complex of factors which there is very good reason to believe has but little, if any, relation to genetic or constitutional factors, and every relation to social ones. It is certain kinds of social organization which make for the production of criminals, not certain kinds of genes. The genetic potentialities of all persons under certain social conditions are capable of being made to function in a criminal manner. Just as genes do not cause a majority of Chinese in the United States to become laundrymen, so genes do not cause certain individuals to become criminals, in both cases it is a special pattern of socio-economic conditions which must be regarded as the principal causative factor.

Constitution. The subject of human constitution has been of interest to men from the earliest times, and most people still tend to see in the physical appearance of the individual clues to his functional character. That there exists some relationship between the body habitus of an individual and his functional character there can be little doubt, and in the last quarter of a century a considerable amount of work has been done which is calculated to throw some light upon the nature of this relationship.

Constitution may be defined as the sum total of the structural, functional and psychologic characters of the individual. It is in large part determined by heredity but influenced in varying degrees by environmental factors. It fluctuates in varying degrees over a wide range of normality and occasionally crosses an arbitrary boundary into abnormality or pathology.

The problem in studying constitution is to analyze and define the relations of its component parts in the individual, and its ultimate goal is the development of a constitutional typology which will allow, on the basis of certain measurements, the classification of individuals into constitutional types. This is obviously an extremely difficult problem, and although much work has been done in this field, the study of constitution is still in its very early beginnings, while the relationships it seeks to discover and elucidate are still largely in the realm of unsolved problems.

In 1921 the German psychiatrist, Ernst Kretschmer, described three morphologic constitutional types, the *pyknic, athletic,* and *asthenic,* and discussed the relation of normal and abnormal types of mind to each of them. He found that manic-depressive psychoses were predominantly associated with the pyknic habitus (stocky, well-padded, compact), while the asthenic habitus (tall, lean) was predominantly associated with schizophrenia. In general the relation has not been confirmed by independent investigators, but the Kretschmerian method of typing is scarcely refined enough since it deals in rather extreme types. The principal fault with most constitutional typologies has been that they have approached the individual as if he were constituted of one piece. Desiring to give a description of the organism as a whole, students of constitution have erroneously assumed that the organism should be measured as a whole. This is a pre-Mendelian method of observing morphologic facts. Human structure is not transmitted as a single morphologic block but as a large variety of distinct units or components in interrelation. Interrelation of these distinct components together forms the complex whole, the morphologic habitus. Because these components are the expression of the modified action of different groups of genes on different autosomes, their varieties and combinations in forming a morphologic whole are practically unlimited. Hence, any attempt to describe morpho-

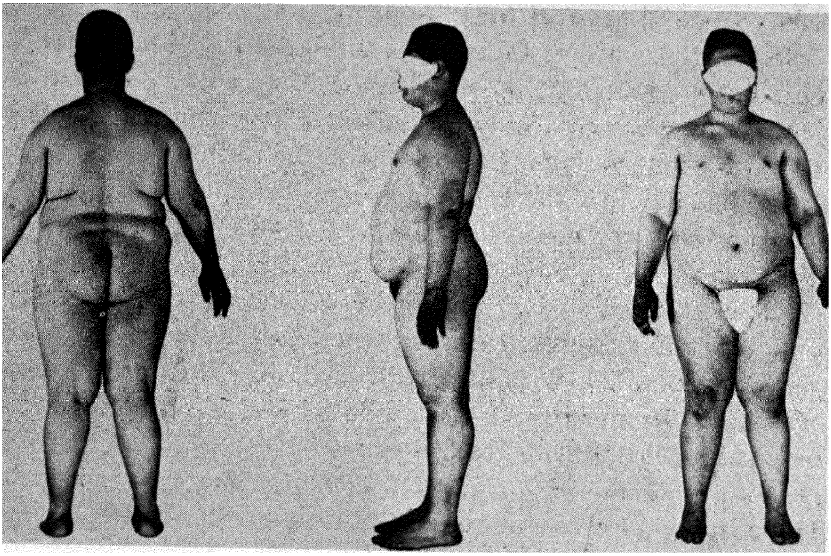


FIG. 137. Somatotype 7-4-1. Mesomorphic endomorph. (Photo, Dr. W. H. Sheldon.)

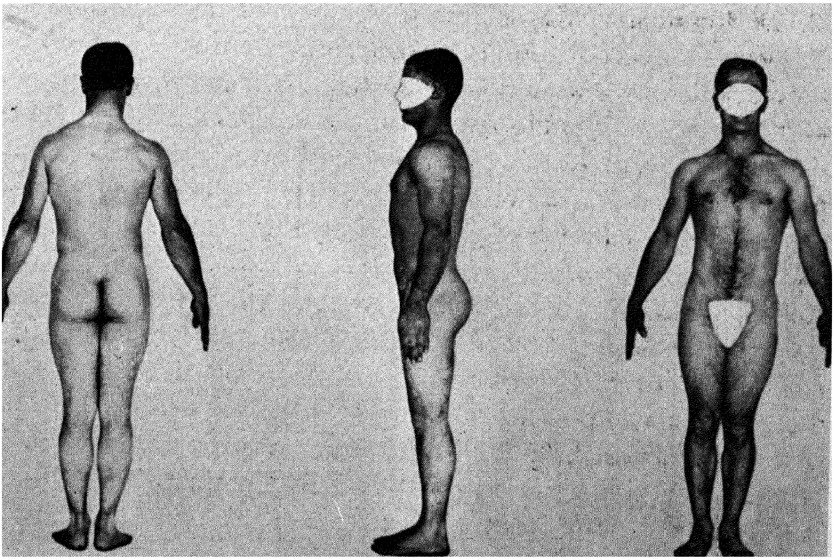


FIG. 138. Somatotype 3-7-1. Endomorphic mesomorph. (Photo, Dr. W. H. Sheldon.)

logic types on the basis of the gross description of the organism as a whole is foredoomed to failure. Certainly the individual must be studied as a whole, but the description of that whole can satisfy scientific requirements only when the component parts which enter into its formation are analyzed and their interrelations properly understood. In these terms the problem of constitutional typology was approached first by W. H. Sheldon and his co-workers.

Following much analysis and sifting Sheldon selected three extreme types of physique; each major or dominant aspect of these types was regarded as something which, in different amounts, enters into the making of every normal body. These types are described as *components,* as follows:

1. *The endomorphic or first component,* characterized by relative predominance of soft roundness throughout various regions of the body. When endomorphy is dominant digestive viscera are massive and tend, relatively, to dominate the body economy. The digestive viscera are principally derived from the *endoderm.* The extreme of this type corresponds to Kretschmer's *pyknic* type.

2. *The mesomorphic or second component,* characterized by relative predominance of muscle, bone, and connective tissue. The mesomorphic physique is normally heavy, hard and rectangular in outline. Bone and muscle are predominant, and the skin is made thick by heavy underlying connective tissue. The entire body economy is dominated, relatively, by tissues derived from the *mesoderm.* The extreme of this type corresponds to Kretschmer's *athletic* type.

3. *The ectomorphic or third component,* characterized by relative predominance of linearity. In proportion to his mass, the ectomorph has the greatest surface area and hence relatively the greatest sensory exposure to the outside world. Relative to his mass, he also has the largest brain and central nervous system. In a sense, therefore, his body economy is relatively dominated by tissues derived from the *ectoderm.* The extreme of this type corresponds to Kretschmer's *asthenic* type.

Sheldon showed that these three morphologic components exist to some degree in every individual, on a sliding scale from very high to very low, and he rates them from 1 for very low to 7 for

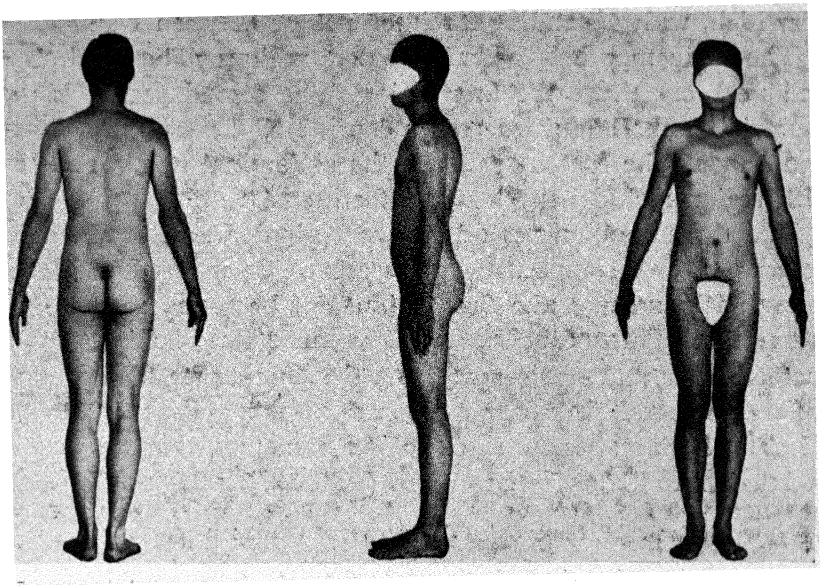


Fig. 139. Somatotype 4-3½-4. Balanced. (Photo, Dr. W. H. Sheldon.)

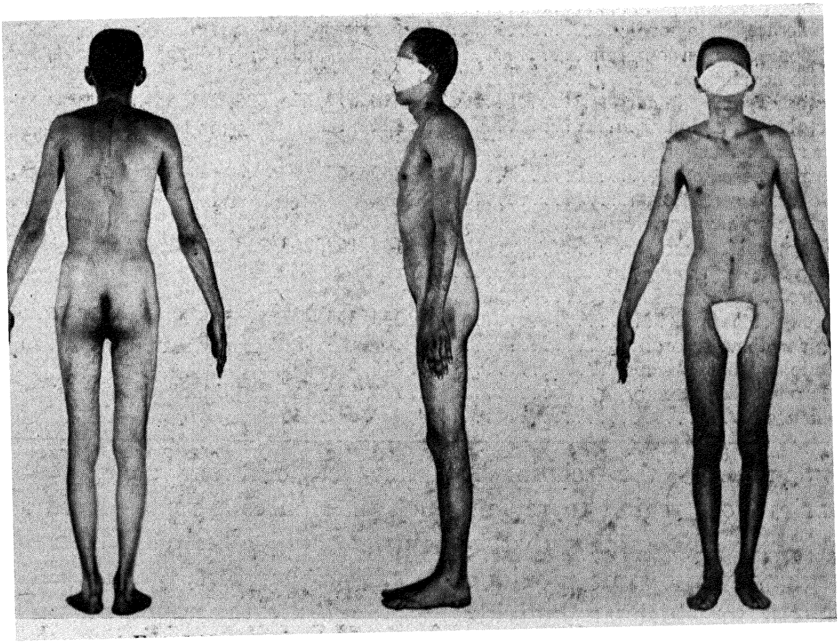


Fig. 140. Somatotype 1½-1½-6½. Strong ectomorph. (Photo, Dr. W. H. Sheldon.)

very high, with 4 standing for intermediate between 1 and 7.

The body may be divided into five regions. The head, face and neck constitute the first region. The second region is the thoracic trunk. The third region consists of the arms, shoulders and hands. The fourth region is the abdominal trunk, and the fifth region includes the legs and feet.

The three components of all five regions are determined by inspection, and component values are assigned on the scale of 1 to 7; for example, the first region may be found to be a 523 somatotype. This means that it is 5 points endomorphic, 2 points mesomorphic, and 3 points ectomorphic. Another region may show different values for the degree of representation of the components. Thus far Sheldon has described 76 basic somatotypes and has classified them into 19 descriptive groups (Table 21).

TABLE 21. SHELDON'S CLASSIFICATION AND SOMATOTYPES

Descriptive Classification	Somatotypes Included
Extreme endomorph	711
Strong Endomorph	622, 522, 533
Moderate Endomorph	433
Mesomorphic endomorph	721, 731, 641, 631, 621, 632, 543, 542, 541, 532
Mesomorph-endomorph	551, 442
Ectomorphic endomorph	712, 613, 612, 623, 523, 524, 534, 514
Ectomorph-endomorph	515, 424
Extreme mesomorph	171
Strong mesomorph	262, 252, 353
Moderate mesomorph	343
Endomorphic mesomorph	271, 371, 461, 361, 261, 362, 352, 453, 452, 451
Ectomorphic mesomorph	172, 163, 162, 263, 253, 154, 254, 354
Ectomorph-mesomorph	244
Extreme ectomorph	117
Strong ectomorph	226, 225, 335
Moderate ectomorph	334
Endomorphic ectomorph	217, 216, 316, 326, 325, 415, 425, 435
Mesomorphic ectomorph	127, 126, 136, 236, 235, 145, 345, 345
Balanced	444, 434, 344, 443

Sometimes the relationships between different components varies from region to region. Such differences are considered as evidence of dysplasia, that is, as disharmonies between different regions of the same physique. Dysplasia, therefore, measures the extent to which an individual falls outside the range of types described by this system. Dysplasias within a region have not yet been studied.

Another contribution of Sheldon and his co-workers is the use of standardized photographs so that individuals observed at different times or places can be directly compared (see pp. 461-462).

When the somatotyping has been completed, the morphologic habitus of the individual has been determined, and the investigation may proceed on the relation of the somatotype to susceptibility or immunity to disease, etc. Development of this method is so recent that studies of this kind are still very few in number.

Physique and Temperament. Quantitative studies have again and again demonstrated that the relationships between physical traits and temperament which are popularly believed to exist do not, in fact, exist. Blondes and brunettes are not temperamentally distinguishable, height, weight, length or breadth, shape of skull, cranial capacity, skin color, or any other physical trait has never been shown to have any connection with temperament or intellect. It would seem that the genetic determinants of temperament are quite independently inherited of those which determine the traits of the body. This is not to say that the possession of certain physical traits may not *socially* condition the behavior of the person. Being a person of color in the United States or the Union of South Africa is an obvious association having marked effects upon behavior in such persons. In societies in which physical beauty is highly valued the homely person is likely to exhibit certain behavioral traits which are the effects of frustration and insecurity. Psychosomatic medicine has revealed the profound effects which the psyche may have upon somatic processes and *vice versa,* and that, indeed, the psyche and the soma are but different aspects of the functioning of the same thing, the organism as a whole. Let any part of the organism be affected and the whole is more or less affected, and at the same time the whole organism affects the part. Genetic, physiological, psychological, and environmental factors of various sorts, enter into the total pattern, and the rôle which each plays must be carefully assessed in considering the status of the organism at any one time. Temperament is a labile system of potentialities which is markedly affected by environmental conditions, and while it is possible to classify temperaments, it is another thing to understand the nature of their determinants.

In their work on *The Varieties of Human Temperament* Sheldon and Stevens have attempted an analysis of the relation be-

TABLE 22. THE SCALE FOR TEMPERAMENT

Name.................... Date........ Photo No.......... Scored by......

I	II	III
VISCEROTONIA. . . .	SOMATOTONIA. . . .	CEREBROTONIA. . . .
( ) 1. Relaxation in Posture and Movement	( ) 1. Assertiveness of Posture and Movement	( ) 1. Restraint in Posture and Movement, Tightness
( ) 2. Love of Physical Comfort	( ) 2. Love of Physical Adventure	— 2. Physiological Overresponse
( ) 3. Slow Reaction	( ) 3. The Energetic Characteristic	( ) 3. Overly Fast Reactions
— 4. Love of Eating	( ) 4. Need of Enjoyment of Exercise	( ) 4. Love of Privacy
— 5. Socialization of Eating	— 5. Love of Dominating, Lust for Power	( ) 5. Mental Overintensity, Hyperattentionality, Apprehensiveness
— 6. Pleasure in Digestion	( ) 6. Love of Risk and Chance	( ) 6. Secretiveness of Feeling, Emotional Restraint
( ) 7. Love of Polite Ceremony	( ) 7. Bold Directness of Manner	( ) 7. Self-conscious Motility of the Eyes and Face
( ) 8. Sociophilia	( ) 8. Physical Courage for Combat	( ) 8. Sociophobia
— 9. Indiscriminate Amiability	( ) 9. Competitive Aggressiveness	( ) 9. Inhibited Social Address
— 10. Greed for Affection and Approval	— 10. Psychological Callousness	— 10. Resistance to Habit, and Poor Routinizing
— 11. Orientation of People	— 11. Claustrophobia	— 11. Agoraphobia
( ) 12. Evenness of Emotional Flow	— 12. Ruthlessness, Freedom from Squeamishness	— 12. Unpredictability of Attitude
( ) 13. Tolerance	( ) 13. The Unrestrained Voice	( ) 13. Vocal Restraint, and General Restraint of Noise
( ) 14. Complacency	— 14. Spartan Indifference to Pain	— 14. Hypersensitivity to Pain
— 15. Deep Sleep	— 15. General Noisiness	— 15. Poor Sleep Habits, Chronic Fatigue
( ) 16. The Untempered Characteristic	( ) 16. Overmaturity of Appearance	( ) 16. Youthful Intentness of Manner and Appearance
( ) 17. Smooth, Communication of Feeling, Extraversion of Viscerotonia	— 17. Horizontal Mental Cleavage, Extraversion of Somatotonia	— 17. Vertical Mental Cleavage, Introversion
— 18. Relaxation and Sociophilia under Alcohol	— 18. Assertiveness and Aggression under Alcohol	— 18. Resistance to Alcohol, and to other Depressant Drugs
— 19. Need of People when Troubled	— 19. Need of Action when Troubled	— 19. Need of Solitude when Troubled
— 20. Orientation toward Childhood and Family Relationships	— 20. Orientation toward Goals and Activities of Youth	— 20. Orientation toward the Later Periods of Life

NOTE: The thirty traits with parentheses constitute collectively the short form of the scale.

tween physique and temperament. These authors found that temperament could be defined in terms of a total of 60 traits, in three correlated clusters of 20 traits each. These traits in their respective clusters or components are listed in the scoring sheet for the scale of temperament (Table 22). The 60 traits collectively make up a scale for measuring what appear to be three primary components of temperament.

Viscerotonia, the first component, in its extreme appearance, is characterized by general relaxation, love of comfort, sociability, conviviality and gluttony for food, people and affection. The viscerotonic extremes are persons who "suck hard at the breast of mother earth" and love physical proximity with others. The motivational organization is said to be dominated by the gut and by the function of anabolism (constructive metabolism). The personality seems to center around the viscera. The digestive tract is king; its welfare defines the primary purpose of life.

Somatotonia, the second component, is roughly characterized by a predominance of muscular activity and of vigorous bodily assertiveness. The motivational organization seems dominated by the soma. These people have vigor and push. The executive department of their internal economy is strongly vested in their somatic muscular systems. Action and power define life's primary purpose.

Cerebrotonia, the third component, is roughly characterized by the predominance of the element of restraint, inhibition, and the desire for concealment. Cerebrotonic people shrink from sociality as from too strong a light. They repress somatic and visceral expression. They are acutely sensitive and react rapidly to external stimuli. They are defective in 'effector' expression, but in 'receptor' activity they greatly exceed both the viscerotonic and the somatotonic. They fear pain and hate noise. They are secretive and apprehensive; love solitude and are shy in society. Imagination is vivid, running ahead of physical performance, which makes them incompetent in speech, in action and in sexual congress. They sleep poorly and are defective in habit formation. Their behavior seems dominated by the inhibitory and attentional functions of the cerebrum, and their motivational hierarchy appears to define an antithesis to both other extremes.

In order to make an analysis of any person in terms of these components, he is observed for at least one year during which a minimum of 20 analytic interviews with him are held. During the interviews an attempt is made to cover the complete history. In scoring, which is repeatedly checked and revised, a seven-point scale is used, having the following approximate interpretations (the parenthetical percentages refer to the approximate frequencies of the respective ratings in a series of about 600 analyses):

(4%) 1. Extreme antithesis of the trait.
(15%) 2. Trait weakly represented, although traces are present.
(29%) 3. Trait distinctly present, but falls a little below the general average.
(29%) 4. Individual falls just below halfway between the two extremes. He is slightly above the general average in the trait.
(15%) 5. Trait strong, although not outstanding.
(6%) 6. Trait very strong and conspicuous, approaching the extreme.
(2%) 7. Extreme manifestation of the trait.

Speaking generally, Sheldon and Stevens found a significant correlation between endomorphy and viscertotonia, mesomorphy and somatotonia, and ectomorphy and cerebrotonia. As would be expected there are, however, many inter- and intra-relationships and subtypes within these groups of a very variable nature, and these form by far the most frequent types.

The extreme viscerotonic will score a 7-1-1, the hypertrophied somatotonic a 1-7-1, and the extreme cerebrotonic a 1-1-7, while the median type will rate a 4-4-4.

As a contribution to constitutional psychology the work of Sheldon and his collaborators is of much interest. It is still in its early beginnings, and the relationships it seeks to discover and elucidate are still largely in the realm of unsolved problems. Somatotyping is the method of constitutional investigation which asks, What can you see that might be related? Its purpose is to discover such relationships as may exist between what one can see and the underlying organization of the organism, to determine the fundamental individuality of the organism in which it departs from the individuality of other organisms. Ideally somatotyping aims at discovering those relationships which would enable one to predict the course through which the organism will travel under given conditions.

Whether any constitutional method can ever be developed which would lead to such results is an open question which future research alone can answer. Meanwhile, a brief account of somatotyping has been given here merely as an example of the latest approach to the study of physique and temperament. Many criticisms have been levelled at this approach. It has been said that there is no evidence that the somatotype is immutable; there is evidence that at the different periods of life, infancy, childhood, adolescence, early manhood, middle age, and old age, the somatotype undergoes change. Bauer has shown that with age the chest becomes more 'lateral' in type, and there is a tendency towards abdominal fat. Lasker has recently reported an increase of 70 or 80 per cent in ectomorphy when somatotyping criteria are arbitrarily applied to a group of men before and after 24 weeks of partial starvation. The superficial soft parts of the body are well known to be highly subject to environmental influences. Nutrition, occupation, exercise, and numerous other environmental factors will make no difference to a man's blood groups or the shape of his nose, but such conditions will, to varying extents, affect the size, proportions, and fatty development of the person. This is a crucial criticism which has yet to be met.

The fact is that the more measurable traits that are included in any attempt to group men together, the more strongly emphasized does the essential individuality of the person become.

Sheldon's definitions of the three temperamental types have been criticised on a variety of scores. If these definitions are to describe average basic responses of the person then it seems scarcely desirable to include such abnormal traits as poor sleep, fear of open spaces, fear of closed spaces, chronic fatigue, timidity, shyness, self-consciousness, and apprehensiveness. But criticisms such as this are not fatal, and can be met by refinements which naturally seem to follow upon the first somewhat crude formulations.

It is important to understand that constitution, body-type, and inheritance are not the same things. Constitution is the aggregate of characters, structural, functional, and mental of the individual, which are in part determined by genes and in part by environment. Obviously, then, constitution embraces both inheritance and body-type. Inheritance is the total genetic endowment with which the individual is born; body-type is one expression of that genetic endowment in interaction with the environment. It should be clear that useful knowledge of the relationship of constitution to temperament and to disease will require the tracking down of alleles, and that body-type short cuts will not suffice.

To conclude, then, thus far all attempts to establish an integral relationship between traits of the body and behavior have failed. The problem, however, is still in its exploratory stage of development. Success, if it is ever achieved, will undoubtedly prove to be so in a statistical sense, that is to say, that some correlations between traits may be found which will allow prediction only within fairly wide limits.

CONSTITUTION AND DISEASE

Much evidence exists which indicates that susceptibility to certain diseases is associated with constitutional factors. But the briefest of surveys of this association can be attempted here. The association is dealt with in several recent volumes fairly exhaustively.

Tuberculosis. Much evidence is now available which points to a high correlation between susceptibility to all forms of tuberculosis and the tall-thin, leptosomic, asthenic or ectomorphic habitus. Petersen has even argued that freedom from tuberculosis depends on natural resistance and not on acquired immunity. The importance of the constitutional factor is well illustrated by the practically identical course which the disease follows in monozygotic twins. It often happens, however, that tuberculosis affects only one of a pair of monozygotic twins. An important fact, since it shows that the constitutional factor is only in part associated with the development of the disease. When only one twin develops the disease the prognosis is good for the affected twin. The affected twin, it is presumed, has succumbed despite a relatively high resistance.

Gastro-Intestinal Disease. Most investigators have found a high correlation between the asthenic habitus and diseases of the gastro-intestinal tract. Diseases of the gall-bladder, however, appear to be closely associated with the thick, stocky build, while the ulcer type is more generally asthenic. Peptic ulcer patients have longer and thinner necks than patients with gall-bladder disease. In persons showing a mixture of feminine and masculine features (gynandromorphy) gastric ulcer appears to be conspicuously absent.

Arthritis. Osteo-arthritis appears to be significantly associated with the endomorphic pyknic habitus, while rheumatoid arthritis has a tendency to be associated with the mesomorphic ectomorph types.

Heart Disease. When valvular diseases of the heart follow rheumatic fever and other infectious diseases, tall thin individuals are most often the victims. For other forms of heart disease the evidence indicates a correlation with mesomorphy.

Infantile Paralysis. Draper first revealed the existence of a constitutional factor in susceptibility to infantile paralysis. Among susceptibles there is a lack of coordination between growth and development, expressed in a tendency to overgrowth and retarded development. Susceptible children often present a facial appearance, marked by the following characters: persistent epicanthic fold, excessive inter-inner canthus space, relatively flat nasal root, large central incisors and central incisor spacing, long curved eyelashes and pigment spots. These individuals are generally endomorphic mesomorphs or mesomorphic endomorphs. Addair and Snyder have recently provided convincing evidence of the genetic susceptibility, of some family lines at any rate, to poliomyelitis. The pedigrees analysed suggest an autosomal recessive gene, showing about 70 per cent penetrance.

Diabetes. In diabetes mellitus two morphologic types have been recognized: one mostly associated with pancreatic diabetes, and the other with diabetes of pituitary origin. Persons with the former are predominantly endomorphic, while those with the latter fall into intermediate and linear groups.

Menstrual Disturbances. Bayer has shown that virile and hypofeminine women are subject to amenorrhea (abnormal stoppage of the menses), hyperfeminine women tend to have disturbances in menstrual rhythm and flow, while feminine types are essentially normal.

Constitutional Factors in Gynecology and Obstetrics. "It is well known that red-haired women frequently have a postpartum hemorrhage even though the delivery was spontaneous and skillfully managed" (Gellhorn). Such observations have impressed obstetricians with the importance of the constitutional factor in determining the character of the various functions subserving the reproductive processes. Familial icterus (hemolytic jaundice), toxemia of pregnancy, difficult labor, infant mortality, and many other obstetric complications are suspected, in many cases, to have an underlying constitutional cause or to be associated with body type. Seibert, for example, has shown that there are certain constitutional differences between mothers who had some infant deaths (infants under one year) and mothers whose reproductive histories showed no infant deaths. In 262 cases investigated, mothers who had experienced infant mortality among their offspring were, on the average, shorter in stature and related measurements than mothers with no infant mortality. The mean girth measurements were greater than in the nonmortality group. In body habitus the former tended towards the endomorph, the latter towards the ectomorph somatotype. The endomorphic character in the former was especially marked in the trunk and legs.

Longevity. Possibly the most complete demonstration of the relationship of a measurable functional character to the rate and character of aging is Bernstein's proof that early onset of longsightedness (presbyopia, due to a loss of elasticity of the crystalline lens) indicates early death by senile degeneration.

Another functional characteristic, in itself complex, with which duration of life is highly correlated, is what Pearl has called the rate of living. Length of life is generally in inverse proportion to rate of living. The more rapid the pace of living, the shorter the time that life endures. To a large extent rate of living is determined by constitutional factors, but their modification is to varying degrees within the power of the individual. Pearl has shown that heredity plays an important part in the determination of human longevity. The interesting question from the constitutional standpoint is whether there are any measurable morphologic or physiologic characters which in the healthy individual would indicate his probable span of life. Pearl and Moffett found, indeed, that in individuals measured when in good health who eventually died of heart or kidney diseases, average minimal chest girth on expiration and maximal chest girth on inspiration were greater in short-lived than in long-lived individuals. In all girths and in body weight, persons destined to die of diabetes on the average exceed persons in normal and most other disease groups.

Regarding body habitus, the short-lived who die of heart or kidney diseases tend to be more frequently pyknic than otherwise, while the short-lived who die of cancer and pneumonia tend to be of intermediate type in the direction of the asthenic habitus.

In all the series studied by Pearl and Moffett, including diseases of the heart and circulatory system, nephritis and other kidney affections, cancer, pneumonia (all forms), accident, and diabetes, the mean pulse rate was higher in the short-lived than in the long-lived group. Mean pulse rate (beats per minute) in the long-lived group was, in the heart group, for example, 72.85, and in the short-lived group 74.38. Pearl and Moffet remark "It is perhaps not unreasonable to suppose that the heart of the short-lived group of the heart series, for example, that had beat more than 18,246,000 times *more* in the first 41 years of its life than had the heart of the average man in the long-lived group of the same series, would not be likely to last so long thereafter. Many diverse lines of inquiry have led to the conclusion that the duration of life in general varies inversely with the rate of living. The present findings as to the comparative rate of heart beat in the long-lived and the short-lived appear to add further confirmation to this generalization."

The same investigators found in the heart series that the mean systolic (heart contraction) and diastolic (heart dilatation) blood pressures of the short-lived group (134/20) were lower than those of the long-lived group (136/46).

Basal Metabolism. Seltzer has shown that "linear" individuals and those with relatively shorter upper and lower extremities, longer torsos, flatter chest outlines and narrower hips relative to breadth of shoulders, have higher oxygen intakes in the resting state than their "lateral" counterparts. In moderate exercise, greater mechanical efficiency is shown by the laterals, while in exhausting work, greater capacity per kilogram of body weight for supplying oxygen to the tissues is shown by the linears.

Lucas and Pryor found that normal slender-built children generally have higher basal rates than broad-built children of the same age-sex group. For linears, high basal metabolic rates are the

TABLE 23. MORTALITY RATES OF MALES AND FEMALES ACCORDING TO ORGAN SYSTEM INVOLVED. WHITE POPULATION OF THE UNITED STATES REGISTRATION AREA, 1930

Organ-system	Mortality Rates									
	Per 100,000 births		Per 100,000 population							
	Age classes (in years)									
	Under 1		1 to 4		5 to 14		15 to 49		50 and over	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Circulatory, blood	439.8	317.8	32.0	28.3	20.5	20.6	66.7	52.5	1238.4	1037.8
Respiratory	1273.2	1075.4	199.0	183.5	33.7	33.3	118.0	92.2	423.0	344.7
Primary and secondary sex organs	56.2	42.3	1.4	1.2	.3	.8	6.5	75.4	124.0	197.1
Kidney and related excretory organs	23.4	23.6	7.1	7.1	4.1	4.9	25.7	33.4	466.2	395.3
Skeletal and muscular system	21.6	17.5	5.2	4.8	5.9	5.0	4.9	3.9	18.0	20.5
Alimentary tract and associated organs	1010.9	784.0	145.3	115.7	29.7	26.1	67.7	56.8	483.6	422.7
Nervous system and sense organs	245.2	237.6	49.3	42.8	23.7	17.0	66.8	36.7	578.3	499.9
Skin	56.0	51.7	2.2	2.9	.9	.8	2.8	2.3	27.9	19.8
Endocrinal system	78.5	54.1	4.2	3.7	2.2	2.7	5.9	10.7	72.8	136.1
Non-specific causes of death										
Violent and accidental deaths	101.4	84.2	66.8	51.2	49.2	20.8	117.5	23.2	218.5	136.1
Premature births	1777.8	1458.2	—	—	—	—	—	—	—	—
Injury at birth	595.9	399.5	—	—	—	—	—	—	—	—
Others	921.3	659.7	14.2	13.3	3.4	2.8	8.2	7.1	99.5	99.2
All deaths	6601.2	5205.6	526.7	454.5	173.5	134.8	490.7	394.2	3750.2	3309.2

Source: Sex Differences in Morbidity and Mortality, A. Ciocco, p. 193. Reprinted from *The Quarterly Review of Biology*, vol. 15, no. 2, June, 1940.

rule, and total calories per hour, calories per kilogram body weight per hour and calories per square meter body surface per hour are also higher.

SEX DIFFERENCES IN CONSTITUTION

The differences between men and women are largely determined by those processes and functions which subserve the end of reproduction. Almost all differences between the sexes stem from this primary diffrence in functional organization. Sex, therefore, is one of the most important elements of constitution, and it begins to exert its effect practically from the moment of conception and continues to the moment of death.

Deaths from almost all causes are more frequent in males at all ages. This is very clearly brought out in Tables 23 and 24. Morbidity, the sickness rate, on the other hand, is higher among females than among males. Males are more likely to succumb to diseases from which the female tends to recover, although rates of susceptibility vary at different ages, and certain diseases affect females oftener than males (Table 25). It must be emphasized that such sexual differences in susceptibility to disease are markedly influenced by differences in occupation, diet, climate, social rôle and status.

TABLE 24. SEX DIFFERENCES IN MORTALITY RATES. WHITES, UNITED STATES, 1930
(After Ciocco, 1940)

Death from Disease of Organ System:	Occurred More Frequently In:
Circulatory, blood	50.2% males
Respiratory	34.2% males
Nervous, sense organs	33.5% males
Alimentary tract	25.6% males
Kidney and excretory	8.9% males
Skin	1.9% males
Skeletal, muscular	0.5% males
Endocrine	13.0% females

In 1948 the average expectation of life of the female child of white parentage in the United States was a little over 71.0 years, for the male 65.5 years. Since the year 1900 the increase has been 20.0 years for the female and 17.3 years for the male.

Table 25. Sexual Differences in Susceptibility to Disease

Males		Females	
Diseases	Preponderance	Diseases	Preponderance
Pneumonia	3–1	Diphtheria	Slight
C. S. meningitis	Slight	Influenza	2–1
Amebic dysentery	15–1	Whooping cough	2–1
Poliomyelitis	Slight	Rheumatic fever	Consid.
Diabetes	3–1	Tonsillitis	Slight
Scurvy	Greatly	Pellagra	Slight
Gastric ulcer	1.1–1	Obesity	Consid.
Acute pancreatitis	Large majority	Gall stones	4–1
Bronchial asthma	More often	Movable kidney	7–1
Pleurisy	3–1	Chlorosis (anemia)	100%
Leukemia	More often	Goiter (exophth.)	6 or 8–1
Hodgkin's disease	More often	Myxedema	6–1
Hemophilia	100%	Hyperthyroidism	10–1
Angina pectoris	6–1	Acromegaly	More often
Addison's disease	More often	Multiple sclerosis	More often
Banti's disease	More often	Combined sclerosis	More often
Alcoholism	6–1	Chorea	3–1
Tabes	10–1	Purpura haemorhagica	4 or 5–1
Paresis	Much more	Migraine	6–1
Progressive muscular paralysis	More often	Raynaud's disease	1.5–1
Erb's dystrophy	More often	Arthritis deformans (menopause)	4.4–1
Syringomyelia	2.3–1		
Cerebral hemorrhage	Greatly	Osteomalacia	9–1
Sciatica	Greatly	Rheumatoid arthritis	3–1
Paralysis agitans	Greatly	Carcinoma gall bladder	10–1
Pseudohermaphroditism	10–1	Chronic mitral endocarditis	2–1
Angina pectoris	5–1		
Coronary sclerosis	3–1		
Coronary insufficiency	30–1		
Pericarditis	2–1		
Myocardial degeneration	2–1		
Myocardial infarction	7–1		
Arteriosclerosis	5–1		
Thromboangiitis obliterans	96–1		
Korsakoff's psychosis	2–1		
Hysteria	7–1		
Chronic glomerular nephritis	2–1		
Duodenal ulcer	5–1		
Gout	49–1		
Carcinoma (head of pancreas)	4 or 5–1		
Cirrhosis of liver	2–1		

If women are biologically stronger and more resistant to disease than men, they are also better shock absorbers, as numerous studies testify. Hysteria occurs more frequently among men than among women. Under heavy bombardment cases of shock and neurosis are far more frequent in the civilian male than in the female population. At all ages suicide rates are much higher among males than females. Epilepsy is much more frequent in males, and stuttering has an incidence of eight males to one female.

To what extent the sexual differences cited are influenced by social factors and to what extent by genetic factors must remain an open question. We know that both types of factors are involved. In recent years it has become increasingly more evident that social factors play a much larger rôle in producing such sexual differences than was previously supposed.

SEX-LINKED, SEX-INFLUENCED, AND SEX-LIMITED GENETIC EFFECTS

The development of traits which are associated in inheritance with sex are of three kinds: (1) sex-linked; (2) sex-influenced; and, (3) sex-limited. When the association is due to a gene lying in the X-chromosome it is said to be *sex-linked*. One of man's 24 pairs of chromosomes differs from the remaining 23 pairs (autosomes) in being intimately, though not exclusively, associated with the determination of sex. In the female this pair consists of two equal-sized chromosomes called the X-chromosomes (allosomes), or sex chromosomes. In the male there is also a pair of chromosomes, but only one of these is a sex chromosome, and this is an X-chromosome which is exactly the same as the X-chromosomes in the female. The male's second chromosome, however, is appreciably smaller, it is called the Y-chromosome and has no direct influence upon sex determination. It is customary to speak of the X- and Y-chromosomes as sex chromosomes, and we shall retain this usage here.

The sex chromosomes are of complex structure, having recently been shown to consist of three distinctive regions, as follows: (1) a portion of the X-chromosome homologous with a corresponding part of the Y-chromosome, the two portions synapsing in maturation so that corresponding genes come to lie opposite each other (synapsis) and segments are exchanged between a pair of the two split chromosomes (chromatids), thus forming chiasmata which hold the four threads together; (2) a region of the X-chromosome not homologous with any portion of the Y-chromosome; and, (3) a portion of the Y-chromosome not homologous with any part of the X-chromosome. Synapsis does not occur between the non-homologous portions (Fig. 141).

Sex-linked genes are carried in the non-homologous portions of the X- and Y-chromosomes. The genes in the X-chromosomes being known as ordinary sex-linked genes, those in the Y-chromosome being termed *holandric* ("wholly male") genes. Though both types of genes occurring in the non-homologous portions of the X-

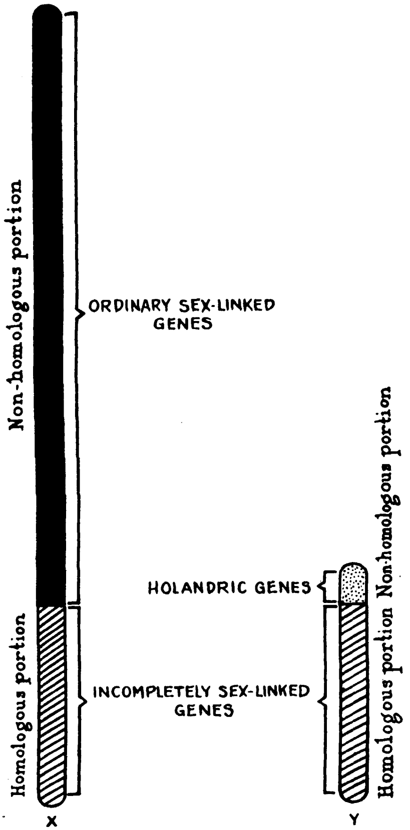


Fig. 141. Diagram of the X- and Y-chromosomes, showing the portions involved in sex-linkage. (Modified after Snyder.)

and Y-chromosomes are strictly speaking sex-linked, it is preferable to restrict the latter phrase, that is, sex-linked, to genes situated in the non-homologous portion of the X-chromosome, using the term *holandric* for genes situated in the non-homologous portion of the Y-chromosome.

The situation of ordinary sex-linked genes is shown in the black (non-homologous) portion of the X-chromosome diagrammatically represented in Fig. 141. The transmission of mutant genes occurring in the sex chromosomes can now be easily followed.

It will be recalled that the male always receives his X-chromosome from the mother and the Y-chromosome from the father (since the mother has no Y-chromosome), whereas the female receives one X-chromosome from each parent.

Table 26. Some Human Traits Reported as Dependent Upon Sex-Linked Genes

(After Snyder)

(Many of these traits have alternative forms dependent upon autosomal genes, and some of them are influenced by variations in environment)

Albinism of the eyes
Alopecia congenita
Anhidrotic ectodermal dysplasia
Coloboma iridis
Color-blindness of the red-green type
Day blindness
Defective hair follicles
Defective tooth enamel
Distichiasis (double eyelashes)
Epidermal cysts
Glaucoma of the juvenile type
Hemophilia
Ichthyosis
Keratosis
Megalocornea
Microcornea
Micropthalmia
Mitral stenosis
Myopia
Night blindness
Nomadism
Nystagmus
Optic atrophy
Peroneal atrophy
Pseudohypertrophic muscular dystrophy
Retinal detachment
Thromboasthenia
White occipital lock of hair

Sex-linked genes can be represented on only one chromosome, the X-chromosome in males. Sex-linked genes can be represented on both X-chromosomes in females. From these facts and the fact that almost all sex-linked mutant genes are recessive, it is possible to give specific advice to families known to be carrying such genes. If the men in such a family do not exhibit the trait, and more than 30 such traits have been described (see Table 26), then clearly the genes for it are not present in his X-chromosome, and he cannot therefore transmit the condition to any of his offspring. He may safely have children. An affected father can transmit his affected X-chromosome to his daughters, who will *all* be carriers; since the sons receive only his unaffected Y-chromosome *none* of them will be affected. The sons may safely marry. Some of the sisters who carry the gene in heterozygous form may have affected sons, and so may some of the apparently normal women in the family. A woman cannot be affected unless her father was affected and her mother carried the gene, unless, in other words, the gene was present on her father's X-chromosome and on at least one of her mother's X-chromosomes.

The holandric genes in the non-homologous portion of the Y-chromosome can only be transmitted from father to son, for the obvious reason that only males ever receive a Y-chromosome, and females never do. Four holandric gene conditions are known in man, namely, ichthyosis hystrix gravior (barklike skin), hypertrichosis of the ears (dense hairy growth on the ears), keratoma dissipatum (nonpainful hard lesions of hands and feet), and a form of webbing of the toes.

Quite recently genes have been located in the homologous portions of the X- and Y-chromosomes. These are known as *incompletely sex-linked genes.* Such genes may be present in both sex chromosomes of both sexes. They will, therefore, behave similarly to autosomal genes in inheritance, with this difference: About half the families in which the father carries the gene will contain more affected sons and unaffected daughters than would be expected on the basis of autosomal inheritance, while the other half will contain more affected daughters and unaffected sons than would be expected. The reason for this being that such genes can cross over from the X- to the Y-chromosome, and vice versa in males, and thus will be differentially transmitted as to sex.

Eight traits due to incompletely sex-linked genes have been described. These are, total color blindness (as opposed to red-green blindness), xeroderma pigmentosum (a skin disease), Oguchi's disease (a type of blindness), spastic paraplegia (a neuromuscular defect), the recessive .form of epidermolysis bullosa (malignant skin blisters), the dominant form of retinitis pigmentosum, hereditary hemorrhagic diathesis (a blood abnormality), and a type of cerebral sclerosis (a mental defect).

Sex-Influenced Genes. When the expression of a gene is dominant in one sex and recessive or intermediate in the other, that is to say, when its expression depends upon the sex of the individual, it is said to be *sex-influenced.* Baldness, absence of upper lateral incisor teeth, ichthyosis (scaling of skin), and Heberdon's nodes (enlargement of terminal joints of fingers), are examples of the action of sex-influenced genes.

Sex-Limited Factors. When certain factors are expressed in one sex but not in the other, they are said to be *sex-limited factors.* The expression of sex-limited factors depends upon the presence or absence of one or more hormones. Complete sex limitation, that is, complete development of the trait in one sex and complete absence in the other is not frequent. An example of such complete sex-limitation is the appearance of coarse hairs on the external ear of Caucasoid man during the process of aging, and the absence of such hairs in women. Under endocrine stimulation of the male sex hormone such auricular hairs may be induced to grow in women. Another example is the presence of a beard in the male and its absence in the female, even though women, as Trotter has shown, have the same number of hairs on the face as men. The difference lies simply in the development of each hair and in its growth. Under the proper endocrine stimulation women are capable of growing beards not one whit inferior to those of men.

There is very good reason to believe that secondary sex characters in general, including not only physical traits but differential response of the nervous system, depend upon sex limited factors. The degree of secondary sexual development in the sexes is obviously differentially limited by the hormones of the glands of internal secretion, in other words, the factors of sex are in themselves genetically limited, but this limitation is to some extent under the control of the hormones.

It is important to note that in one family a trait may be due to a sex-linked dominant gene, while in another family the same trait may be due to an autosomal recessive gene, and in still another family to an autosomal dominant gene. Such cases may represent the expression of differences in translocation or position effects.

Mutant genes and linkage between such genes occur, of course, in autosomes, but their study is considerably more difficult than sex-linkage. Several such linkages have, however, been described, and it is reasonably certain that in time several others will be. Examples of such linkages are ear flare and finger length, finger length and eye color, ear size and ability to taste phenylthiocarbamide, hair whorl and cross eyes, cross eyes and hair color, eye color and tongue curling, hair shade and hair color, ability to taste mercapto-benzo-selenazol and ear size, ability to taste MBS and tongue curling, and several others. However, the only well established linkage of this sort is between sickle-shaped red blood corpuscles and the MN blood type.

Penetrance, Expressivity, and Viability of Genes

Under the conditions of development genes show varying degrees of activity. They are influenced by internal and external environmental factors, and one non-allelic gene may act upon another to inhibit its action (epistasis), or may itself be inhibited by a non-allelic gene (hypostasis).

Penetrance. When a gene regularly produces the same effect as, for example, do the blood group genes, it is said to have *complete penetrance.* When the trait is not manifested in some individuals it is said to have *reduced penetrance.* Dominant genes with low penetrance may be mistaken for recessives. When the penetrance of an autosomal gene is completely reduced in one sex, the gene is sex limited.

Expressivity. When the manifestations of a trait produced by a gene are different from individual to individual, the gene is said to have *variable expressivity.* When the manifestation of the trait is constant, the gene is said to have constant expressivity. The dominant gene for allergy shows variable expressivity, and may take such forms as asthma, eczema, "hay fever," angioneurotic edema, or urticarial rash.

Viability. Genes carried in the homozygous state which shorten the life span of the individual are known as lethal genes. Such genes are incompatible with life at various stages during the development of the individual. This means that such genes may exert their effect at fertilization and at almost any time thereafter. Most of these lethals are recessive. In Table 27 are listed the twenty or so conditions which have been reported as due to lethal genes.

TABLE 27. CONDITIONS REPORTED AS DUE TO LETHAL-GENES
(After Snyder)

Recessive lethals	
Acute idiopathic xanthomatosis (Niemann-Pick's disease).	Great enlargement of spleen and liver with discoloration of skin.
Amaurotic idiocy	
(a) Infantile type (b) Juvenile type	Impairment of vision leading to total blindness, degeneration of nervous system and idiocy.
Degeneration of the cerebral white matter	
(a) Acute infantile type	
(b) Subacute juvenile type	
(c) Convulsive type	
Epidermolysis bullosa	A skin disease in which blisters from on the slightest pressure
Gargoylism	Multiple growth derangement, gargoyle-like face
Glioma retinae	Tumor of the retina
Ichthyosis fetalis	Scaling of the skin
Infantile muscular atrophy	Wasting of muscles with paralysis
Micropthalmia of the sex-linked type	Abnormally small eyes
Pseudohypertrophic muscular dystrophy	Muscular enlargement and paralysis
Semidominant lethals	
Minor brachydactyly	Shortness of fingers
Pelger's anomaly	Unsegmented leucocytes
Sebaceous cysts	Cystic tumors of sebum secreting glands
Spina bifida	Congenital cleft of vertebral column
Telangiectasia	Dilatation of capillaries, particularly serious nose bleeding

SOME SOCIAL CONSEQUENCES OF THE BIOLOGICAL DIFFERENCES BETWEEN THE SEXES

In human society the social status of the sexes is greatly influenced by the physical differences existing between them. The most important of these differences is physical strength. By virtue of the possession of this one advantage men are able to enforce their will upon the opposite sex. The greater physical power of the male is the one factor which has weighted the balance of social power in his favor. In human as in non-human primate societies social sanctions, in the ultimate analysis, rely upon force for their maintenance. The difference between human and non-human primate societies in this respect would appear to lie in the degree to which force has been converted into a power for the development and maintenance of social relations. It was Plato who said that civilization was the victory of persuasion over force. Monkey overlords use their power to gratify their immediate desires, human overlords to fulfill both their immediate desires and their remote wants. It is a difference of degree not of kind.

The correlation, in almost every society of animals, is so complete that one may lay it down as a general law that wherever one sex is larger or physically stronger than the other, that sex will occupy a position of dominance with respect to the smaller or physically

TABLE 28. SOME PRESUMED SOCIAL CONSEQUENCES OF THE BIOLOGICAL DIFFERENCES BETWEEN THE SEXES
(Modified after Scheinfeld, *Women and Men*).

Biological Sex Differences	Functional Expression	Social Consequences
Men bigger, more powerful	Greater capacity for heavy labor	Dominance of males. Different jobs, rôles, assigned each sex; in anticipation, different training given to each
Women bear children, nurse them	Movements impeded, kept closer to home	
Greater muscular development in male	Urge to physical exertion, greater pride in it	Greater interest of male, in sports, etc.
Male's larger size, higher metabolism, greater activity	Need for more food, more expenditure of energy	Greater drive in work, achievement
Lesser strength of female	Inability to cope with male physically	Round-about "feminine" devices to achieve ends
Pregnancy in women	Greater risk in sexual relationships, uncertainty of paternity. Bad habits may affect children	"Double standard" of conduct, stricter codes for behavior of unmarried girls and married women
Earlier puberty in girls	Ready for mating earlier	Girls permitted to marry, reach "age of consent" earlier
Differences in genitalia and body	Garments adjusted differently for comfort, utility	Differences in dress, styles
Menstruation	Effects on body, mind, consciousness of blood issue, other symptoms	Taboos on women, psychological and social restraint
Male conscious of strength	Tendency of men to treat women gently	Codes of chivalry, etiquette
Rôle in sex relationships	Women can have intercourse without desire, men cannot	Prostitution largely confined to women, rape to men
Menopause in women	Reproductive capacity ends much earlier than men's	Men's marriage chances continue beyond women's
Female biologically more resistant to disease, bodily upsets	Her life span longer, surplus of women increasing	Threat to monogamous marriage system; problems of widowhood

less powerful sex. The relationship between strength and sexual or social dominance in human societies has often been neglected or overlooked by those who are inclined to attribute the differences in sexual status to exclusively cultural factors. In human societies the more powerful male is able to establish a physical and social supremacy over the female, which is the starting point of that social supremacy of the male that we find in practically all human societies. From such an initial gross mammalian advantage arise the variegated ways in which the social status of the sexes is expressed.

Another important difference is the difference in reproductive functions. These functions similarly serve to put the female at a physical disadvantage in comparison with the male. But while such differences serve as a basis for rationalization or a point of departure for the recognition of differences in social capacity and status, the ascription of the different rôles and statuses is almost entirely a matter of cultural determinance. In Table 28 the most general social and behavioral consequences of the biological differences between the sexes are briefly listed.

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON THE STRUCTURE AND FUNCTIONS OF MAN

In the laboratory it is possible to demonstrate the effects of slight changes in temperature, amount of light, humidity, or wakefulness upon the experimental animal. Growth, development, reproductivity, and behavior may all be affected. Such experiments are easily repeated and the results checked and verified. With human beings such experiments are not easily possible, though man's own mobility has provided thousands of such unpremeditated experiments. Yet, interestingly enough, when evidence is accumulated which proves that man is in many ways as susceptible as other animals are to the physical effects of changes in environment, the proof is generally treated with the greatest incredulity. Perhaps it is that the insecurity of life in general causes men to hold fast to some fancied ideal of stability and immortality, at least physically, of their own type. The facts, however, indicate that environment is a very potent force in its action upon the organism.

Environment is a term for a very large complex of conditions, each of these conditions acting with different degrees of intensity upon the organism at different times. By environment is here understood any condition, or group of conditions, external to the organism which may in any way affect it. This includes such conditions as variations in temperature, humidity, barometric pressure, number and kinds of particles in the air, solar and cosmic radiation, food, water, mineral content of the soil, and all that is embraced under the terms social and economic conditions.

Since, in human societies, it is the regulative effect of the socioeconomic conditions which play a dominant rôle in modifying the action of purely physical factors, it must be re-emphasized here that the importance of these regulative conditions must always be borne in mind and given proper consideration in any attempted evaluation of the effects of the environment upon the individual.

Changes in Bodily Form of the Descendants of Immigrants From One Geographic Area to Another. In 1912 Boas conclusively showed that American-born descendants of immigrants differ in type from their foreign-born parents. Table 29 shows the kind and degree of differences in the measurements of children of immigrants born in the United States compared with those of immigrants born in Europe. The results set out in this table prove that the form of the head may undergo certain changes, with change in environment, without change in descent. In other words, that the pattern of the genotype may remain unaltered but that as a result of the effects exercised by a new environment its physiological expression undergoes modification. Furthermore, Boas showed that the influence of environment makes itself felt with increasing intensity according to the time elapsed between the arrival of the mother and the birth of the child. This is well brought out in Fig. 142.

The American-born descendants differ in head form from their parents. The differences develop in early childhood, and persist throughout life. The head index of the foreign-born is practically the same, no matter how old the individual at the time of immigration. This might be expected when the immigrants are adult or nearly mature, but even children who come to the United States when one year or a few years old develop the head index character-

TABLE 29. INCREASE (+) OR DECREASE (−) IN MEASUREMENTS OF CHILDREN OF IMMIGRANTS BORN IN THE UNITED STATES COMPARED WITH THOSE OF IMMIGRANTS BORN IN EUROPE (FROM BOAS).

Nationality and Sex	Length of Head mm.	Width of Head mm.	Cephalic Index	Width of Face mm.	Stature
Bohemians:					
Male	−0.7	−2.3	−1.0	−2.1	+2.9
Female	−0.6	−1.5	−0.6	−1.7	+2.2
Hebrews:					
Male	+2.2	−1.8	−2.0	−1.1	+1.7
Female	+1.9	−2.0	−2.0	−1.3	+1.5
Sicilians:					
Male	−2.4	+0.7	+1.3	−1.2	−0.1
Female	−3.0	+0.8	+1.8	−2.0	−0.5
Neapolitans:					
Male	−0.9	+0.9	+0.9	−1.2	+0.6
Female	−1.7	+1.0	+1.4	−0.6	−1.8

istic of the foreign born. For Jews this index ranges around 83, that of the American-born changes suddenly. The value drops to about 82 for those born immediately after the immigration of their parents, and reaches 79 in the second generation, i.e., among the

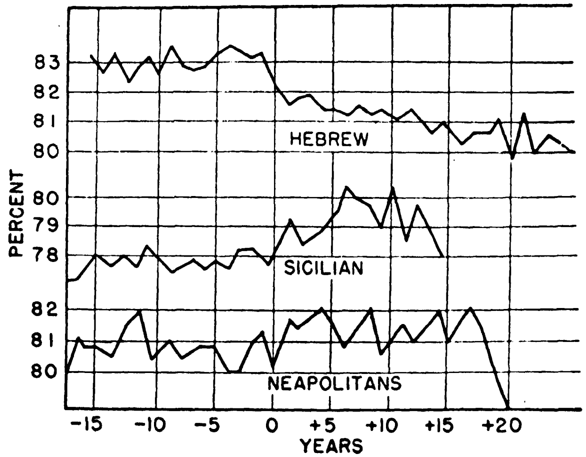


FIG. 142. Head breadth taken as a per cent of head length (cephalic index) in immigrants and their descendants. (−) Those born in Europe, 5, 10, and 15 years before immigration. (+) Those born in America 5, 10, 15 and 20 years after immigration of mother (after Boas).

children of American-born offspring of immigrants. The effect of American environment makes itself felt immediately, and increases slowly with the increase of time elapsed between the immigration of the parent and the birth of the child. Observations made in 1909 and 1937 yield the same results, save that there is an appreciable increase in all measurements in the latter series.

Boas found similar modifications in the head form of the descendants of Spanish ancestry living in Puerto Rico. The average head index of Spaniards being 77 while that of their Puerto Rican descendants is 82.5.

In 1918 Guthe confirmed Boas's findings with respect to changes in the cephalic index of the American born offspring of Russian Jews living in Boston.

Returning to Table 29 it will be observed from the figures there given that there is, in general, a negative correlation between stature and cephalic index; that increase in stature is accompanied by a decrease in cephalic index. The changes in cephalic index, therefore, may at least in part be considered as functionally associated with changes in stature.

In recent years (1939) findings similar to those of Boas have been obtained by Shapiro on the Hawaiian born children of Japanese migrating from Japan to the Hawaiian Islands. This is by far the most exhaustive study of its kind, and covers a great many more characters and conditions than Boas was able to investigate.

Shapiro found that the changes in the first generation descendants of Japanese in Hawaii was limited principally to their quantitative characters, chiefly those of size and proportion. Here is a list of the characters principally affected:

The Hawaiian born males show significant increments over the immigrants in the following measurements:

1. Stature
2. Sitting Height
3. Trunk Height
4. Upper Arm Length
5. Lower Arm Length
6. Total Leg Length
7. Lower Leg Length
8. Shoulder Breadth
9. Head Breadth
10. Head Height
11. Inter-Ocular Width

In other words the Hawaiian born males are taller, broader in shoulders, longer in limbs, and have broader and higher heads than their Japanese born parents. But they also show significant decreases in the following measurements:

1. Chest Width
2. Chest Depth
3. Head Length
4. Total Face Height
5. Nose Breadth

The following are the significant alterations in proportions among the Hawaiian born males:

1. Lower Relative Hip Width
2. Lower Shoulder-Hip Index
3. Higher Tibio-Femoral Index
4. Lower Fronto-Parietal Index
5. Lower Cephalo-Facial Index
6. Lower Nasal Index
7. Higher Head Length-Height Index
8. Lower Nose Length-Height Index
9. Increased Cephalic Index

In a more recent investigation of the physical characters of Chinese immigrants and American-born Chinese in the eastern United States Lasker (1946) found changes in some 25 different characters.

American born Chinese males show significant increments over the immigrants in the following measurements:

Stature
Span
Total Arm Length
Upper Arm Length
Lower Arm Length
Leg (Tibial) Length
Foot Length
Hand Breadth
Total Facial Height
Nasal Height
Nasal Index

Slight though significant increments were observed in:

Sitting-Height
Shoulder Width
Bi-Iliac Width
Chest Width
Hand Length
Hand Breadth
Face Breadth
Upper Facial Height

Significant decreases were observed in the following:

Chest Depth
Nasal Breadth

Other changes observed were

Coarser Hair
Slightly Hairier
Sclera Less Frequently Pigmented
More Prominent Nose
Torus Palatinus More Frequent

On the basis of Shapiro's and Lasker's studies we may say then that the typical Oriental youth born and brought up in Hawaii or the United States when compared with his ancestral stock or immigrants from his ancestral homeland, is taller, with longer arms and legs, has relatively slenderer hands and feet, and a flatter chest. His head is likely to be shorter but broader and his nose to be relatively narrower, and he has more body hair.

In a study of 2,252 Jews of eastern European origin Dornfeldt (1941) found that the cephalic index was lower for Jews born in Berlin than for those born abroad, that is to say, that the heads of children born in Berlin tend to increase in length and to decrease in breadth.

Spier (1929) in a study carried out at Seattle, found that American-born children of Japanese parents were taller at all ages than the Japanese-born children from the district of southern Japan from which most of the Seattle Japanese were believed to have come. Children born six or more years after the arrival of the mother in the United States had a greater average size. Children whose mothers migrated to the United States prior to 1909 were somewhat taller than those whose mothers migrated to the United States after 1909.

Ito (1936) found that newborn babies of Japanese parentage in the United States were far superior in physical growth at birth to those born in Japan, though the body proportions characteristic of the Japanese infant were fully retained under the new environment.

In a later study on four groups of Japanese women from 18 to 30 years of age reared under different environments, Ito (1942) found a significant increase in stature in the American-reared Japanese whether born in the United States or Japan, as compared with those reared in Japan. The figures are as follows:

Born and Reared in Japan	*Born in U.S., and Reared in Japan. Returned to U.S.*	*Born in Japan and Reared in U.S.*	*Born and Reared in U.S.*
149.8 cm	151.9 cm	153.9 cm.	154.0 cm

Facts such as these constitute strong evidence that the increased stature of the American-reared women of Japanese ancestry is principally due to the effect of the more favorable American environment, and is not simply a reflection of selection, as some writers have supposed.

Ito also found that the average age at menarche (the first mentruation) was about 20 months earlier in the Japanese women reared in the United States than for those reared in Japan whether born in the United States or in Japan.

In the lateral development of the body the American-reared women are slightly superior to the Japanese-reared, except in chest circumference which is reduced, a compensatory response, doubtless to the markedly increased stature.

Goldstein (1943) investigated the presumed effects of the American environment on Mexican immigrants in Texas and their American-born children. The following significant changes were found in the sons as compared with their Mexican-born parents:

Increase in:	*Decrease in:*
Stature	Weight
Hand Length	Hand Breadth?
Ear Index	Bizygomatic Breadth
	Bigonial Breadth?
	Nose Height
	Nose Breadth
	Ear Height
	Ear Breadth
	Nasal Index

In qualitative traits the American-born sons differed from their Mexican-born fathers in having:

More Medium Body Build
Less Body Fat
Wavier Hair
Lighter Hair Color?
Darker Eye Color
Lower Nasal Bridge Height
Shallower Nasal Root
Thicker Lips
More Shovel Shaped Incisors
Less Dental Caries

A comparison of the immigrant Mexicans with the sedentary Mexicans in the districts from which they came, revealed the fact that the immigrants differed from the "sedentes" in the direction realized by the American-born children of the former. A similar finding was made by Shapiro on Japanese sedentes, immigrants, and their Hawaiian-born offspring.

The results obtained by these and many other investigators show that significant changes occur in various dimensions and proportions of the body, as well as in certain qualitative traits, following upon birth and development in a habitat not that of the parents.

What can be the cause or causes of these changes?

From the work of Shapiro and Goldstein it appears that, at least in Japanese and Mexicans, a trend to vary is already present in the immigrants. The new environment selectively stimulates these preadaptive tendencies to greater development in the generations born and bred in it. This interpretation is supported by the evidence derived from all the studies thus far made on the subject.

Immigrants presenting developmental trends of different kinds entering the same environment will have offspring who are affected by the environment in different ways, owing to their original preadaptive genetic differences.

Immigrants presenting developmental trends of the same kind entering different environments may be affected in different ways owing to the differences in the action of the differing environments.

Once more we perceive the important rôle which the environment plays in the development of variations in human types. It is not, however, the environment alone which produces the changes observed in the descendants of immigrants, but the interaction between the genotype and the environment. The two can never be dissociated. As Boas puts it, "If there is any kind of environmental influence, it is obvious that we can never speak of a genetic type *per se,* but that every genetic type appears under certain environmental or physiological conditions, and that in this sense we are always dealing with the physiological form of a certain genetic type."

Climate. Climatic factors exert very definite effects upon the human organism. Whole libraries have been written upon the subject, but a great part of this work suffers from the incompleteness of its scientific treatment. On the other hand, such rigorously scientific studies as have been made, in general serve to corroborate the effects of climatic changes upon man as have been experimentally demonstrated to occur in lower animals. For example, Hartman found that in the colony of macaque monkeys living at Baltimore, ovulation was inhibited during the summer months (June, July, and August), and there was a greater irregularity of the menstrual cycle, and an increase in amenorrhea. Similar findings were made by Engle and Shelesnyak on pubertal girls in New York City, the authors concluding that "The pubertal individual is a physiologically unstable organism, in which slight extrasomatic factors may profoundly influence somatic responses, so that phenomena may appear here which disappear with maturity."

The evidence strongly suggests that seasonal changes in climate continue to exert their effects upon the functions associated with the reproductive system, in both sexes, throughout the effective duration of those functions.

Some fifty years ago Engelmann showed that age at menarche (the first menstruation) in the descendants of European immigrants tended to approach the age at menarche of the aboriginal American Indians, and that the longer the American ancestry of the female the earlier was the age at menarche. Thus the mean age at menarche was about 15 years in Europe but in America it was 14.2 years, while for the American Indians it was about 13 years. Thirty years later Mills found that the average age at menarche of white females in the United States had apparently dropped to 13.55 years.

Such facts are not to be construed as meaning that climatic conditions eclipse in importance the genetic and cultural factors. They do not. Climate represents but one complex of variables in a much larger universe of variables all of which act upon the potentials of the organism to the extent to which the environing conditions make possible.

Although the influence of climatic factors upon the maturation of sexual functions has frequently been vigorously denied, the indubitable and unequivocal proof of that influence is to be seen in the fact that the breeding seasons of all animals characterized by such circumscribed periods of reproductivity are markedly affected by climatic influences. In the macaque monkey there is a relative sterility period during the summer months, whether those months of summer fall in June, July, or August as in the Northern Hemisphere, or in November, December and January as in the Southern Hemisphere. Furthermore, the sexual functions and breeding seasons of animals can be altered by experimentally varying the climatic conditions to which they are exposed. In man there is some reason to believe that climatic factors exert their effect upon almost every aspect of his reproductive functions. Monge (1948) and others have found that removal from low to high altitudes (3,000 to 6,000 meters) in the Andes will not only produce sterility and impotence in man (as well as in animals) but in some cases actual atrophy of the gonads. In most cases these changes endure until the organism becomes adjusted to the new environment.

The migratory behavior and sexual periodicity of birds, as Rowan was the first to show, and the sexual periodicity of small mammals as Bissonnette and others have since shown, are closely associated with the intensity and duration of the light to which they are exposed. Changes in the pituitary gland, in the sexual glands, and in hormone levels have been experimentally demonstrated as following upon variable periods of exposure to light. Rowan has shown in the case of birds that increased activity as a result of the prolonged exposure to light rather than the light itself is a determining factor.

Temperature has been experimentally shown to be associated with sexual behavior in rats, high temperature, as well as low, being associated with reduced sexual activity. Evidence has been adduced to show that temperature similarly affects man. Here, too, as in the case of light the effect is mainly indirect, the greater lassitude and reduced energy being the cause of low sexual activity rather than the direct action of temperature itself.

The direct action of light upon the human organism is known principally from its effect upon body pigments and the skin. The effects upon more general physiological activities are known but not yet understood, even though the beneficial and disease effects of light are fairly well known (Blum).

General Climatic Effects Upon the Individual. Growth and development, energy levels, metabolism and its pathological states, infectious diseases, body resistance, sclerosis and failure in the circulatory system, dental caries, weight, height, and intelligence, every phase, indeed, of the life of the individual is influenced by climatic factors. Almost everyone is aware of the fact that certain diseases are more prevalent in winter than in summer, while others are more common in summer than in winter; the common cold is

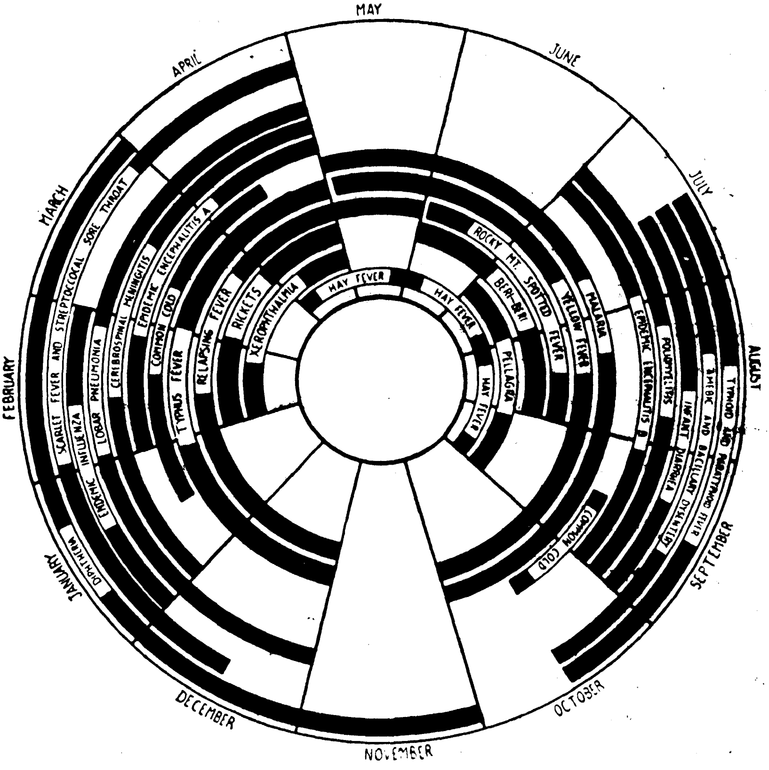


FIG. 143. The seasonal incidence of some diseases. (From Perla and Marmorston. Courtesy, Williams & Wilkins.)

an example of the first kind, and hay-fever of the second. The reader will recall many other examples of the relationship between disease, the weather, and the seasons (see Fig. 143).

Evidence is now available which indicates that the course of practically every disease is influenced not only by seasonal changes but by changes in the weather from hour to hour, while quite a number of disorders, such as sinusitis, and some joint and respiratory disorders, are actually activated by changes in humidity and barometric pressure. But we are not here concerned with the effects of climate upon disease, but rather with climatic effects upon the normal structure and functions of man.

It is has been shown that the growth of the human body proceeds at different rates during the different seasons. Thus, maximal increase in height generally occurs in the spring, while maximal increase in weight occurs during the autumn. Interestingly enough there appears to be a tendency for mental functions to be in their maximal phase when weight increase is dominant, and in their minimal phase when height increase is dominant.

Studies by many different investigators on white populations throughout the world have led to the following conclusions (Fitt):

Mental abilities are at their highest in midwinter and at their lowest during the transition period from winter to spring or in early spring.

Muscular ability is highest in midsummer, and lowest in mid-spring and late autumn.

Gross mortality rates are higher in the spring-summer half of the year than in the autumn-winter half.

Suicide and abortion rates are highest in summer and lowest in winter.

Conception rates are lowest in summer, and the greatest number of menstrual irregularities occur in the same season.

There exists a rather considerable amount of evidence which suggests that individuals born during the autumn-winter period tend, in many ways, to be more favored than those born during the spring-summer period. During this period the vitality of the newborn is higher, and such individuals grow to be taller, heavier, and stronger, and, some investigators claim, also more intelligent, on the whole, than those born during the spring-summer period. Evidence of this kind suggests that seasonal factors exert a conditioning effect upon genetic development. That this is so in the case of the lower animals has been repeatedly demonstrated by experimental means, and by the detailed analysis of observations.

In these matters we may, however, be dealing not so much with the direct as with the indirect effects of climate, such, for example, as the changes in number, distribution, and virulence of disease-producing micro-organisms which may act more severely at one season than at another.

Under the general rubric of climatic conditions may be classed the foods consumed by man, since the qualities of food are determined, for the most part, by climatic conditions.

The foods consumed by man vary considerably in different parts of the world, and since there can be no question as to the importance of their effects upon the growing individual and the group, the nutritional factors must always be borne in mind in any attempt at the evaluation of differences and likenesses between individuals and groups. There is definite evidence available that the shape of the head, for example, is affected by nutritional factors. Experimentally this has been demonstrated on dogs fed on a somewhat iodine-deficient diet. The mention of iodine recalls the fact that in areas of the world in which the soils and foods are deficient in iodine very striking arrests in development may occur. In certain parts of Switzerland, in the Tyrol, and in the Pacific Northwest, there were, until very recently, large numbers of individuals whose thyroid glands functioned at a very low level because the low iodine content of the soil upon which they lived was reflected in the still lower iodine content of the water and the foods they consumed. Hence, the absence of the normal iodine intake necessary for the proper functioning of the thyroid gland resulted in such iodine-deficiency diseases as cretinism, arrested physical and mental growth, simple goiter, Graves' disease (exophthalmic goiter) and serious disturbances of metabolism (see Fig. 144). The domesticated animals living in these regions were similarly affected. People who live sufficiently near the sea-coast for the evaporated sea salts to be borne inland by the winds, never suffer from deficiencies of this sort. As might have been expected exophthalmic goiter is more frequent in iodine deficient areas than elsewhere.

The relation of food to some of the differences exhibited by the various ethnic groups of mankind is still an almost completely unexplored field. It is one which would richly repay investigation. It is, in reality, a part of the study of human ecology, that is, the study of man in relation to his total environment.

Environmental Effects as Determined by Socio-Economic Factors. Socio-economic factors are not generally regarded as physical environmental factors, and this is, of course, quite a proper view to take, but since these factors, for the most part, determine the kind of physical environment to which the individual shall be exposed, it is obvious that they play an important regulative rôle in the psycho-physical history of the individual. This important fact is too often overlooked. The history of public health provides a very clear illustration of the influence of socio-economic factors upon the incidence of disease and mortality rates. Improved social and economic conditions have significantly served to decrease these rates. From an average expectation of life of 33.5 years in antiquity, to 35.5 years at the beginning of the 19th century, we had advanced to only 40 years by the middle of the same century; and then, as Dublin says, "Shortly before the turn of the century came what may be called the era of discovery of the basic facts with regard to the control of environment, causation of disease, and the series of practical administrative measures which have since been

FIG. 144. Seven cretins from the Urnatsch Almshouse, Appenzelle Canton, Switzerland. The tall man is normal, the height of the woman immediately in front of him is just 39 inches. (Courtesy, Dr. J. F. McClendon.)

TABLE 30. EXPECTATION OF LIFE AT BIRTH BY SEX IN VARIOUS COUNTRIES FOR SPECIFIED PERIODS

Country and Period	Total Persons[1]	Males	Females	Country and Period	Total Persons[1]	Males	Females
North and South America				France			
United States				1898–1903	47.4	45.7	49.1
White				1947	65.3	62.8	67.7
1900–1902	49.7	48.2	51.1	Switzerland			
1901–1910	50.9	49.3	52.5	1901–1910	50.8	49.3	52.2
1919–1921	57.4	56.3	58.5	1939–1944	64.9	62.7	67.0
1920–1929	59.2	57.9	60.6	Germany			
1929–1931	60.9	59.1	62.7	1901–1910	46.6	44.8	48.3
1930–1939	62.6	60.6	64.6	1932–1934	61.4	59.9	62.8
1939–1941	64.9	62.8	67.3	Austria			
1948	68.3	65.5	71.0	1901–1905	40.1	39.1	41.1
Non-White				1930–1933	56.5	54.5	58.5
1900–1902 (Negroes)	33.8	32.5	35.0	Czechoslovakia			
1948	60.3	58.1	62.5	1899–1902[3]	40.3	38.9	41.7
Canada				1929–1932	53.6	51.9	55.2
1926–1930	58.7	57.7	59.7	Poland			
1947	67.2	65.2	69.1	1931–1932	49.8	48.2	51.4
Mexico				Hungary			
1930	33.3	32.4	34.1	1930–1931	49.8	48.3	51.3
Panama				1941	56.6	54.9	58.2
1941–1943	52.0	50.5	53.5	Finland			
Colombia				1901–1910	46.7	45.3	48.1
1939–1941	46.3	[2]	[2]	1941–1945	57.9	54.6	61.1
Venezuela				Bulgaria			
1941–1942	46.7	45.8	47.6	1900–1905	42.2	42.1	42.2
Chile				1925–1928	46.3	45.9	46.6
1919–1922	31.6	30.9	32.2	Russia (European)			
1939–1942	41.9	40.7	43.1	1896–1897	32.4	31.4	33.4
				1926–1927	44.4	41.9	46.8
				Portugal			
				1939–1942	50.7	48.6	52.8
				Spain			
Europe				1930–1931	50.3	48.7	51.9
England and Wales				Italy			
1901–1910	50.5	48.5	52.4	1901–1910	44.5	44.2	44.8
1937	62.3	60.2	64.4	1930–1932	54.9	53.8	56.0
Scotland				Greece			
1910–1912	51.7	50.1	53.2	1920	44.7	42.9	46.5
1930–1932	57.8	56.0	59.5	1928	50.0	49.1	50.9
Northern Ireland							
1900–1902	48.7	50.7	46.7	*Oceania*			
1936–1938	58.5	57.8	59.2	Australia			
Ireland				1901–1910	57.0	55.2	58.8
1925–1927	57.7	57.4	57.9	1932–1934	65.3	63.5	67.1
1940–1942	60.0	59.0	61.0	New Zealand			
Iceland				1901–1905	59.4	58.1	60.6
1901–1910	50.7	48.3	53.1	1934–1938	67.0	65.5	68.5
1931–1940	63.3	60.9	65.6				
Norway				*Africa and Asia*			
1901–1911	56.3	54.8	57.7	Egypt			
1921–1931	62.4	61.0	63.8	1936–1938	38.6	35.7	41.5
Sweden				Union of So. Africa			
1901–1910	55.8	54.5	57.0	European			
1936–1940	65.6	64.3	66.9	1920–1922	57.4	55.6	59.2
Denmark				1940	63.8	61.5	66.1
1901–1905	54.6	52.9	56.2	Non-European			
1941–1945	66.7	65.6	67.7	1935–1937	40.6	40.2	40.9
Netherlands				Japan			
1900–1909	52.2	51.0	53.4	1899–1903	44.5	44.0	44.9
1931–1940	66.5	65.7	67.2	1935–1936	48.3	46.9	49.6
Belgium				India			
1891–1900	47.1	45.4	48.8	1891–1901	23.8	23.6	24.0
1928–1932	57.9	56.0	59.8	1921–1931	26.8	26.9	26.6

[1] Average of male and female except for United States, white, in 1939–1941.
[2] Not available.
[3] Based on data for Bohemia and Moravia-Silesia.
Source: *Statistical Bulletin*, March 1950, Metropolitan Life Insurance Company, New York.

crystallized in the modern public health movement. As this program developed, the expectation of life at birth responded rapidly and definitely so that each new set of tables showed a corresponding increase in the expectation of life. By 1900, the expectation in the United States had jumped to about 50 years; by 1920, to 55 years and by 1930 to a little over 60 years." By 1948 the expectation of life was a little over 71.0 years for the female, and somewhat over 65.5 for the male.

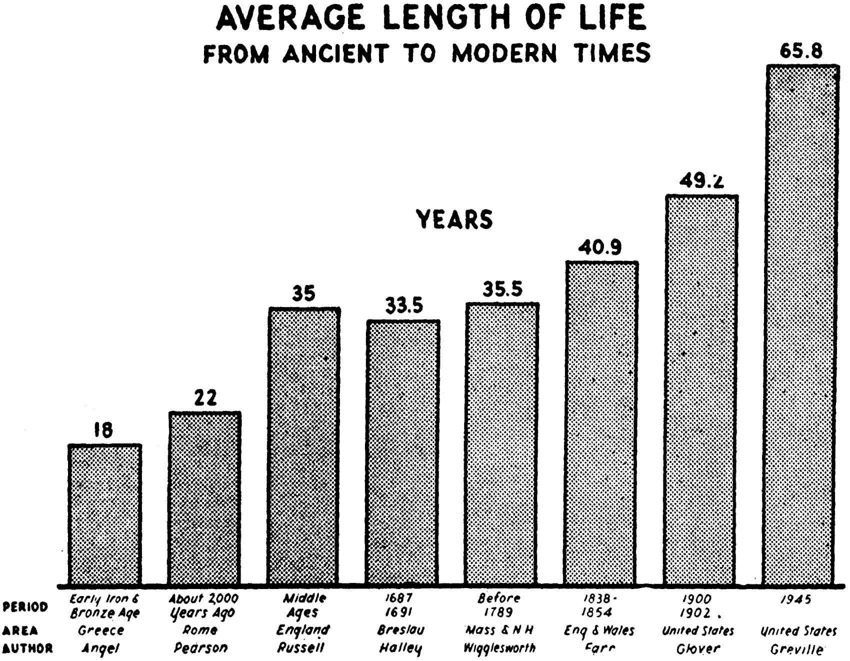


FIG. 145. Average length of life from Ancient to Modern Times. (Courtesy, Metropolitan Life Insurance Company, New York.)

Can it ever be too strongly emphasized that this doubling of the average expectation of life was achieved solely by *the social regulation of environmental conditions?* It is not necessary in this volume to cite the now well known facts regarding the very considerable reduction in infant mortality as well as in other mortality rates, during the last fifty years. The data for expectation of life at birth by sex is given in Table 30.

The relation between economic status, as judged, and for the most part determined, by annual income, and disability from disease, constitutes a very convincing demonstration of the influence of the economic factor upon the conditions determining the physical well-being of the individual. The figures taken from the National Health Survey, 1935-36, shown in Table 31 make this abundantly clear. As will be seen from this Table members of families on relief suffer more than two-and-one-half times the volume of disability from all diseases combined than do families with incomes of $5,000 and over. The ratio for specific diseases ranges from almost nine times for tuberculosis to 1.24 times for infectious diseases. The facts brought out in this table should at this late date be known and understood by everyone. Similar tables could be provided for almost every country in the world. It is here necessary to point out that the relation between socio-economic conditions and disease is not simply one-way, for disease

TABLE 31. RATIO OF ANNUAL PER CAPITA VOLUME OF DISABILITY IN THE UNITED STATES* FOR LOW INCOME GROUPS TO THAT IN THE HIGHEST INCOME GROUPS; 1935-36 ACCORDING TO SPECIFIED DIAGNOSIS CLASSIFICATIONS†

	INCOME STATUS OF FAMILY			
Diagnosis	Relief	Under $1000 per year	$1000 to $1500 a year	$5000 and over
Tuberculosis	875	388	250	100
Orthopedic Impairments	420	283	175	100
Rheumatism	369	213	138	100
Digestive Diseases	340	180	114	100
Nervous Diseases	287	204	135	100
Degenerative Diseases	268	156	109	100
Accidents	221	173	129	100
Respiratory Diseases	189	121	91	100
Infectious Diseases	124	93	93	100
All Diagnoses	266	166	121	100
Diagnoses not elsewhere grouped	261	160	127	100

* Defined as the product of the frequency of illness and the duration of illness.

† Adjusted to the age composition of the National Health Survey total white population, 1935-36.

Source: National Health Survey, 1935-36, Preliminary Reports, Sickness and Medical Care Series, Bulletin No. 9, *Disability from Specific Causes in Relation to Economic Status* (Washington, 1938), p. 9.

tends to reduce the wage-earner to a low income group. However, the fact remains that the incidence of disease is to a very large extent a function of socio-economic factors.

The relation between occupation and physical disability of various sorts is, of course, well known and need not be dealt with here.

The effects of dietary habits, and such practices as drinking and smoking, which are all socially conditioned, are more or less well known. As Pearl has shown, heavy drinking and even moderate smoking are associated with reduced longevity.

Growth. Among the most striking effects of socio-economic factors upon the organism are those which express themselves in the growth of the individual. Differences in environment determined by these factors are operative from the moment of conception, if not before. The best discussion of the subject is to be found in Sanders' book, *Environment and Growth.*

Growth may be defined as increase in size, while by development is to be understood increase in complexity.

A detailed and rigorously critical study of the evidence shows that, regardless of area, children reared in a superior socio-economic environment are, on the average, heavier and taller than their age-mates who have been exposed to a less favorable environment. A general improvement in the environment of the child, whether introduced by increased income or by placement in an institution where his status is improved, or by more competent care, tends always to accelerate growth. Conversely, an increase in untoward conditions, disease, poverty or a general deterioration of the environment, is followed by a decline in the rate of growth.

From such findings it should be evident that no studies of human growth which fail to pay careful attention to the socio-economic factors can be regarded as satisfactory, for the evidence strongly suggests that there are few, if any, aspects of the growth process which are not affected by these factors.

These facts were well brought out in one of the earliest studies made on the relation between socio-economic factors and growth. This study, carried out in Glasgow, Scotland, during the years 1905-1906, was devoted to an investigation of the heights and weights of 70,000 school children between five and 18 years of age. The results obtained were then correlated with the types of school which the children attended, this yielded four socio-economic district school groups from A to D, where "A" were from the poorest districts of the city and "D" from the most prosperous. The results of this study are shown in Table 32.

TABLE 32. HEIGHT (INCHES) AND WEIGHT (POUNDS) IN 70,000 GLASGOW (SCOTLAND) SCHOOL CHILDREN, 1905–1906, BY ASCENDING ORDER (FROM A TO D) OF SOCIO-ECONOMIC STATUS OF SCHOOL

Age:	5	6	7	8	9	10	11	12	13
Boys				*Height* (*Inches*)					
Group A	41.3	43.0	45.1	47.0	48.8	50.6	52.3	53.8	55.2
Group B	42.1	44.0	45.9	47.7	49.5	51.1	52.8	54.3	55.5
Group C	42.1	44.0	46.2	48.1	49.9	51.5	53.5	55.0	57.2
Group D	43.0	44.8	46.9	49.0	50.9	52.6	54.2	55.9	57.7
Girls									
Group A	41.0	42.9	44.6	46.6	48.5	50.3	52.4	54.4	55.8
Group B	42.0	43.7	45.6	47.4	49.2	51.1	53.0	55.2	57.1
Group C	41.9	43.7	45.6	47.6	49.4	51.2	53.3	55.4	57.0
Group D	42.7	44.8	46.4	48.6	50.4	52.2	54.1	56.5	58.7
Boys				*Weight* (*pounds*)					
Group A	40.9	44.2	48.0	52.3	56.7	61.6	66.4	71.7	75.6
Group B	42.0	45.6	49.6	53.9	58.4	62.7	67.8	72.9	77.3
Group C	42.5	45.9	50.1	54.4	59.5	63.9	69.1	75.6	82.2
Group D	43.3	46.6	51.2	56.3	61.2	66.3	70.8	76.9	83.2
Girls									
Group A	39.9	43.0	46.4	50.5	54.7	59.5	65.3	72.4	76.8
Group B	40.6	43.9	47.7	51.8	55.8	60.8	66.8	74.3	81.3
Group C	41.3	44.7	48.1	52.7	56.9	61.9	68.4	76.1	83.0
Group D	41.8	45.6	49.3	54.3	58.8	64.4	70.5	78.8	89.0

From E. M. Elderton, "Height and Weight of School Children in Glasgow," *Biometrika*, 10(2/3): 288–340, 1914.

From Table 32 it will be seen that at practically every age, and for both sexes, a very appreciable and regular difference was shown between the children of the four graded socio-economic districts, in both height and weight, and this always in favor of the higher socio-economic groups. Thus, at age nine the average height of boys in district A was 48.8 inches, in B 49.5 inches, in C 49.9 inches, and in D 50.9 inches. At every age we observe a steady increase from group A to group D. Boys from district D at age five are between 1.7 inches and at age thirteen 2.5 inches taller than those of district B.

Later studies carried out in many different parts of the world have fully confirmed the capital importance of the environment and its effect upon the processes of growth. One of the most striking of these studies, by Craven and Jokl (1946), evaluates the growth records of 1,067 physically substandard adolescent boys studied at the Physical Training Battalion in Pretoria, South Africa. It was found that within the first nine months these boys spent at the training station they grew in bulk, on the average, at a rate five times as great as they would have grown in their unsatisfactory home environment. Nutritional factors would seem to be those most significantly involved. In Table 33 are set out the figures for five different English speaking countries with somewhat different food and other economic habits, showing the percentages of children, between the ages of five and 15 years, by socio-economic status who are under average height.

TABLE 33. PERCENTAGES OF CHILDREN, AGE 5 TO 15 YEARS, WHO ARE UNDER AVERAGE HEIGHT, CLASSIFIED BY COUNTRY AND SOCIO-ECONOMIC STATUS

Location of School	United States	Canada	Scotland	England	Ireland
Prosperous District.......	7.5	11.0	11.2	18.5	22.7
Average District.........	18.3	23.4	24.6	24.4	24.3
Poor District............	36.4	31.6	27.3	35.1	30.7

Adapted from Cudmore and Neal, "A Height and Weight Survey of Toronto Elementary School Children 1939," Ottawa, 1942.

These figures tell a remarkable, and almost dramatic, story. They show how the least number of children under average height and the greatest number of children under average height occur in the land in which the greatest extremes of socio-economic welfare are to be found, in the United States. Here we find that the percentage of children from the prosperous districts who are under average height is only 7.5 while in the poor districts that percentage is as high as 36.4 per cent. Only England, with its (then) notoriously bad nutrition, comes anywhere near the figure with 35.1 per cent. On the average, however, there are less under height children in the United States than in the other four English-speaking countries. Indeed, English children from prosperous districts do not do as well as American children from average districts. On the whole these figures would point to the nutritional factor as being the one most directly involved here.

Studies carried out by Boas on institutionalized children have very impressively demonstrated the effect of nutrition upon stature. With an ill balanced diet the children were retarded in stature, when the diet was improved there were not only fewer under height children, but all those who had been retarded finally attained normal height.

In a study already cited Goldstein has shown that the descendants of Mexican immigrants in Texas are taller and better developed than Mexicans of the same generation living in Mexico. He found also that the adult children of Mexican parents in Mexico proper, as well as those born of Mexican parents in the United States were taller and better developed than their parents, the American born, however, being always superior in these respects to the Mexican born. Goldstein attributes these changes to improvement in living conditions, that is, better and more food, better housing, health, and sanitation.

From such findings it should be evident that the general environmental factors can scarcely ever be adequately separated from the factors which are broadly classified under heredity. Methodologically, there will always be good reason for attempting to separate out these factors, but while this is so there is also a sound case for bearing in mind the fact that there is such a thing as social heredity as well as biological heredity, and that strictly speaking the two can never be completely separated. The general framework of the individual is due to its genotype which is biologically inherited, but the detailed development of this framework is always more or less considerably influenced by the environment which the individual has socially inherited. Hence, strictly speaking heredity must be regarded as the blending of two inheritances, the one biological, and the other social. A great deal of much needed attention has been paid to the former, but far too little to the latter type of inheritance and its effects. It has been the principal purpose of the present chapter to draw attention to the much neglected important physical effects of the latter.

FOR FURTHER READING, CONSULT:

Bews, J. W.: *Human Ecology*. New York, Oxford University Press, 1935.
An introduction to the study of man in relation to his total environment.

Dahlberg, G., Environment, inheritance and random variations with special reference to investigations on twins. *Acta Genetica et Statistica Medica*, Basle, *1: 1;* 104-114, 1948.
A valuable discussion of chance and prenatal influence upon development, with a long-overdue caution with respect to inferences concerning the mechanism of heredity in man drawn from the study of so-called identical twins.

Draper, G., Dupertius, C. W. and Caughey, J. L. Jr.: *Human Constitution and Clinical Medicine*. New York, Hoeber, 1944.
An important study of constitution and disease.

Ewing, O. R.: *The Nation's Health*. Washington, D.C., Federal Security Agency, 1948.
An illuminating report on the state of the nation's health, with recommendations for its improvement.

Fitt, A. B.: *Seasonal Influence on Growth, Function and Inheritance*, London, Oxford University Press, 1941.
A useful and informative analysis.

Gates, R. R.: *Human Genetics*. 2 vols., New York, Macmillan, 1946.
An exhaustive source book. To be used with caution.

Halliday, J. L.: *Psychosocial Medicine*. New York, W. W. Norton, 1948.
A brilliant application of the concepts of psychosomatic medicine to the illness of communities and social groups.

Krogman, W. M.: The growth of man. *Tabulae Biologicae, 20:*VI-963, 1942.

Lessa, W. A.: *An Appraisal of Constitutional Typologies*. American Anthropological Association, Memoir No. 62, 1943.
A well balanced critical examination of both psychological and morphological constitutional typologies.

Mead, M.: *Male and Female*. New York, Morrow, 1949.
A brilliant study of the sexes in a changing world, full of illuminating insights and provocative ideas.

M'Gonigle, G. C. M., and Kirby, J.: *Poverty and Public Health*. London, Gollancz, 1936.
An impressive survey of the relation between poverty, health, and its social and biological consequences.

Monge, C.: *Acclimitization in the Andes*. Baltimore, Johns Hopkins Press, 1948.
An extremely interesting study of the effects of climatic effects upon the physiological functions and survival of man, under differences of air density, temperature, and atmospheric pressure.

Montagu, M. F. Ashley: Constitutional and prenatal factors in infant and child health. In *Symposium on the Healthy Personality* (edited by M. J. E. Senn), New York, Josiah Macy Jr. Foundation, 1950, p. 148-210.
An examination of the evidence concerning the roles played by genetic and environmental factors in the development of the fetus, and the influence of these factors upon the postnatal development of the person.

Newburgh, L. H. (editor). *Physiology of Heat Regulation and the Science of Clothing*. New York, Saunders, 1949.

An invaluable work on man's adjustment to climate and clothing as a thermal barrier. The opening chapter by F. R. Wulsin brings together the material on adaptations to climate, among non-European peoples.

Newman, H. H.: *Multiple Human Births.* New York, Doubleday, Doran, 1940.

The most reliable and readable account of the subject.

———, Freeman, F. N. and Holzinger, K. J.: *Twins: A Study of Heredity and Environment.* Chicago, Univ. Chicago Press, 1937.

The most authoritative study of its kind.

Perla, D. and Marmorston, J.: *Natural Resistance and Clinical Medicine.* Baltimore, Williams & Wilkins, 1941.

The best and most exhaustive discussion of genetic, ethnic, environmental, climatic, and numerous other factors influencing natural resistance.

Petersen, W. F.: *The Patient and the Weather.* Ann Arbor, Michigan, Edwards Bros., vols. 1-4, 1934-39.

A very full presentation of original observations on the relation between changes in the weather and associated changes in persons suffering from various diseases.

Sanders, B. S.: *Environment and Growth.* Baltimore, Warwick & York, 1934.

An excellent review and analysis of the data on man.

Scheinfeld, A.: *Women and Men.* New York, Harcourt, 1944.

An excellent discussion of the differences between the sexes.

Schwesinger, G.: *Heredity and Environment.* New York, Macmillan, 1933.

A good presentation of the problem, and a clear discussion of the data presented.

Sheldon, W. H.: *The Varieties of Human Physique.* New York, Harper & Bros., 1940.

———, *The Varieties of Human Temperament,* New York, Harper & Bros., 1942.

———, *Varieties of Delinquent Youth.* New York, Harper & Bros., 1949.

The three fundamental works on the techniques and principles of somatotyping.

Škerlj, B.: *Development of Secondary School Students of Ljubljana.* Institut za Antropologijo, Univerza V Ljubljana, Ljubljana, 1950.

A valuable study of the relationship of social factors to physical development.

Stern, B. J.: *Society and Medical Progress.* Princeton, Princeton Univ. Press, 1941.

An excellent, and very readable, account of the progress made in human health under improved living conditions, and the development of medical and public health measures.

Thorndike, E. L.: *Human Nature and the Social Order.* New York, Macmillan.

A fundamental book on the expression of human nature in the United States.

Tucker, W. B. and Lessa, W. A.: Man: a constitutional investigation. *Quart. Rev. Biol., 15:* 265-289, 1940.

A valuable survey of constitutional classifications.

Woodworth, R. S.: *Heredity and Environment.* New York, Social Sc. Res. Council, 1942.

A critical survey of recently published material on twins and foster children.

APPENDIX

A PRACTICAL SYNOPSIS OF METHODS OF MEASUREMENT IN PHYSICAL ANTHROPOLOGY

THE MEASUREMENT OF MAN

THE following account is intended to give the reader a working knowledge of some of the methods of measurement most commonly used in physical anthropology. For a more complete account the reader should refer to the works listed at the conclusion of this appendix.

In view of the fact that no two persons are ever alike in all their measurable characters, that the latter tend to undergo change in varying degrees from birth to death, in health and in disease, and since persons living under different conditions, and members of different ethnic groups and the crosses between them, frequently present interesting differences in bodily form and proportions, it is necessary to have some means of giving quantitative expression to the variations which such traits exhibit. *Anthropometry* constitutes that means. It is the technique of expressing quantitatively the form of the body. Anthropometry means the measurement of man, whether living or dead, and consists primarily in the measurement of the dimensions of the body.

While the methods of measurement used in physical anthropology are numerous, there are only two which are uniquely its contribution and which are peculiar to it, these are anthropometry and anthroposcopy. Other methods have been borrowed from anatomy, medicine, physiology, biochemistry, genetics, and statistics. In fact, physical anthropology makes use of every method which is capable of throwing light upon the significant likenesses and differences existing between individuals and groups of men.

Anthroposcopy is the visual observation and description of physical traits which do not easily lend themselves to exact measurement. For example, form and character and distribution of the hair, skin color, eye color, eye folds, form of lip, of nose, and the like.

Physiometry, the measurement of the physiological functions of the body, constitutes an important adjunct of anthropometry, the methods of which are mostly borrowed from physiology and serology.

Anthropometry is conveniently subdivided as follows:

Somatometry: The measurement of the body in the living and in the cadaver.
Cephalometry: Included in somatometry, the measurement of the head and face in the living and in the cadaver.
Osteometry: The measurement of the skeleton and its parts.
Craniometry: Included in osteometry, the measurement of the skull.

The techniques of anthropometry are best acquired from an experienced worker in the field of laboratory. The attainment of accuracy in anthropometry requires a good deal of practice. A fundamental rule to bear in mind is that when a problem requiring the assistance of anthropometry is presented, all those parts of the body, and only those, should be measured which are capable of throwing some light upon that problem. If the form and dimensions of the lower jaw are the subject of principal interest, it is very unlikely that the length of the forearm will cast any additional light upon the problem. The dimensions of the head would seem more likely to be of assistance, and in any event constitute relevant information for an understanding of the lower jaw in its anatomico-physiological relationships, hence it were advisable to make relationally significant measurements of the head.

On the other hand if one is interested in relative growth, rates of growth may be discovered to exist for lower jaw and for upper and lower extremities which are similar. This, indeed, has recently been found to be the case.[1] In studies of growth few measurements can be irrelevant.

New methods based on sound principles may always be devised by an investigator to meet the demands of his particular problem. Measurements based on genuine functional biological relations are those most to be encouraged. The development of such biologically based measurements is to be preferred to the slavish

---

[1] Shepherd, R. H., Sholl, and Vizoso, A.: The size relationships subsisting between body length, limbs and jaws in man. *J. Anat.,* 83: 296-302, 1949.

repetition of those embalmed in anthropometric manuals, not excluding the present one.

Essential Historical Data

The history of the person measured should always be taken, since that history is to some extent part and parcel of the body being measured. Anthropometric findings should, so far as possible, always be evaluated in the light of the historical data. The following constitute the minimum historical data to be gathered:

Name
Sex
Age, to the nearest birthday
Birthplace
Ethnic group
Birth order, 1st, 2nd, etc.
Brothers
Sisters
Mother's ethnic group
Father's ethnic group
Religion
Occupation
Social status
Economic status
Physical environment
First menstruation
First conception
Marital status
Children
Illnesses

Instruments in Somatometry

The following instruments are those most commonly used in somatometric as well as in osteometric studies.

Weight Beam Scale.[2] To determine weight, preferably in grams.

Camera. Photography of subjects.

Measuring Tape. Graduated in millimeters, of good flexible steel.

Anthropometer.[3] For measuring height and various transverse diameters of the body, this convenient instrument generally consists of four hollow tubes which fit into one another to form a rigid rod of about two meters in length. Each tube is graduated in

---

[2] No. 66830, C. H. Stoelting & Company, Illinois, weighs up to 240 pounds, the beam is graduated in both pounds and grams. This balance scale is portable and therefore lends itself for use in field work. A remarkably light scale (total weight two pounds) has recently been developed by Dr. Morris Steggerda. This scale is capable of weighing a man of 325 pounds. It is obtainable from the Swan Tool and Manufacturing Machine Company, 30 Bartholomew Avenue, Hartford, Connecticut.

[3, 4, 5] May be inexpensively purchased from the Swan Tool and Manufacturing Machine Company, 30 Bartholomew Avenue, Hartford, Connecticut.

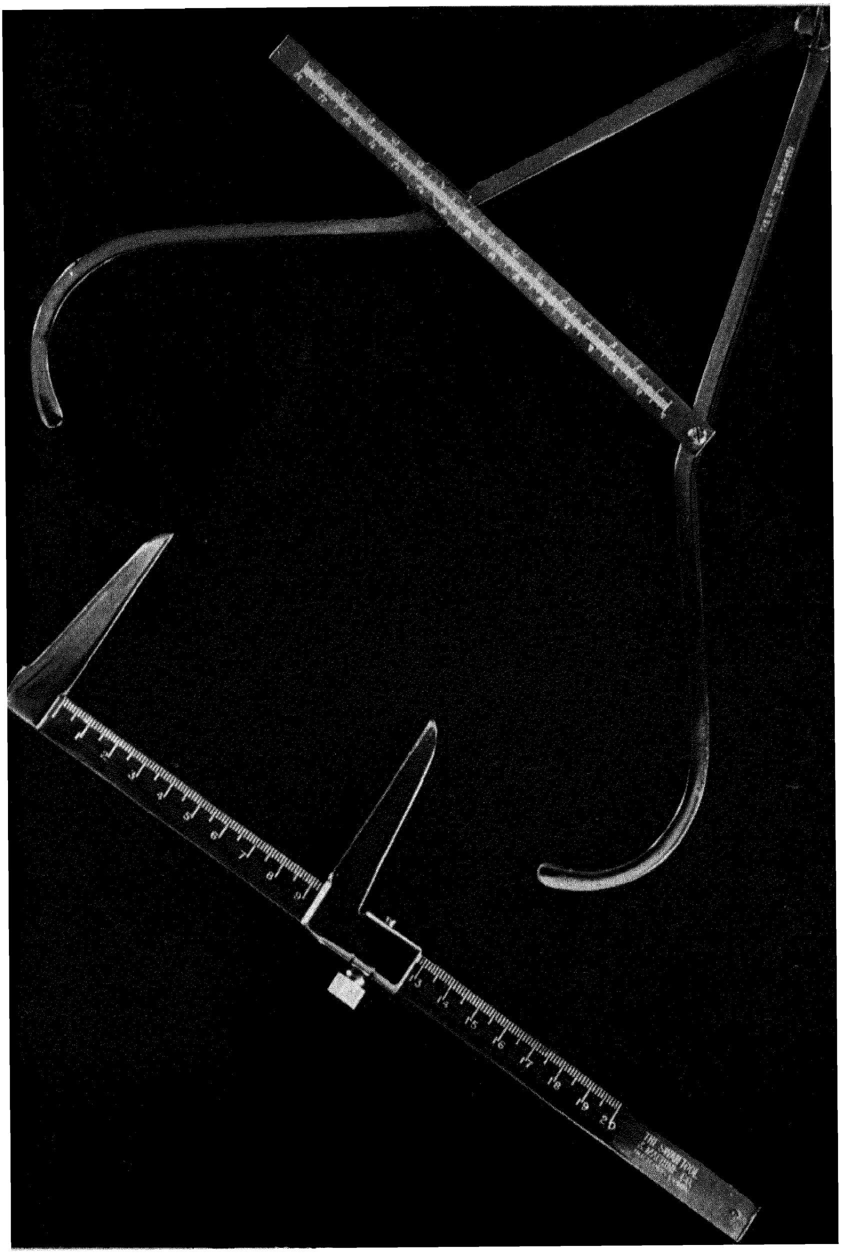


FIG. 146. Sliding compass (below) and spreading calipers (above). (Photo Dr. Morris Steggerda and the Swan Tool and Machine Company, Hartford, Conn.)

millimeters, one side reading from above and the other from below zero to two thousand millimeters. This instrument may be used for taking stature, sitting-height, and various other heights, as a caliper in taking transverse diameters, and as a pelvimeter.

Spreading Caliper.[4] For measuring such diameters of the head as the length and breadth of the head, bizygomatic diameter, etc.

Sliding Compass. For measuring shorter diameters such as those of the nose, ears, hand, etc.[5]

Head Spanner. For determining the height of the head.[6]

SOMATOMETRY

Measurement of the Dimensions of the Body

It is desirable to make most measurements with the subject in the standing position. To this rule measurements of the head and face, sitting-height, and a few others constitute the only exceptions.

Whenever possible all measurements should be made during the morning rather than the afternoon or evening, for the reason that individuals generally decrease in height from morning towards evening, and further because they tend to be more relaxed during the morning.

Where the body as a whole is being measured it is preferable that the subject be completely unclothed. When this is not possible the investigator will have to make the best of the situation encountered. All measurements on the living should be made with a minimum of pressure by the instruments.

Landmarks (see Figs. 147 and 148). In order that all measurements shall be comparable it is customary to take them from certain definite points, these are designated as landmarks. These landmarks will not be listed separately here but will be defined in connection with the measurements to be taken.

Measurements With Subject in Standing Position

Position of Subject. All measurements, unless otherwise indicated, should be made with the subject standing in the military

---

[6] This and all other anthropological instruments may be ordered from Siber Hegner & Co., Ltd., Talstrasse 14, Zurich, Switzerland. New York office: 183, Madison Avenue, New York 16, New York. Delivery: four to six weeks. U.S. duty: 45 per cent! Also Gilliland Instrument Co., Oakland, California.

position at attention, head erect, looking straight ahead, so that his visual axis is parallel to the surface of the floor. The latter is the best free approximation to the Frankfurt Plane (p. 451).

1. *Standing Height or Stature* (Anthropometer). The distance from the highest point of the top of the head in the mid-sagittal plane to the floor.

2. *Suprasternal Height* (Anthropometer). From the middle of the anterior-superior border of the manubrium sterni to the floor.

3. *Right Acromiale Height* (Anthropometer). From the most lateral projection of the lateral border of the acromion of the scapula to the floor.

4. *Right Radiale Height* (Anthropometer). From the highest point of the head of the radius (usually at the dimple of the elbow) to the floor.

5. *Right Stylion Height* (Anthropometer). From the distolateral end of the styloid process of the radius to the floor.

The *upper* and *lower arm dimensions* may be obtained by the subtraction of measurements 4 from 3 and 5 from 4, but are more accurately measured directly.

6. *Upper Arm Length* (Anthropometer). From acromiale to radiale when the arm is hanging down and the palm facing inward.

7. *Lower Arm Length* (Anthropometer). From radiale to stylion when the arm is hanging down and the palm facing inward.

8. *Total Arm Length* (Anthropometer). From acromiale to stylion when the arm is hanging down and the palm facing inward or by adding measurements 6 and 7.

9. *Total Upper Extremity Length* (Anthropometer). From acromiale to dactylion, *i.e.* the tip of the middle finger.

10. *Right Dactylon Height* (Anthropometer). From the middle of the tip of the middle finger when the fingers are removed from contact with the thigh and are pointing perpendicularly downwards to the floor.

11. *Right Iliocristale Height* (Anthropometer). From the most laterally projecting point on the crest of the right ilium to the floor.

12. *Right Iliospinale Height* (Anthropometer). From the right anterior-superior iliac spine to the floor.

13. *Right Trochanterion Height* (Anthropometer). From the

superior surface of the greater trochanter of the femur to the floor.

14. *Right Tibiale Height* (Anthropometer). From the superior surface of the medial condyle of the tibia to the floor.

15. *Right Sphyrion Height* (Anthropometer). From the inferior surface of the medial malleolus to the floor.

Transverse and Antero-Posterior Dimensions

16. *Span* (Anthropometer). The distance between the tips of the middle fingers of each hand when the arms are outstretched sidewards horizontally from the body. Measured from behind.

17. *Bi-Acromial Breadth* (Anthropometer used as sliding compass). The distance between the most lateral margins of the acromion processes of the scapula, the subject standing as he does normally.

18. *Chest Breadth or Transverse Diameter of the Thorax* (Anthropometer used as sliding compass). The transverse distance between the most lateral points on the chest. The mean of the measurements made at expiration and inspiration while the subject is breathing normally.

19. *Chest Depth or Antero-Posterior Diameter of the Thorax* (Large Spreading Caliper). At the level of the inferior angles of the scapulae. The mean of the measurements made at expiration and inspiration while the subject is breathing normally.

20. *Bi-Iliac or Pelvic Breadth* (Anthropometer used as a sliding

---

»»→

FIG. 147 Landmarks of the body (after Martin).

FIG. 147A. Landmarks on the frontal view. 1, vertex; 2, trichion; 3, nasion; 4, prosthion; 5, gnathion; 6, suprasternale; 7, akromion; 8, mesosternale; 9, thelion; 10, radiale; 11, omphalion; 12, iliocristale; 13, iliospinale anterior; 14, symphysion; 15, trochanterion; 16, stylion; 17, phalangion; 18, daktylion; 19, tibiale; 20, sphyrion.

FIG. 147B. Landmarks in the lateral view. 1, vertex; 2, nasion; 3, stomion; 4, gnathion; 5, cervicale; 6, akromion; 7, suprasternale; 8, mesosternale; 9, thelion; 10, radiale; 11, omphalion; 12, iliospinale anterior; 13, symphysion; 14, trochanterion; 15, stylion; 16, phalangion; 17, daktylion; 18, pternion; 19, akropodion.

FIG. 147C. Landmarks in the posterior view. 1, vertex; 2, cervicale; 3, akromion; 4, radiale; 5, lumbale; 6, iliocristale; 7, iliospinale posterior; 8, trochanterion; 9, phalangion; 10, daktylion; 11, tibiale; 12, sphyrion.

compass). From iliocristale, the most lateral point on the crest of the ilium to iliocristale.

21. *Bi-Trochanteric or Hip Breadth* (Anthropometer used as a sliding compass). From trochanterion, the most lateral point on the great trochanter, to trochanterion.

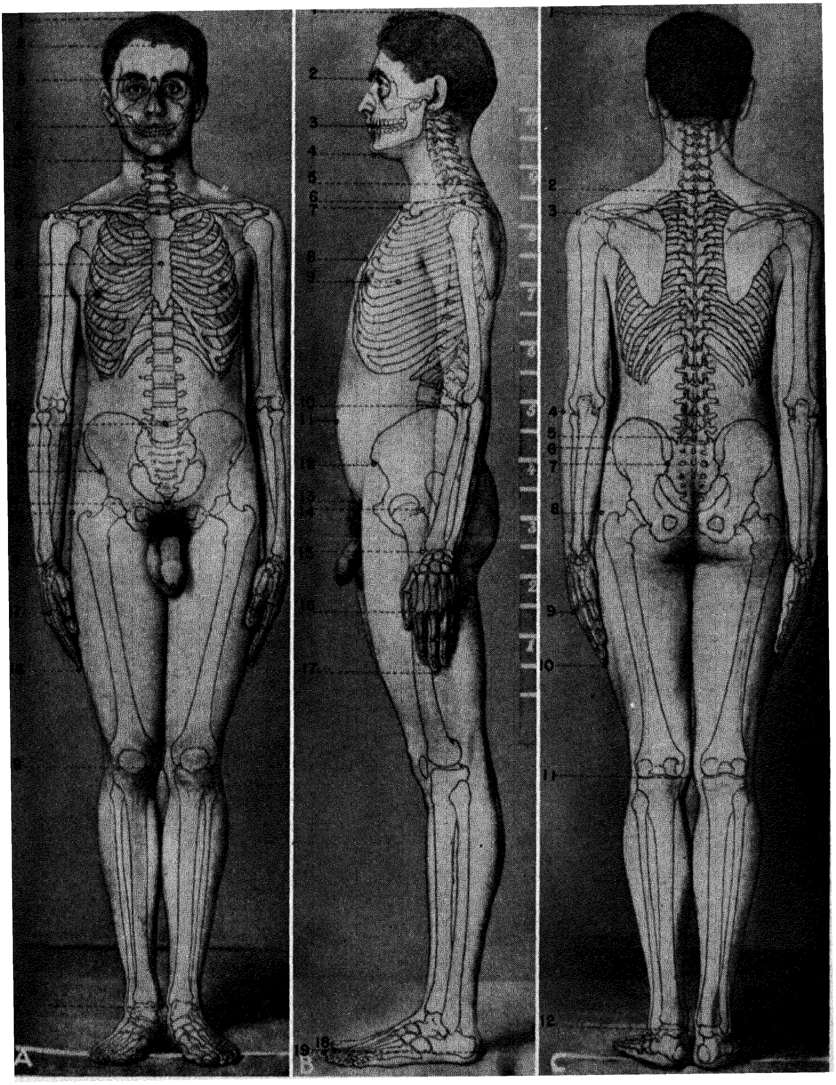


FIG. 147. See legend opposite page.

Girths

22. *Axillary Chest Girth* (Tape). The tape applied well up in the axillary fossae. Mean reading of measurements during normal inspiration and expiration.

23. *Mesosternale Chest Girth* (Tape). At the level of the mesosternale. Mean of measurements during normal inspiration and expiration.

24. *Minimum Circumference of the Trunk-Waist Girth* (Tape). The minimum waist girth. Mean of measurements during normal inspiration and expiration.

25. *Maximum Gluteo-Pubic Circumference—Hip Girth* (Tape). The subject stands in the military position at attention. The tape is placed over the most prominent portion of the buttocks, is brought around the level of the greater trochanters to terminate anteriorly at the level determined by the buttocks and trochanters in the pubic region.

26. *Maximum Circumference of the Right Arm* (Tape). When the arm is hanging relaxed at the subject's side.

27. *Maximum Circumference of the Right Forearm* (Tape). Immediately distal to the elbow joint, with the whole extremity relaxed.

28. *Minimum Circumference of the Right Forearm—Girth of Wrist* (Tape). Slightly above the level of the styloid processes of the radius and ulna.

29. *Maximum Circumference of the Right Thigh* (Tape). Perpendicular to the long axis of the thigh, with the tape in the gluteal fold.

30. *Minimum Circumference of the Right Thigh* (Tape). Slightly proximal to the condyles of the femur.

31. *Maximum Circumference of the Right Leg—Girth of Calf* (Tape). The level of the maximum diameter above the floor should also be recorded.

32. *Minimum Circumference of the Right Leg—Girth of Ankle* (Tape). Slightly above the level of the malleoli.

Measurements With Subject in Sitting Position

Sitting Heights

A bench or box, high enough to keep the subject's feet away from the ground is placed against a wall, and the subject is instructed to take his seat in such a manner as to enable him to swing his legs freely over the front of the bench or box, while his scapular and sacral regions are resting vertically against the surface of the wall. In this position all measurements are taken from the specified landmark to the seat of the bench or box. The subject sits erectly with the head in the plane of the visual axis.

33. *Sitting Vertex Height* (Anthropometer). From the highest point, in the sagittal plane, of the head to the surface upon which the subject is seated.

34. *Sitting Suprasternale Height* (Anthropometer). From the middle of the anterior-superior border of the manubrium sterni to the floor.

By subtracting 34 from 33 the height of the head and neck is obtained.

Dimensions of the Hand and Foot

35. *Maximum Hand Length* (Sliding Compass). The hand is laid flat on a table. The distance from the mid-point of a line connecting the styloid processes of radius and ulna to the most anterior projection of the skin of the middle finger.

36. *Hand Breadth* (Sliding Compass). From the radial side of the second metacarpo-phalangeal junction to the ulnar side of the fifth metacarpo-phalangeal junction.

37. *Maximum Foot Length* (Spreading Calipers). From the most posteriorly projecting point on the heel (akropodion) to the tip of the most anteriorly projecting toe (pternion), when the subject is standing erect.

38. *Foot Breadth* (Anthropometer as Sliding Compass). From the medial margin of the head of the first metatarsal to the lateral margin of the head of the fifth metatarsal.

Dimensions of the Head

Measurements of the head are best made while the subject is comfortably seated in a chair. As for the rest of the body so in the case of the head, the measurements which the investigator will want to make upon the head will, for the most part, be determined by the nature of his problem. Below are given the measurements most generally made, but the investigator may devise others to suit the special requirements of his particular problem. Such new measurements, however, must have some morphological basis and should not begin and end, as it were, in thin air.

Before listing the measurements made to determine the various dimensions of the head it is necessary to define the landmarks from which such measurements are conventionally made. The position of these landmarks is shown in Fig. 148.

Alare (al). The most lateral point on the wing of the nose.

Cheilion (ch). The most lateral point at the corner of the lips.

Ectocanthion (ex). Outer corner of the eye or palpebral opening.

Endocanthion (en). Inner corner of the eye or palpebral opening.

Euryon (eu). The most lateral point on the side of the head.

Frontotemporale (ft). The most medial (deepest) point on the incurvure of the temple, just above and lateral to the orbit (see Fig. 148).

Glabella (g). The most prominent point, in the midsagittal plane, between the eyebrows.

Gnathion (gn). The lowest median point on the lower border of the mandible.

Gonion (go). The most lateral point upon the postero-inferior angle (formed by the ramus and the body) of the mandible.

Infradentale (id). The highest point on the gum between the mandibular central incisors.

Labrale inferius (li). The median point in the lower margin of the lower membranous lip.

Labrale superius (ls.) The median point in the upper margin of the upper membranous lip.

Metopion (m). The median point of a line connecting the two frontal eminences.

Nasion (n). The point at which a horizontal tangential to the highest points on the superior palpebral sulci intersects the midsagittal plane (Fig. 148A). The subject should be looking straight ahead.

Ophryon (on). The median point of a line drawn tangent to the upper border of the eyebrows.

Opisthocranion (op). The point of most backward projection of the head, in the mid-plane.

Orbitale (or). The lowest point in the margin of the orbit.

Otobasion inferius (obi). The lowest point at which the ear attaches to the side of the head.

Porion (po). The point 5.0 mm. above the middle of the external border of the roof of the cutaneous external auditory meatus.

Postaurale (pa). The most posterior point on the helix of the ear.

Preaurale (pra). The point at which a straight line drawn from the postaurale perpendicular to the long axis of the external ear meets the base of the external ear.

Pronasale (prn). The tip of the nose.

Prosthion (pr). The lowest point on the gum between the maxillary central incisors.

Stomion (sto). The central point in the oral fissure when the lips are closed.

Subaurale (sba). The lowest point on the inferior border of the ear lobule when the head is held in the Frankfurt Plane.

Subnasale (sn). The point at which the nasal septum, between the nostrils, merges with the upper cutaneous lip in the mid-sagittal plane.

Superaurale (sa). The highest point on the superior border of the helix.

The Frankfurt Plane or Horizontal (F.H.). The plane determined by the lowest points on the infra-orbital margins (the *orbitalia,* "or" in Fig. 148B) and the tragion or tragial notch of the ear ("t" in Fig. 148A). This corresponds almost exactly to the plane of the visual axis, which obtains when the individual is looking straight ahead of him.

Tragion (t). The notch immediately above the tragus of the ear.

Trichion (tr). The mid-point at the hairline on the forehead.

Tuberculare (tu). Darwin's point on the ear; the tubercle on the upper portion of the helix.

Vertex (v). The highest point of the head, in the mid-sagittal plane, when the head is held erectly or in the Frankfurt Plane.

Zygion (z). The lateralmost point on the zygomatic arch.

Cephalometry

Measurements of the Head

Maximum Head Length (Spreading Caliper). The distance between the glabella and the farthest projecting point in the midsagittal plane, on the back of the head (occiput). The latter point is termed the opisthocranion.

Maximum Head Breadth (Spreading Caliper). The greatest transverse diameter of the head. This is usually found at a point over each parietal bone (each point is termed the euryon).

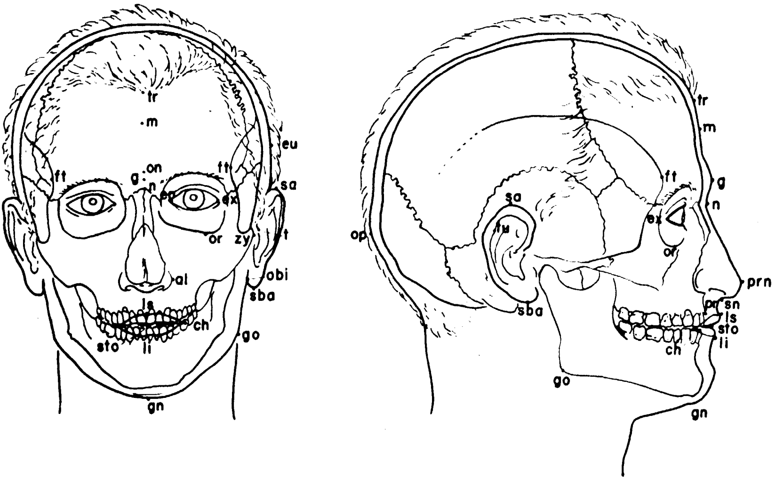


FIG. 148A FIG. 148B

FIG. 148. A. Landmarks in the frontal view of the head. B. Landmarks in the lateral view of the head. al, alare; ch, cheilion; ex, ectocanthion; en, endocanthion; eu, euryon; ft, frontotemporale; g, glabella; gn, gnathion; go, gonion; li, labrale inferius; ls, labrale superius; m, metopion; n, nasion; on, ophryon; op, opisthocranion; or, orbitale; obi, otobasion inferius; prn, pronasale; pr, prosthion; sba, subaurale; sn, subnasale; sa, superaurale; t, tragion; tr, trichion; tu, tuberculare; zy, zygion. (From Martin, *Lehrbuch der Anthropologie,* 1928. Courtesy, Gustav Fischer, Jena.)

Head Height (Todd's Head-Spanner). The fiber-tipped movable horizontal rods are inserted into the ear-holes so that they touch the roof of the latter, the rods are then secured by screws. The orbital arm is then placed at the level of the most inferior point on the infraorbital margin and kept there. As long as this position is maintained the head is in the Frankfurt Plane in relation to the measuring ruler. The latter is then released to the level of the top of the head, and the measurement read off. Eight mm. may be deducted from this measurement to allow for the thickness of the skin and subjacent tissues, should the height of the skull be desired. Five millimeters should then also be deducted to allow for the thickness of the tissues forming the roof of the ear-hole.

Minimum Frontal Breadth (Spreading Caliper). The shortest distance between the origins of the zygomatic processes of the frontal bones (the fronto-temporales, "ft" in Figs. 148A and 148B).

Bizygomatic Breadth (Spreading Caliper). The distance between the most laterally situated points on the zygomatic arches (the zygia, "zy" in Fig. 148B).

Bigonial Breadth (Spreading Caliper). The distance between the gonial points.

Physiognomic Facial Length (Sliding Compass). From trichion to gnathion.

Morphological Facial Height (Sliding Compass). From nasion to gnathion.

Total Jaw Height (Sliding Compass). From subnasale to gnathion. The jaws must be normally closed without undue pressure.

Inter-Canthic Diameter (Sliding Compass). From the medial point of the junction of the upper and lower eyelids ("en" in Fig. 148A) of one side to the other.

Extra-Canthic Diameter (Sliding Compass). From the lateral point of the junction of the upper and lower eyelids ("ex" in Fig. 148A) of the one side to the other.

Nasal Length (Sliding Compass). From nasion to subnasale.

Maximum Physiognomic Nasal Breadth (Sliding Compass). The maximum transverse distance between the most laterally situated points on the wings of the nose (the alare, "al" in Fig. 148A).

Maximum Breadth of the Mouth (Sliding Compass). The maximum breadth of the mouth when the face is in a relaxed condition (from "ch" to "ch" in Fig. 148A).

Physiognomic Ear Breadth (Sliding Compass). The distance between the superaurale and the subaurale ("sa" and "sba" in Fig. 148B).

Physiognomic Ear Breadth (Sliding Compass). The distance between the preaurale and the postaurale. ("pra" and "pa" in Fig. 148B).

Girths

39. *Maximum Circumference of the Head* (Tape). From the smooth area between eyebrows (glabella) around the maximum projection of the occiput (opisthocranion) to the glabella.

40. *Circumference of Neck* (Tape). At the level of the most prominent portion of the thyroid cartilage.

Indices

An index, as used in anthropometry, is the ratio of one measurement to another expressed as a percentage of the larger one. Thus, if it is desired to determine the proportional relation of the breadth of the head to its length, the length is equated to the value of 100, and the breadth is then expressed as a ratio of 100. This yields the cephalic index, in which breadth is to length as x is to 100, the value of x being found by multiplying the actual value of the breadth by 100 and dividing by the actual length. Thus:

$$\frac{\textbf{Breadth} \times \textbf{100}}{\textbf{Length}} = \textbf{Cephalic Index (x).}$$

By means of indices obtained in this way, it is possible to convey an exact idea of the proportion which one measurement bears to another, and thus something of the form of the structures concerned, in a single numerical expression. For example, a cephalic index of 75 per cent means that the breadth of the head is to its length as 75 is to 100; which clearly means that the breadth of the head is equal to three-fourths of its length or is 75 per cent of its length. An index greater than 75 would mean that the head was so much broader in relation to its length, and an index below 75 would mean the opposite. Thus, an index of 100 would mean that the head was as broad as it is long, and an index of 50 that the breadth of the head was exactly equal to half its length.

The number of indices which have been devised are almost countless. A good general rule to follow is to use or devise only such indices as are absolutely necessary to the prosecution, and the presentation of the results, of an investigation.

In comparing any two measurements it is sometimes convenient to refer them to some definite standard, preferably one which is not too variable. Total stature and sitting heights are as near as we can get to such standards, and any bodily measurement may be expressed as an index with reference to total height or sitting height, thus:

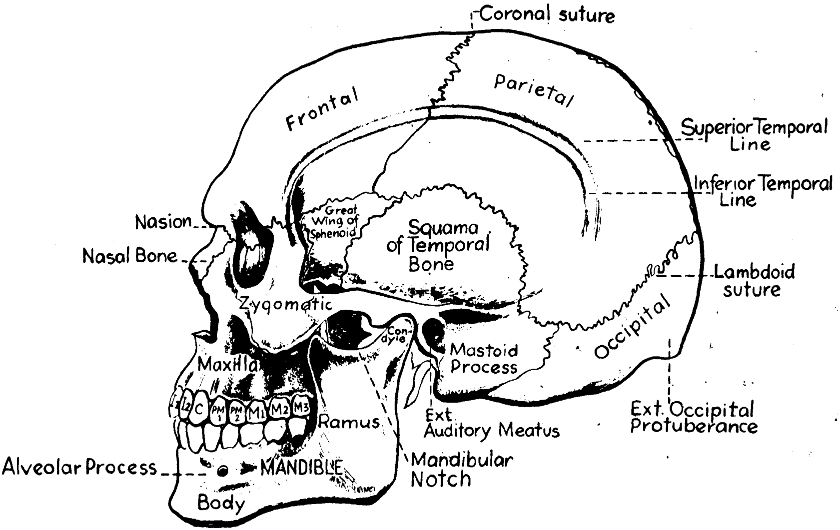


FIG. 149. The Human skull.

$$\frac{\textbf{any bodily measurement} \times \textbf{100}}{\textbf{total height or stature}} = \textbf{stature index of measurement used}$$

$$\frac{\textbf{any bodily measurement} \times \textbf{100}}{\textbf{sitting height}} = \textbf{sitting height index of measurement used}$$

The following represent some of the anthropometric indices most commonly used:

$$\textbf{Cephalic index} = \frac{\textbf{Maximum Head Breadth} \times \textbf{100}}{\textbf{Maximum Head Length}}$$

Dolichocephalic	**× – 75.9**
Mesocephalic	**76.0 – 80.9**
Brachycephalic	**81.0 – 85.4**
Hyperbrachycephalic	**85.5 – ×**

Brachial Index $= \dfrac{\text{Length of Forearm} \times 100}{\text{Length of Upper Arm}}$

Forearm-Hand Index $= \dfrac{\text{Hand Length} \times 100}{\text{Length of Forearm}}$

Hand Index $= \dfrac{\text{Hand Breadth} \times 100}{\text{Hand Length}}$

Tibio-Femoral Index $= \dfrac{\text{Length of Lower Leg} \times 100}{\text{Length of Thigh}}$

Lower Leg-Foot Index $= \dfrac{\text{Length of Foot} \times 100}{\text{Length of Lower Leg}}$

Intermembral Index $= \dfrac{\text{Length of Entire Arm} \times 100}{\text{Length of Entire Leg}}$

Femero-Humeral Index $= \dfrac{\text{Length of Upper Arm} \times 100}{\text{Length of Thigh}}$

Tibio-Radial Index $= \dfrac{\text{Length of Forearm} \times 100}{\text{Length of Lower Leg}}$

Trunk Index $= \dfrac{\text{Biacromial Breadth} \times 100}{\text{Sitting Suprasternale Height}}$

There are many more indices than these, but it is unnecessary to deal with them here. Additional lists of indices will be found in the works on anthropometry cited in the bibliography.

A large number of constitutional indices have been devised, but not one of these has yet proved satisfactory, for the reason that constitution is far too complex a thing to be expressible in terms of a single index.[7]

---

[7] For a list of constitutional indices see Tucker, W. B. and Lessa, W. A.: Man: a constitutional investigation. *Quart. Rev. Biol. 15:* 413-414, 1940.

Cranial Capacity in the Living

This may be computed by the Lee-Pearson formula, as follows: For *males,* .000337 (cephalic length − 11) × (cephalic breadth − 11) × (ear head-height — 11) + 406.01; for *females,* .0004 (cephalic length − 11) × (cephalic breadth − 11) × (ear head-height − 11) + 206.60.

Anthroposcopic Observations

In making visual observations on the subject the investigator must strive to attain the greatest precision, to eliminate the element of subjective judgment, and to obtain as objective a record as possible. The ideal at which to aim is the attainment of standards of accuracy which are as nearly quantitatively expressible as possible. Hence, methods contributing towards this end are, in all instances, to be preferred. The development of such methods is an urgent desideratum. Many anthroposcopic methods at present in use are hopelessly unreliable. Only a few of those available methods can be dealt with here which are capable of yielding relatively sound and comparable observations.

All observations should be made in good light.

Abbreviations which have been used in recording some observations are: abs = absent, undeveloped, none; sl. = slight, very small; sm. = small, submedium, few; + = average, medium, several; + + = above average, large, pronounced, many; + + + = great, very many, extraordinary development; ? = not observable.

1. *Somatotype.* Made from photographs taken in the standard positions described hereunder in direction 18 p. 461-462.
2. *General Sex Facies or Appearance* (after establishment of puberty).
   Whether the mature subject appears to deviate from normalcy; whether he is hypogonadal or gynandromorphic, infantile or juvenile, masculine or feminine (in the opposite sex), adult or senile. By "hypogonadal" is to be understood inadequate development of the secondary sexual characters. By "gynandromorphy" the degree or prominence of the secondary sexual characters of the one sex present in a member of the opposite sex. Since many groups differ from American North European

white standards, the observer should take great care in arriving at his standard of the norm in such groups.

3. *Skin Color.* There is no rule as to where skin color should be taken.

   The inner surface of the upper arm has been frequently used on the assumption that it is a region not too much exposed to sunlight. Whatever region is used should be used constantly in the series under investigation. Skin color should be determined by the use of some fast and easily reduplicable color standard. The best available color standards are obtainable from the non-profit Munsell Color Company (of which Mrs. R. B. Bellamy is manager), 10 East Franklin Street, Baltimore 2, Maryland. It will be found useful to cut a small square out of a piece of cardboard, and hold this over the desired area on the subject for comparison with the color squares on the Munsell charts. This eliminates the distraction of adjoining areas of skin color and speeds accurate matching of colors.

   Record presence and position of any variably pigmented areas, including the so-called "blue-spot" (miscalled "Mongoloid spot") in infants.

4. *Hair Color.* Scalp, face, and body hair, eyebrows, mustache, beard, chest, abdomen, pubes, and extremities, to be observed and recorded separately. Use Munsell color standards. Collect samples of hair and record area from which taken.

5. *Hair Form.* Usually but quite inadequately described as: Straight, low wave, medium wave, deep wave, curly, frizzly or kinky, and coiled or spiral tufts (pepper corn). More exact standards of description are in process of being developed by Dr. Stanley Garn of the Forsyth Infirmary, Boston, Massachusetts.

»»→

FIG. 150. Skin folds over the upper eyelid in man. →The right eye is shown with the root of the nose, nasion, toward the middle of the page. a, complete Mongoloid fold, b, internal epicanthic fold, c, no fold, d, external epicanthic fold, e, median fold. a′, mid-sagittal section showing the relation of the skin fold to the upper eyelid in the Mongoloid, and c′ in the non-Mongoloid. (Modified after Hooton, *Up From the Ape,* 1946. Courtesy, The Macmillan Co.)

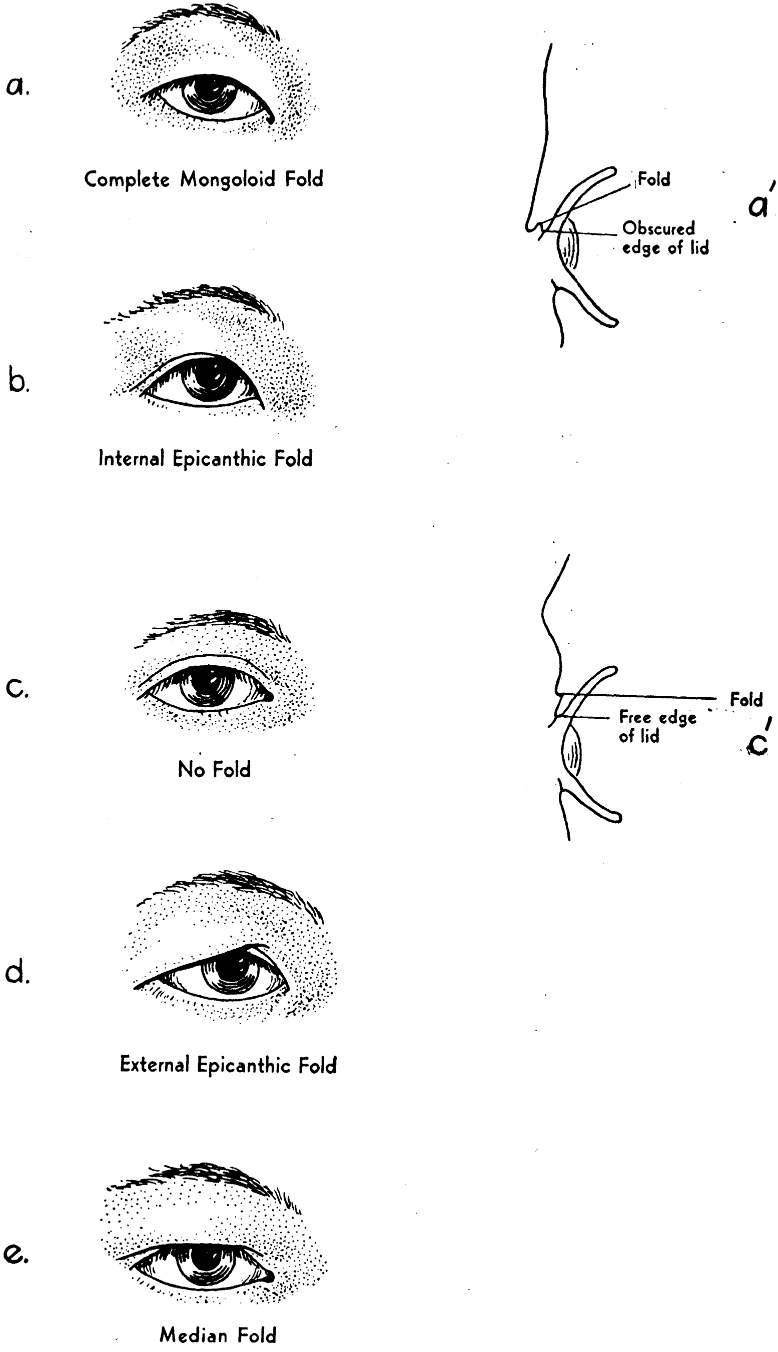


FIG. 150. See legend opposite page.

6. *Hair Quantity.* Number of hairs in a square centimeter of scalp; whether thick, medium, thinning, thin; degree and pattern of baldness.
7. *Eye Color.* With the subject in good light and facing a white surface the iris is matched with Munsell color samples. Record raying, zoning, and spotting of iris.
8. *Supraorbital Ridges.* Absent, slight, medium, and pronounced.
9. *Ear Form.* Degree of rolling of helix; whether lobe of ear is free or attached; Darwin's point; size; shape.
10. *Eyefolds.* The arrangements of the skin over the upper eyelids and canthi.

    Described and defined as follows (see Fig. 150):

    i. *Complete Mongoloid Fold:* The skin above the upper eyelid is loose and hangs down over the free margin of the eyelid.
    ii. *Internal Epicanthic Fold:* The skin hangs over the inner canthus alone.
    iii. *External Epicanthic Fold:* The skin hangs over the external canthus alone.
    iv. *No Fold:* The skin forms a gentle arch above the upper eyelid.
    v. *Median Fold:* The skin hangs down over the middle part of the margin of the upper eyelid and leaves both canthi exposed.
    vi. *Pseudo-Mongoloid Fold:* Usually present in babies but disappears within a year or two with growth; occurs often as an age change in older people, simulating the appearance of the complete Mongoloid fold.
11. *Nose Form.*
    i. *Nasal Profile:* Concave, straight, convex, concavo-convex.
    ii. *Nasal Root:* Flat, recessed, medium, prominent.
    iii. *Nasal Tip:* Narrow, medium, thick, bulbous.
12. *Nostrils.* Broad, oval, round. Angle in relation to mid-sagittal plane.
13. *Lips.*
    i. *Membranous:* Thin, medium, thick, very thick; degree of eversion.
    ii. *Integumental:* Thickness.

14. *Dentition.* A dental form showing the occlusal surfaces of the teeth of the upper and lower jaws should be used, and all observations marked, whenever possible, directly upon the teeth referred to. A dental mirror will be found useful. The following details should be noted:
    - i. *Occlusion or Bite:* Estimated horizontal distance between upper and lower incisors. Recorded as + when upper teeth are in advance of the lower; as − when lower teeth are in advance of the upper.
    - ii. Level above gum of erupting teeth, in millimeters.
    - iii. Shovel-shaped incisors.
    - iv. Supernumerary teeth.
    - v. Congenitally missing teeth.
    - vi. Unerupted teeth.
    - vii. Crowding.
    - viii. Rotation.
    - ix. Accessory cusps or tubercles.
    - x. Wear of occlusal surfaces.
    - xi. Teeth lost by extraction or otherwise.
    - xii. Caries.
    - xiii. Fissural patterns of occlusal surfaces of mandibular three molars, Y5, +5, Y4, or +4.
15. *Mandibular Torus.* Bony thickening, inner sides of mandible.
16. *Palatal Form.* Narrow, intermediate, broad; low, medium, high. Whether torus palatinus (a piling up of bone along the course of the palatine intermaxillary suture which may be felt and often seen at the median raphe in the living) is present.
17. *Chin Form.* Pointed, rounded, square; receding, vertical, slight, medium, marked protrusion. The observer must define his standards and consistently adhere to them.
18. *Standard Photographs.* The aim should be to obtain photographs which give as complete a view of the nude body as possible and all its outlines. This is particularly necessary for somatotyping. Full length views of the front, back, and left side are desirable. Front view and left profile photographs of the head may be taken as supplementary, or when full views in the nude are not possible. The subject should always be placed at a constant distance from the lens of the camera, the back-

ground should always be as nearly uniform as possible, and floor, wall or ground and background so arranged that they merge in the photograph, and preferably appear *white.* For purposes of standard reproduction any background may be air-brushed white. Use panchromatic film. Women should pile the hair on top of the head in a hair net, in order not to obscure the outlines of the neck and shoulders.

Frontal View

i. Subject in normal standing position breathing normally, with lower extremities just sufficiently separated so that the inner aspects of the thighs do not touch.
ii. Eyes looking straight ahead.
iii. Arms, hands, and fingers straight. Lock olecranon process.
iv. Hands five inches out from thighs.
v. Right and left hands palm facing thigh.

Left Profile

i. Arms, hands, and fingers straight. Held flat against the body in center of body outline, so that neither elbow nor hand break the outline behind or in front.
ii. Knees and legs perfectly in line. Do not lock.
iii. Face in perfect profile, subject looking straight ahead.

Back View

i. As front. If lighting is oblique arms should be carried forward to prevent shadow on flanks.[8]

FINGER, PALM, TOE, AND SOLE PRINTS

The skin on the palmar and plantar surfaces of the human hand and foot differs in character from that covering other parts of the body. The palmar and plantar skin is corrugated into continuous ridges and lacks both hairs and sebaceous (oil) glands. Sweat glands are, however, numerous. These corrugated ridges are known as friction ridges and are present in all primates.[9] These

---

[8] For the most recent recommendations for the standardization of techniques in posing the subject see Dupertuis, C. W. and Tanner, J. M.: The pose of the subject for photogrammetric anthropometry, with especial reference to somatotyping. *Am. J. Phys. Anthropol.,* n.s. *8:* 27-47, 1950.

[9] For a comprehensive study see Midlo, C. and Cummins, H.: Palmar and Plantar Dermatoglyphics in Primates. *American Anatomical Memoirs,* No. 20, Philadelphia, Wistar Inst., 1942.

ridges are obviously of great assistance in handling and grasping since they help to counteract slipping. Since from the time of their formation in the early fetus to the final disintegration of the skin after death the patterns which these ridges present remain unaltered[10] they are of use not only for the purpose of identification, in recognizing types of twins, but also in studies of heredity, raciation, sex differences, growth, bodily symmetry, and comparative primatology. *Dermatoglyphics* (*derma,* skin—*glyphe,* carve,) is the name given to the study of the ridge patternings of the skin of the fingers, palms, toes, and soles.

The materials necessary for making finger and palm prints, toe and sole prints are the following: A plate of lucite or bakelite 8″ x 10″ and ¼″ thick, a tube of printer's ink, a rubber roller, and a good grade of white, *not* highly sized, paper or the standard cards customarily in use measuring 8″ x 8″ for finger prints.

An even film of ink is spread on the lucite or bakelite base, and each finger is then rolled firmly from the inner to the outer edge on the film, the same operation then being repeated upon the paper or cards.

A solvent should be available with which to clean fingers. Fingers for printing should be perfectly clean and dry. After the prints have been made the solvent may be used to remove the ink from the fingers.

In palm printing the inked roller is passed several times over the whole area to be printed from the base of the fingers where they join the palm to the flexion creases on the wrist. The ulnar or little finger side of the subject's palm is then laid against the paper and the hand rolled palm downward to the radial or thumb side. Appreciable pressure must be applied to the back of the hand and over the knuckles in order to obtain satisfactory impressions of the central portions of the palms and bases of the fingers. It is essential to print each tri-radius (triangular group of consolidated ridges) at the base of each finger, as well as the carpal tri-radius located at the base of the thumb.

The sole is inked and printed in the same way as the palm.

---

[10] The ridges on the terminal digits may be so worn down as to be invisible. This is often the case in stenographers. In shoeless people (who habitually wear no shoes) the plantar and toe ridges may be similarly worn down.

Each toe is printed separately. Persons suffering from athlete's foot should not be printed even if their friction ridges are visible.

Physiometric Observations

The measurement of the physiological functions of the body will include functions which are sensibly influenced by environmental factors like pulse and even color vision, and some that are not, such as the ability to taste certain substances which is a genetically conditioned trait. A distinction between modifiable physiological functions and genetically conditioned functional traits will not be made here, though the distinction can, of course, and should for certain purposes, be made.

Ten basic observations are here listed which can be made with a reasonable degree of expedition and considerable accuracy.

The subject should always be examined alone. The presence of other persons is distracting, and the desire to imitate or look for clues in the behavior of others confusing. Among non-literate peoples special precautions and cross-checking must be instituted in order to make quite certain the instructions have been understood and the desire of the subject to please has not been too overwhelming.

1. *Physical Fitness or Step Test.* Take pulse with stop-watch. Write down the mean of four one-minute observations. The subject is then asked to step rapidly on and off a 12 inch step or platform for one minute. The exact pace is set with a metronome. Take pulse immediately after subject has completed this operation and determine how long the pulse takes to return to normal.

2. *Dynamometric Strength.* Use a physician's dynamometer with light attached. The mean of the maximum of three squeezes with the hand customarily used for squeezing.

3. *Resistance to Ultra-Violet Ray Burning.* Ethnic variations in sensitivity to skin burning as exhibited in erythema or reddening of the skin due to ultra-violet radiation is something concerning which we know very little. In view of the possibility of selective differences in the frequency of this trait as between different ethnic groups it would be of considerable interest to know whether or not such differences exist. An apparatus suitable for this purpose has been successfully used by Dr. George Levene of

Massachusetts Memorial Hospitals, Boston. This consists of a small ultra-violet generator which measures 3 x 6 x 18 inches and weighs a little over seven pounds. There is a one inch square window which is applied to the surface of the skin for a predetermined period of time. The instrument is extremely critical in its radiation, with an intensity exposure of 2,537 angstrom units. The constancy of characteristic tube radiation is controlled by measuring the output from time to time with a special ultra-violet photometer. When the type of radiation varies the lamp is replaced. The degree of erythema or reddening can be measured either by determining the temperature difference between the area of erythema and non-exposed skin by means of a sensitive thermocouple, or by color comparison using the standard Munsell color charts.

This apparatus was designed by Mr. Ronald J. McKenzie of Sylvania Electric Products, Inc., 126 Washington Street, Salem, Massachusetts, who will be glad to answer inquiries concerning it.

For use in the field an electric current supply is, of course, necessary.

4. *Handedness.* Whether subject habitually uses one hand in preference to the other, or is ambidextrous.

5. *Ability to Taste PTC (Phenyl-Thio-Carbamide).* A method of testing ability to taste phenyl-thio-carbamide at various graded standard measurable concentrations has recently been introduced by Harris and Kalmus. A solution containing 0.13% of phenyl-thio-carbamide (or phenylthiourea) is made up with boiled tap water, and serial dilutions made up as in Table 34.

(1) Starting from the higher dilutions and working down, the subject is given a few c.c. in a glass till he says he perceives a definite taste. This gives an approximate value for his threshold.

(2) The subject is now presented with eight glasses four of which contain a few c.c. of water and four contain a few c.c. of the solution determined in stage (1). The glasses are arranged at random. The subject is told that four of them contain the substance and four contain water, and he is asked to taste them all and to separate them into the two groups of four. The quantity of fluid is not limited, and glasses are refilled during the test if desired. If the two groups of four are correctly separated the test is

repeated with the next lower concentration and so on, until the subject can no longer discriminate correctly. The lowest concentration at which a completely correct answer is given is taken as the threshold. If, on the other hand, the subject is unable to separate the two groups accurately, the test is repeated in the same manner with increasing concentrations till a concentration is reached when a completely correct answer is given. Since there are both sexual and age differences in the threshold ability to taste PTC, age and sex should be carefully recorded for each subject.

TABLE 34. CONCENTRATIONS OF P.T.C. SOLUTIONS

Solution No.	P.T.C. Mgm. per Liter
1	1300.00
2	650.00
3	325.00
4	162.00
5	81.25
6	40.63
7	20.31
8	10.16
9	5.08
10	2.54
11	1.27
12	0.63
13	0.32
14	0.16

In the field it may not be possible to use the above method. Under such conditions the following is a useful procedure:

A slip of paper impregnated with phenyl-thio-carbamide is given to the subject and he is asked to place it upon the back of the tongue. He is then asked whether he tastes anything. If the subject is a taster he will reply in terms indicating that he tastes something bitter. If he is a non-taster he will generally indicate that he tastes nothing. In order to check the honesty of replies each subject should be given several tests with blank strips among those offered.

6. *Ability to Roll Sides of Tongue Upward When Mouth is Open.* If the investigator is able to perform this act he should show the subject what is required. If he is unable to do so he

should stick out his tongue and with his fingers press against the edges of the tongue thus rolling the sides upwards. The literate subject will not generally need a demonstration.

FIG. 151. The palmaris longus muscle. The tendon toward outer margin of this page is the palmaris longus. The right forearm is shown.

7. *Ability to Turn One Side of the Tongue Up, With the Mouth Open.* The subject is asked to rotate the tongue so that the left side is upward and the right remains either stationary or is lowered, and vice versa. Sides to be recorded for ability and non-ability.

8. *Color Blindness.* Best tested with the *Dvorine Color Discrimination Screening Test,* obtainable from Israel Dvorine, 2328 Eutaw Place, Baltimore 17, Maryland. Tests A and B should be used.

9. *Palmaris Longus Muscle.* The central tendon of the forearm at the wrist which is normally visible and can be well defined when the subject's fingers are flexed upon the wrist. Three tendons are generally visible in this region, one on the thumb side of the wrist (flexor carpi radialis) and one on the little finger side (flexor carpi ulnaris). The tendon of the palmaris longus muscle is situated between them. It is the most central tendon of the wrist. Record presence or absence. When absent check on as many members of subject's family as possible.

10. *Serological Traits.* A knowledge of the gene frequency distribution of the A, B, and O blood groups, the blood types M, N, and MN, and the Rh types in man is of considerable value in the study of human relationships.

If blood testing cannot conveniently be done the investigator should make complete arrangements with the scientific worker or workers within easiest reach to do the testing. Such complete arrangements will, of course, include the manner of preservation, sealing, and sending of blood samples.

If it is desired to send blood any distance or to keep it for more than a day, about 1 c.c. of blood should be taken with a sterile syringe under aseptic conditions, placed in a sterile tube with sterile stopper and allowed to clot. A suitable cell suspension can be made from this. If the blood is going to be tested promptly a sample may be taken directly into 0.9% sodium chloride solution by pricking the lobe of the ear or a finger, or in the case of infants the big toe, with a spring blood lancet. The skin and the blade of the lancet should be cleaned with alcohol or acetone, waiting for the disinfectant to evaporate before taking the blood.

Preservatives do not help a great deal. However, red cells remain agglutinable (for A, B, M, and N) for some weeks if preserved in Rous-Turner solution (3.8% sodium citrate solution 2 parts, 5.4% glucose solution 5 parts) or preferably in the ACD (citric acidcitrate-dextrose) mixture used in blood banks.

The A, B blood groups can be determined from dried blood stains, mummified tissues, and even from skeletal remains of the recent period if they are in a suitable state of preservation.

Blood Typing Technique

A number of techniques are available from which each investigator may select those most suitable for his work. However, failure to follow certain practices, such as the use of positive and negative controls, has led to serious errors which have encumbered the literature and led to the formulation of fallacious theories.

A spring lancet is used to draw blood either from an ear lobe or a finger. The ear lobe is preferable for it is easier to clean, and less liable to infection. The lobe is first swabbed with alcohol and then rubbed vigorously with cotton to stimulate circulation.[11] It is next punctured with the lancet and a few drops are caught in a 13 x 100 mm. tube containing 1½ c.c. of physiological saline (.9%). These suspensions are centrifuged at 1200-1500 r.p.m. (revolutions per minute). The supernatant (that part of the fluid which floats on the surface) is drawn off and replaced with fresh saline, the resulting suspension of washed cells should be a 2% suspension, to be determined by visual inspection. All suspensions should be uniform, and all cells should be washed at least once.

Tests for the presence of group substances A and B, and M and N are made by placing one drop of the 2% cell suspension in a tube (10 x 75 mm.) to which is added one drop of the appropriate serum, anti-A, anti-B, anti-M, and anti-N. These tubes are then centrifuged one minute at 1000-1500 r.p.m. After all the tubes have been centrifuged and replaced in the tube rack, the rack of tubes is shaken until the cells of the known negative control are resuspended. The tubes may be read by simply holding them over a magnifying mirror. Each tube should be compared with a known positive and negative reaction included in the series being tested for control. Those specimens which give a positive

---

[11] In the rare event that it is not possible to draw blood from the ear lobe it may be taken in the same way as from the ear lobe from the tip of the middle finger. In cases in which the blood does not immediately appear a minute or so should be allowed to elapse before the attempt is made to express blood by pressure. Fear often produces a vaso-constrictor effect. This should be allowed to wear off before any attempt is made to obtain the blood.

reaction, i.e., clumping or agglutination of the cells, with the anti-A serum should next be tested with anti-A_1 serum. This subdivision of A is especially useful among aboriginal populations of the New World where presence of A_2 may indicate mixture with White populations.

Tests for the presence of the A and B antigens may also be made on slides. For this kind of test the slide is used to pick up a drop of blood directly from the ear, one drop at either end of the slide for the anti-A and the anti-B serum. After a drop of the serum is added to the drop of blood the two are mixed with a toothpick and the slide is rotated to insure thorough mixing. The reaction should be easily visible to the eye.

Special care must be taken in using the anti-Rh sera owing to their considerably weaker reactions. A smaller tube (7 x 50 mm.) may be used in order to conserve sera and to facilitate reading the results in the tube by means of a microscope. When the tubes have been prepared, as in the A, B, M and N tests, by the addition of one drop of serum to one drop of 2% suspension of washed cells, the rack of tubes is placed in a pan of water and they are incubated for one hour at 37.5° C. Following this they are centrifuged at slow speed, 300-500 r.p.m. Before reading, each tube should be rotated or shaken gently to remove false agglutination. If the cells are not agglutinated they will be dispersed and resuspended, if they are agglutinated they will remain in clumps. These clumps of agglutinated cells vary in size with the strength of the reaction. It is useful to record the strength of each reaction as a check on the strength of various sera and as an indication of homo- or hetero-zygosity. Care must be taken not to shake out a positive reaction. In the case of a person who is heterozygous, rh′ hr′ +, the reactions may be very weak. All Rh tests should be read under the low power of a microscope. This may be done by holding the tube directly under the objective, or by removing a drop of the suspension on a glass rod and placing it on a slide.

In the field where laboratory facilities are not available it is often necessary to use a stove for incubating the Rh tests. One practical method of maintaining the bath at the necessary uniform temperature is to place the tray containing the tubes over another pan of water so that the heat is derived from the steam of the lower pan of water rather than directly from the top of the stove which is subject to wide fluctuations in temperature.

For centrifuging the small Rh tubes corks may be dropped in each of the centrifuge tube jackets so that the small tubes can be easily removed.

No tests should be conducted without the use of known controls, if possible both negative and positive controls. For this purpose it is desirable to type in advance all members of a field party. Reactions should be read twice. In this way those which are slow in developing will not be missed and an additional check on recording errors is provided. Sera should be permitted to come to room temperature before use, at all other times they should be kept in refrigeration. Diluted serum often declines in strength, consequently no more sera should be prepared than are needed for current typing.

Equipment

For field work certain eventualities must be anticipated which would otherwise retard the work. Sufficient glassware should be taken so that it is possible to work two or three days while tubes are drying. A good quality soap, such as Swan or Ivory, is adequate for washing the glassware. Precautions must be taken to be sure that the tubes are clean, dry and sterile.

Serum containers should be identified not only by labels but also by etching with a diamond pointed glass marking pencil. Even labels secured with cellulose tape will come off after exposure to moisture. This may happen when a boat carrying equipment ships water or when a refrigerator is inadvertently defrosted.

China marking pencils of different colors should be used to facilitate identification of individual tubes in tests employing different sera, thus, tests with anti-A serum may be marked with red and tests with anti-B serum marked with blue.

Four-tube hand operated centrifuges are available from such houses as Eimer and Amend, New York City.

Tuberculin syringes are useful for measuring small amounts of serum and saline. It is useful to weigh out salt in advance for preparing additional amounts of physiological saline in the field. This will obviate the need for carrying scales and save time.

A list of equipment is appended here, the appropriate numbers or amounts depend, of course, on the extent of the work to be done.

Equipment List:

laboratory microscope
centrifuge
15 ml.* tubes
13 x 100 mm., 8 x 75 mm., and 7 x 50 mm. tubes
ground glass slides
glass rods
pipettes
1 cc. tuberculin syringes and # 22 needles
laboratory thermometers
alcohol
test tube brushes
cotton
tube racks
lancets
distilled water
liter pitcher
diamond pointed glass marking pencil
magnifying mirror (shaving mirror)
colored marking pencils
beakers
soap
toothpicks
pans (for incubating and washing)
sera
corks

Collection of Bone Samples for Typing

Cancellous tissue such as that found in the bodies of the vertebrae or in the heads of the long bones is most suitable for blood typing. This can best be obtained by scraping with a bone curette. With care it is possible to remove the cancellous tissue from a vertebra without damaging its walls for measurement. The

---

* ml., milliliter, approximately 1 cubic centimeter.

bone should be placed in a tube and made airtight. Morphological data and cultural data concerning the skeleton should be secured. Care must be taken in the case of incidental bones or mass burials that more than one specimen is not taken from one individual or that several specimens taken from one skeleton are attributed to only one.

Technique of Blood Typing Skeletons

TEST FOR THE PRESENCE OF BLOOD GROUP SUBSTANCES IN SKELETONS

This is an absorption technique which involves the application of serum of known strength to a specimen of pulverized bone. After a period of incubation the supernatant serum is drawn off the specimen and tested against fresh red cells of the appropriate group. If the group substance, which determines the blood type, is present in the specimen of bone, the antibodies of the serum are wholly or partially absorbed and the strength of the serum is thereby reduced. The consequent failure to agglutinate red cells is presumptive evidence that agglutinins were removed from the serum and therefore that the group substance was present in the skeleton tested.

The sera to be employed are titered by testing successively doubled dilutions, e.g., 1:2, 1:4, 1:8, 1:16, against a 1% suspension of fresh red cells. If 1:16 is the limiting titer, that is if it gives a ± reading whereas the next higher dilution shows no agglutination, this is taken as the end point. Counting back three dilutions, to 1:2, gives the proper dilution to be applied to the specimen. These dilutions may be made in 13 x 100 mm. tubes. From each of these tubes 0.05 cc. of the diluted serum is drawn, by means of a tuberculin syringe, and placed in a 7 x 50 mm. tube, to which is added 0.05 cc. of 1% cell suspension. These are then placed in a rack and shaken at four minute intervals for thirty-two minutes. Readings of the degree of agglutination are made with the low power of a microscope. All cell suspensions should be washed, measured, and the titration should be performed before each test.

The cancellous tissue is pulverized before each test in a mortar, and 0.25 gram placed in a 13 x 100 mm. tube. Nine-tenths of a cc. of serum is added to this and the two are thoroughly mixed by

ANTHROPOMETRY and MORPHOLOGY

Name Place Area Field number
Sex Age Birthdate Examined: Date Time Observer
Related to: Birthplace Ancestry
Father's name Appearance Occupation Birthplace Age if living Died at age? Cause of death
Mother's name Appearance Skills Birthplace Age if living Died at age? Cause of death
Brothers
Sisters
Stillbirths Birth rank
Single? Married? At age? Divorced? Widowed? Childhood
Boys
Girls
Diet Breakfast Lunch Supper
Occupation Religion Biographical
Social status Economic status Housing
Illnesses at age ?
Handedness
Film number
Frames
Recorder

Weight	Biacromial	Bi-auricular breadth	Stature/$\sqrt[3]{\text{Weight}}$
	Bi-iliac	Bizygomatic breadth	Relative sitting height
Stature	Chest breadth	Bigonial breadth	Relative chest circumference
Acromion height	Chest depth	Total face height	Relative shoulder breadth
Trochanter height	Abdomen depth	Upper face height	Thoracic index
Tibiale height	Chest circumference	Chin height	Hand, L-Br. index
Sphyrion height		Nose height	
Span	Head circumference	Nose breadth	Cephalic index
Sitting height	Head length	Interorbital	Mean height index
Foot length	Nasion-occipital length	Biorbital	Fronto-parietal
Foot breadth	Head breadth		Cranio-facial
Humerus length	Auricular-vertex height	Mouth breadth	Fronto-gonial
Radius length	Auricular-nasion length	Ear height	Facial index
Hand length		Ear breadth	Upper facial index
Hand breadth	Minimum frontal breadth		Nasal index

Skin color **Forehead, Inner arm** Pale Pink 3 "White" Brunet 7–9 Swarthy 10, 11 R. br 12–14, 16 Lt. br. 15, 17, 18 Lt. y. br. 4, 5 Y. br. 19–20, 6 Md. br. 21–25 Choc. 26–29 Dk. br. 30–35 Black 36	Vascularity Sl. + ++ Freckles None Few + ++ Moles None Few + ++	Hair form Straight Low waves Deep waves Curly Frizzly Woolly Texture Fine + Coarse Wiry Quantity Sm. + ++	Baldness Abs. Sl. + ++ Beard quantity Ssm. Sm. + ++ Body hair Abs. Sl. + ++	Hair color Head Beard Black 27 Dk. br. 4–5 Brown 7–9 Red br. 6, 10 Gld. br. 11–16 Ash br. 22–26 Golden 17–19 Ash 20, 21 Red 1–3 Grey, sl. Grey, + White Red pigment Abs. Pres:	Iris color Black Dk. brown Dk.-lt. br. Lt. brown Green-br. Grey-br. Blue-br. Green Grey Blue Other Unmatched	Yellow pigment None Trace Sl. + ++ Mixed eyes +++ dark ++ dark Even ++ light +++ light Pigment dots Abs. Pres:	Iris pattern Clear Rayed Zoned Scalloped Diffuse Spotted Conjunctiva Clear Yellow Grey Bloodshot Orbit height Low + High	Eyefolds Absent Internal Sl. + ++ Median Sl. + ++ External Sl. + ++ Complete:
Palpebral slit Down Horiz. Up sl. Up + Up ++ Opening ht. Sm. + ++ Eyebrow thickness Sl. + ++ +++	Concurrency Abs. Sl. + ++ Temp. hair jct. Abs. Sl. + ++ Browridges Ssm. Sm. + ++	Nasion depr. Trace Sl. + ++ +++ Bony profile Straight Concave Wavy Convex Salience Sl. + ++	Root height Sm. + ++ +++ (ssm.) Root breadth Ssm. (+++) Sm. + ++ Bridge height Sm. + ++ +++ (ssm.)	Bridge breadth Ssm. (+++) Sm. + ++ Tip thickness Ssm. (+++) Sm. + ++ Tip shape Pointed Bilobed Angular Rounded Blobby Snub	Septum tilt Up + Up sl. Horiz. Down sl. Down + Nostril form Slit Ellipse Intermed. Round Visibility, lat. None Sl. + ++	Vis., frontal None Sl. + ++ Nostril axes Parallel Obl. sl. Oblique + Transverse Alae Compressed + Flaring Extended	Lip thickness V. thin (+++) Thin + ++ Eversion Sl. + ++ +++ Lip seam Abs. Sl. + ++	Integ. lips Thin + Thick Alv. prognathism Abs. (+++) Sl. + ++ Chin projection Negative Neutral Sl. + ++
Chin type Median Triangle Bilateral Malars Anterior proj. Abs. (+++) Sl. + ++ Lateral proj. Compr. Sl. + ++ +++	Gonia eversion Compr. Sl. + ++ +++ Ear projection Sl. + ++ Helix Flat Sl. roll + ++	Anti-helix Sl. + ++ Darwin's pt. Abs. Pres: Ear sinus Abs. Pres: Lobe None Soldered Attached Free Long & free	Temp. fullness Flat Sl. + Lambd. flat. None Sl. + ++ Occ. curve Flat Sl. + ++	Blood type A, B, O: M, N: Rh'-C: Rho-D: Rh''-E:	P-T-C Taste-blind Tastes: Tongue-roll Abs. Pres: Trilling Abs. Pres. Th-sound Abs. Pres.	Somatotype Temperament Nutrit. state Menarche *or* Voice-change Pulse rate	Asymmetry Pathology	Type
Tooth eruption **Incomplete** **Complete** **M_3 suppr.** **Other** **No. teeth lost** **No. teeth carious** **Teeth wear** **None** **Sl.** **+** **++** **+++**	Crowding None Sl. + ++ Pyorrhea None Sl. + ++ Absorption None Sl. + ++	Palate height Low + ++ +++ Palate form Parabolic Elliptical Hyperbolic V Small U Broad U Palatine torus Absent Ridge: Mound: Lump:	Shovel Is. Abs. Sl. + ++ Upper cusp no. Lower cusp no. Teeth rotated Central trema	Molar pattern Plus Dryopith. Bite Under Edge Sl. over + over ++ over Accessory cusps Teeth size	Left Dentition Right $\overline{\underline{8}}\ \overline{\underline{7}}\ \overline{\underline{6}}\ \overline{\underline{5}}\ \overline{\underline{4}}\ \overline{\underline{3}}\ \overline{\underline{2}}\ \overline{\underline{1}}\quad \overline{\underline{1}}\ \overline{\underline{2}}\ \overline{\underline{3}}\ \overline{\underline{4}}\ \overline{\underline{5}}\ \overline{\underline{6}}\ \overline{\underline{7}}\ \overline{\underline{8}}$ X: missing *: carious s: suppressed m: milk tooth retained w: worn down to roots			

rotating the tube and with a glass rod. For each skeleton tested a separate tube is prepared for the anti-A serum and for the anti-B serum. Each tube is sealed with a cork and placed in a refrigerator at 10° C. to incubate 48 hours. The tubes should be agitated at 12 hour intervals.

At the end of two days the tubes are removed from the refrigerator and permitted to return to room temperature. They are then centrifuged and the supernatant serum drawn from each by means of a tuberculin syringe with a flat ended needle. Physiological saline is added to each specimen to equal the amount drawn off and it is titrated again in three successively doubled dilutions to duplicate the original dilutions. 0.05 cc. of each dilution is placed in a blood group tube, with 0.05 cc. of 1% fresh red cell suspension and shaken as before at four minute intervals for thirty-two minutes. The results are again read with the low power of the microscope. Failure of the supernatant to agglutinate the appropriate red cells indicates that group substance of that group was present in the specimen and absorbed the agglutinins. Agglutinins should be cleared from at least two tubes, in a number of tests, for the results to be considered positive. Controls should, of course, be employed in all tests. A description of the technique employed in testing skeletons may be found in "Blood-Group Tests on Stains, Mummified Tissues, and Cancellous Bone," by P. B. Candela, *Am. J. Phys. Anthrop.* 25:187-214, 1939.

Anthropometric Recording Blanks

Printed blanks for the recording of anthropometric, anthroposcopic, physiometric, and morphological measurements greatly facilitate the processes of recording and analysis of data. Typical blanks are here reprinted through the courtesy of Dr. J. L. Angel.

Craniometry

Why Measure Skulls?

For several generations physical anthropologists measured skulls in the belief that thereby they were likely to obtain results which would enable them to trace the relationships between the races of mankind. It was believed that the form of the skull in particular remained constant in each race, and that different races typically showed different cranial indices. Hence, all one had to do was to measure skulls, calculate the indices, and draw the more or less 'obvious' conclusions. Unfortunately for this rather naive belief there are several crucial objections to it. In the first place the form of the head is now known to be subject to change through environmental influences. In the second place there are great differences in intragroup variability in all measurements and indices among the ethnic groups of mankind. In the third place closely related groups and individuals frequently exhibit considerable differences in cranial measurements and indices, while more distantly related groups and individuals exhibit striking likenesses (see Figs. 132 & 134). Finally, the cephalic index of a whole group will change in the course of time as the trend towards brachycephalization in man abundantly shows. Why then, it may well be asked, measure skulls? The answer is: Precisely in order to obtain this kind of knowledge, and in order to be able to give as accurate a description of a skull or group of skulls as possible.

The importance of craniometry in the description and analysis of the remains of fossil man and other primates is obvious; in the comparative study of the primates it is an indispensable tool, as it is in growth studies of the skull, the growth of the dental apparatus, in the study of the character and relationships of individuals and departed populations which are known mainly or solely from their cranial remains, in forensic medicine, in the identification of persons from their crania, and finally when the genetics of the skull comes to be thoroughly studied, as it must, craniometric techniques will become increasingly indispensable.

Definitions

Skull. In practice this term is commonly used with the following two interchangeable meanings, (1) the skeleton of the braincase, face, and lower jaw, (2) the skeleton of the braincase and face without the lower jaw. To this double usage there is no objection, though strictly speaking the term is by most anthropologists and anatomists defined in the first sense.

Cranium. The skull minus the lower jaw.

Calvarium. The skull minus facial portion and lower jaw, i.e., the braincase.

Calva or Calotte. The skull cap, i.e., the top of the braincase or calvarium minus its base.

Landmarks

There has, in the past, been a great superfluity of landmarks on the skull, most of which have rarely been used. Only those which are in most common use will be defined here, others are indicated in Fig. 148.

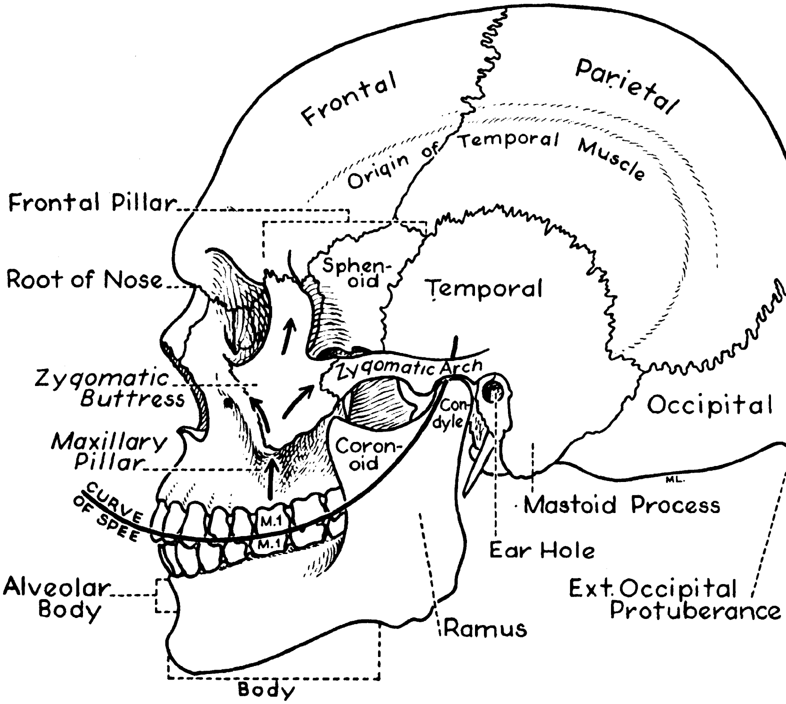


FIG. 152. Showing the buttresses of the skull and the directions of distribution of the forces transmitted from the lower first through the upper first molar tooth.

Braincase

1. *Glabella* (gl). The most prominent point on the middle of the frontal bone between the supraorbital ridges and above the nasofrontal suture.

2. *Bregma* (br). The point of intersection of the coronal and sagittal sutures.

3. *Opisthocranion* (op). The most distant (posterior) point on the skull from the glabella in the mid-sagittal plane, excluding the external occipital protuberance or inion.

4. *Inion* (in). The base of the external occipital protuberance in the mid-sagittal plane.

5. *Opisthion* (o). The median point on the posterior margin of the occipital foramen.

6. *Basion* (ba). The median point on the anterior margin of the occipital foramen.

7. *Porion* (po). The highest middle point on the margin of the external auditory meatus.

Facial Skeleton

8. *Nasion* (na). The mid-point of the naso-frontal suture.

9. *Nasospinale* (ns). The point at which a line tangent to the lower margins of the nasal aperture is intersected by the mid-sagittal plane. Since the base of the anterior nasal spine usually prevents actual instrumental contact with this point, it is usual to take the measurement at the level of the nasospinale somewhat to one side and deduct the two or three millimeters from the final measurement.

10. *Prosthion* (pr). The most antero-inferior point on the maxilla between the upper central incisor teeth.

11. *Dacryon* (da). The point on the medial wall of the orbit at which the frontal, lacrimal, and maxillary bones meet.

12. *Infradentale* (id). The most antero-superior point on the alveolar margin between the lower central incisors on the lower jaw.

13. *Gnathion* (gn). The middle point on the lower border of the mandible.

14. *Gonion* (go). The most lateral external point of junction of the horizontal and ascending rami of the lower jaw.

15. *Ectomolare* (ecm). The most lateral point on the outer surface of the alveolar margins, usually opposite the middle of the second molar tooth.

16. *Endomolare* (enm). The most lateral point on the inner surface of the lingual margins of the alveolar processes, usually opposite the middle of the lingual surfaces of the second molar teeth.

17. *Orale* (ol). The point in the bony palate where the mid-sagittal plane bisects a line drawn tangentially to the point of maximum convexity of the lingual margins of the alveoli for the two central incisor teeth.

General Comments

It should always be remembered that the best preserved of skulls is a fragile and valuable object. It should therefore always be handled with considerable care. There is something about the gaping orbits of the skull which seems universally to suggest that it be picked up by introducing the thumb in one orbit and several fingers in the other. This is invariably fatal to the papyrus-thin bones of the medial orbital walls. Hence, all persons likely to handle skulls must be instructed never to handle a skull in this manner, and they should be similarly instructed never to lift it by the zygomatic arches. The skull is best handled with one hand at the supratemporal crests or at the occipito-parietal regions. Teeth are extremely fragile, and the enamel is easily cracked and chipped. Loose teeth should be firmly glued into the sockets in which their roots belong.

In measuring skulls a moderately soft doughnut shaped pad 1½ inches thick with an outside diameter 8½ inches, and an internal diameter of 3¼ inches will be found useful upon which to rest the skull in any desired position. A cloth bag 8 by 8 inches or more, filled with rice or sand is preferred by many workers.

Instruments should be frequently checked for accuracy, and each measurement should be made in a uniform manner. It is important to record the technique used in making each measurement and to make this record an intrinsic part of the report of these measurements, whether the report is intended for publication or not.

Cranial Measurements

1. *Maximum Cranial Length* (Spreading Caliper). From glabella to opisthocranion.

2. *Maximum Cranial Breadth* (Spreading Caliper). At right angles to the mid-sagittal plane wherever maximum breadth is found, above the level of the supramastoid crests or posterior roots of the zygomatic arches and the regions below.

3. *Basion-Bregma Height* (Spreading Caliper). From basion to bregma.

4. *Minimum Frontal Cranial Breadth* (Spreading Caliper). Minimum breadth between the temporal crests on the frontal bone.

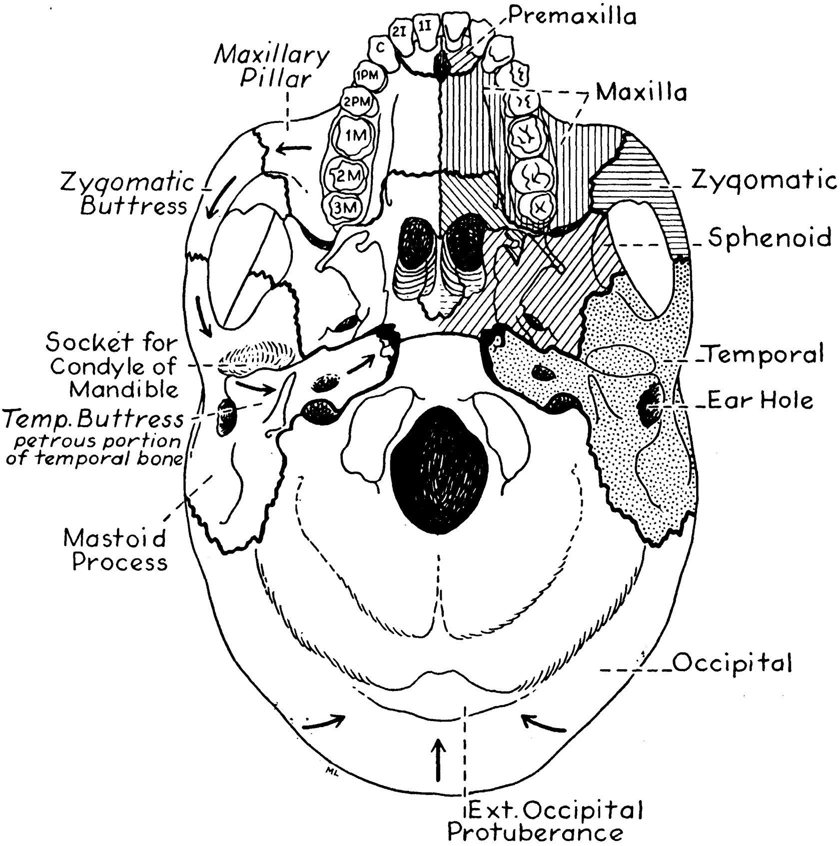


FIG. 153. Basilar view of the skull showing directions in which compressive strains transmitted through the first upper molar (1M) are taken up by the zygomatic buttress, while those from the back of the skull pass down toward the external occipital protuberance.

5. *Maximum Bizygomatic Breadth* (Spreading Caliper). The greatest breadth between the two zygomatic arches.

6. *Total Cranial Facial Height* (Sliding Compass). From gnathion to nasion.

7. *Upper Cranial Facial Height* (Sliding Compass). From prosthion to nasion.

8. *Basion-Prosthion Line* (Sliding Compass or Spreading Caliper). From basion to prosthion.

9. *Nasal Height* (Sliding Compass). From nasion to the mean of the lowest points on the lower borders of the nasal aperture (the subnasale) on each side of the nasal spine.

10. *Nasal Breadth* (Sliding Compass). The maximum distance between the lateral margins of the nasal aperture perpendicular to the mid-sagittal plane.

11. *Upper Nasal Breadth* (Sliding Compass). The distance between the points of juncture of the naso-frontal and naso-maxillary sutures on the right and left sides.

12. *Lower Nasal Breadth* (Sliding Compass). The distance between the points at which the naso-maxillary suture terminates at the nasal aperture on the left and right sides.

13. *Orbital Breadth* (Sliding Compass). Owing to the variability in the conformation and orientation of the orbits these are conventionally treated as rectangles. The horizontal axis being determined by an imaginary line running from dacryon to the middle of the lateral orbital border (ectoconchion). Right and left orbits are recorded separately.

14. *Orbital Height* (Sliding Compass). The maximum height from the upper to the lower orbital borders perpendicular to the horizontal axis of the orbit.

15. *Interorbital Breadth* (Sliding Compass). The distance between the right and left dacryon points.

16. *Bi-Orbital Breadth* (Sliding Compass). From the middle of one lateral orbital border (ectoconchion) to the other.

17. *Maxillo-Alveolar Length* (Sliding Compass). From prosthion to the points of bisection of a line tangent to the posterior terminal borders of the alveolar processes (maxillary tuberosities).

18. *Maxillo-Alveolar Breadth* (Sliding Compass). Maximum distance from one external lateral alveolar border to the other, usually opposite the second molar teeth. (ectomolare).

19. *Mean Diameter of Foramen Magnum* (Sliding Compass). Maximum length from basion to opisthion, and maximum transverse diameter.

20. *Bi-Condylar Width* (Sliding Compass). Distance between

the most external points on the condyles of the lower jaw.

21. *Symphyseal Height* (Sliding Compass). Distance between gnathion and infradentale.

22. *Bigonial Diameter* (Sliding Compass). Distance between right and left gonion points.

23. *Height of Ascending Left Mandibular Ramus* (Measuring Board or Sliding Compass). Usually taken with a specially designed hinged measuring board from which the height of the ramus may be read directly from the base of the ramus to the highest point on the left condyle. In the absence of a measuring board, from left gonion to the highest point on the left condyle.

24. *Minimum Breadth of Left Ascending Mandibular Ramus* (Sliding Compass). Least distance between the anterior and posterior borders of the left ramus perpendicular to its height.

25. *Maximum Cranial Circumference* (Steel Tape). Above the level of the brow ridges around the most distant projection of the occiput to the zero point anteriorly.

26. *Transverse Cranial Arc* (Steel Tape). From left porion across bregma to right porion.

27. *The Frankfurt Horizontal* (FH) *Plane*. The horizontal plane of the skull determined by the right and left porion and the lowest point on the inferior margin of, preferably, the left orbit (orbitale). The skull is usually oriented in this plane when measurements taken in a constant plane are to be made, or when craniograms, photographs, or other illustrations are to be made for comparative or illustrative purposes.

28. *Auricular Height*. This important measurement may be taken with Todd's Head Spanner or the Western Reserve Craniostat. Both instruments are provided with a simple device for determining the Frankfurt Horizontal plane. Measurements are read directly. Ranke's or Mollison's craniophor require the determination of bi-porionic breadth and the distance of each porion from the bregma. The vertical section of the triangle thus formed yields auricular height.

29. *Cranial Capacity*. Cranial capacity has been measured in a variety of ways and the results obtained are not always strictly comparable, hence it is extremely important to know when comparing figures for cranial capacity obtained from the literature what method was used. The most usual procedure is to fill the

cranial cavity with some material which will easily conform to the internal irregularities and spaces of the braincase. Mustard seed or small shot is frequently used, the material being thoroughly distributed by agitating the skull either in one's hands or in an apparatus specially devised for the purpose. When the skull is securely filled the contents are then poured into a cubic centimeter measuring glass which is then agitated until it is thoroughly packed and the reading taken directly. Alternatively the mustard seed may be weighed and multiplied by a factor to give volume. Tildesley has used the following formula on the Burmese skull:

$$\textbf{Volume of 1000 grams of seed} = \frac{\textbf{C.c. of seed} \times \textbf{1000}}{\textbf{Weight of seed in grams}} = \textbf{Cr.c.}$$

Methods such as this avoid the possibility of error when the measuring glass is used. Formulae which give very satisfactory results have been worked out by different investigators for several groups. The best of these formulae for determining cranial capacity are the following, where L is cranial length, H is auricular height, H′ basion-bregmatic height, and B cranial breadth. L is multiplied by B, and the product multiplied by H or H′:

Female Capacity $.000375 \times LBH + 296.40$
All Races: Male Capacity $.000365 \times LBH - 359.34$ (Pearson)
Negroids: Capacity $.0003849 \times LBH + 96 \pm 65/\sqrt{N}$ (Isserlis)
Australoids: Capacity $.000263 \times LBH' + 404.9 \pm 35.1/\sqrt{N}$ (von Bonin)
Caucasoids: Capacity $.000366 \times LBH + 198.9$ (Hooke)[12]

Craniometric Indices

30. *The Cranial Index*

$$\frac{\textbf{Max. Breadth} \times \textbf{100}}{\textbf{Max. Length}}$$

Dolichocranic	×–74.9
Mesocranic	75.0–79.9
Brachycranic	80.0–84.9
Hyperbrachycranic	85.0–89.9

---

[12] For further details see Hambly, W. D.: Cranial capacities, A study in Methods, *Fieldiana Anthropology* (Chicago Natural History Museum), *36*:25-75, 1947.

31. *Cranial Length-Height Index*

$$\frac{\textbf{Basion-Bregma Height} \times \textbf{100}}{\textbf{Max. Length}}$$

Chamaecranic	×–69.9
Orthocranic	70.0–74.9
Hypsicranic	75.0–×

32. *Cranial Breadth-Height Index*

$$\frac{\textbf{Basion-Bregma Height} \times \textbf{100}}{\textbf{Max. Breadth}}$$

Tapeinocranic	×–91.9
Metriocranic	92.0–97.9
Acrocranic	98.0–×

33. *Total Facial Index*

$$\frac{\textbf{Nasion-Gnathion Height} \times \textbf{100}}{\textbf{Bizygomatic Breadth}}$$

Hypereuryprosopic	×–79.9
Euryprosopic	80.0–84.9
Mesoprosopic	85.0–89.9
Leptoprosopic	90.0–94.9
Hyperleptoprosopic	95.0–×

34. *Upper Facial Index*

$$\frac{\textbf{Nasion-Prosthion Height} \times \textbf{100}}{\textbf{Bizygomatic Breadth}}$$

Hypereuryene	×–44.9
Euryene	45.0–49.9
Mesene	50.0–54.9
Leptene	55.0–59.9
Hyperleptene	60.0–×

35. *Nasal Index*

$$\frac{\textbf{Max. Nasal Breadth of Nasal Aperture} \times \textbf{100}}{\textbf{Nasion-Nasospinale Height}}$$

Leptorrhine	×–46.9
Mesorrhine	47.0–50.9
Chamaerrhine	51.0–57.9
Hyperchamaerrhine	58.0–×

36. *Orbital Index*

$$\frac{\textbf{Max. Orbital Breadth} \times \textbf{100}}{\textbf{Max. Orbital Length}}$$

Chamaeconch	×–75.9
Mesoconch	76.0–84.9
Hypsiconch	85.0–×

37. *Palatal Index*

$$\frac{\textbf{Max. Palatal Breadth} \times \textbf{100}}{\textbf{Max. Palatal Length}}$$

Leptostaphyline	×–79.9
Mesostaphyline	80.0–84.9
Brachystaphyline	85.0–×

38. *Maxillo-Alveolar Index*

$$\frac{\textbf{Bi-Ectomolare Breadth} \times \textbf{100}}{\textbf{Maxillo-Alveolar Length}}$$

Dolichuranic	×–109.9
Mesuranic	110.0–114.9
Brachyuranic	115.0–×

Estimating Age of Skull

During the process of growth and development the skull shows, within broad limits, certain relatively constant changes which may be used as criteria of age. While there is an appreciable amount of variability both in the order and time of eruption of the teeth, these features may nevertheless be utilized in the aging of a skull up to the age of 25 years.

Approximate Age of Tooth Eruption

Deciduous or Milk Dentition	
Lower Central Incisors	6 to 9 months
Upper Incisors	8 to 10 months
Lower Laterial Incisors and First Molars	15 to 21 months
Canines	16 to 20 months
Second Molars	20 to 24 months
Permanent Dentition	
First Molars	6th year
Central Incisors	7th year

Lateral Incisors	8th year
First Premolars	9th year
Second Premolars	10th year
Canines	11th to 12th year
Second Molars	12th to 13th year
Third Molars	17th to 25th year

The deciduous or milk teeth number 20 and the deciduous dental formula is written in minuscule letters $i\,\frac{2}{2}$, $c\,\frac{1}{1}$, $m\frac{2}{2}$ (incisors 2, canines 1, molars 2, on each side and in each jaw). It is to be noted that no premolars are present in the deciduous dentition. The formula for the permanent dentition is written in capital letters $I\,\frac{2}{2}$, $C\,\frac{1}{1}$, $PM\,\frac{2}{2}$, $M\,\frac{3}{3}$.

The closure or obliteration of the sutures on the external surfaces of the skull constitutes another fairly useful means of aging the skull. This has been worked out principally by Todd and Lyon on whites and Negroes in whom the pattern and time of closure appears to be much the same.[13]

The metopic or medio-frontal suture through which sutural junction between the two hemi-frontal bones is established in the infant skull usually commences to obliterate at the level of the frontal eminences during the latter half of the first year. The process of obliteration proceeds towards the bregma, and by the conclusion of the second year the greater part of the suture is obliterated. A small supra-nasal portion remains unobliterated till the sixth year, though remnants of this may persist into adult life. The whole suture remains unobliterated in about 8.5 per cent of Caucasoids, 1.2 per cent of Negroids, and in less than 1.0 per cent of Australoids.

The seven unossified areas in the membrane between the bones known as fontanelles undergo closure in the following order:

Sagittal: (Situated at the obelion) At birth or before the fourth month.

Posterior: (Situated at apex of occipital bone) Two months after birth.

---

[13] Todd, T. W. and Lyon, D. W.: Ectocranial closure in adult males of white stock. *Am. J. Phys. Anthropol., 8*:23-46; 47-71; 149-168, *7*:325-384, 1925.

Antero-Lateral: (Paired. At pterion) Three months after birth.

Postero-Lateral: (Paired. At posterior-inferior angle of parietal bone) End of the first year.

Bregmatic: (Situated at bregma) During the second year.

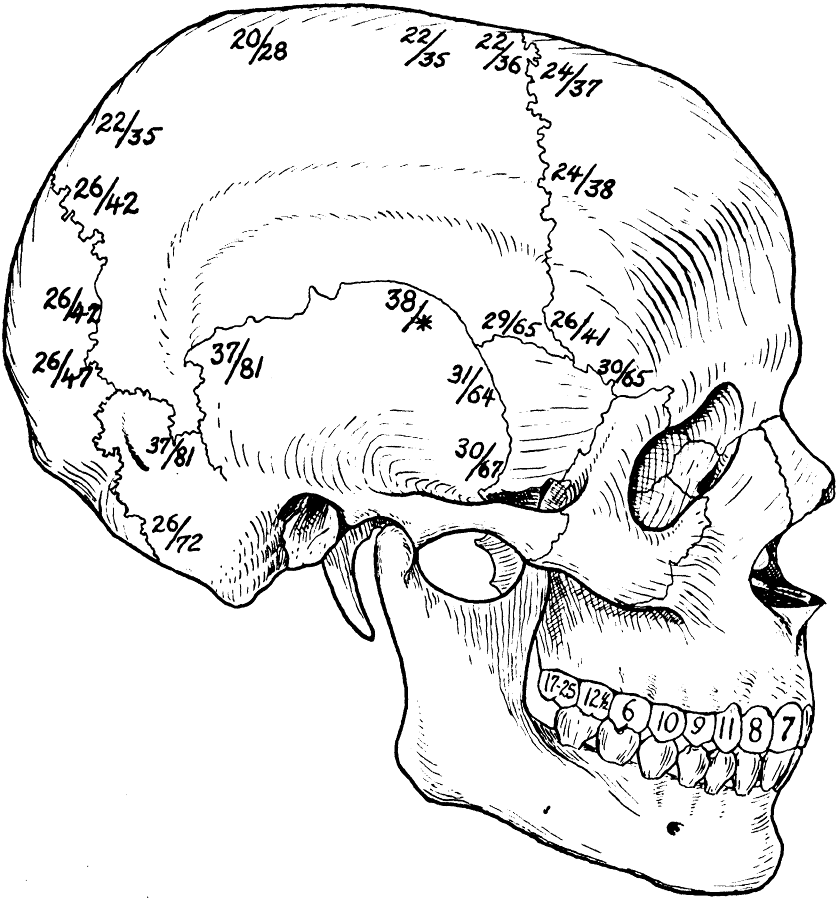


Fig. 154. Suture closure of the skull. The superior figures indicate the age at which the portion of the suture commences to obliterate, the inferior figures the age at which obliteration is completed. The * indicates that the suture never completely closes. The figures on the upper teeth give the usual ages in years of the eruption of each permanent tooth.

During the second year the halves of the mandible unite at the symphysis, and the mastoid process appears.

At birth the occipital bone consists of four parts: an upper or squamous portion, two lateral portions, and a basilar part. The squama unites with the lateral parts between the third and fifth years; the lateral parts with the basi-occipital during the fourth or fifth years. The basi-occipital is united to the basi-sphenoid by a strip of cartilage. The area it occupies is known as the basilar suture. This undergoes obliteration between the age of 20 and 25 years.

TABLE 35. ECTOCRANIAL SUTURE CLOSURE IN MALES

Suture	Commencement and Course		Termination or Peak	General Rate
Sagittal (s)	22	Slow to 26		slows at 31 at 3.9
Spheno-frontal, lesser	22		35	slows at 30 at 3.0
			64	final burst of activity.
Spheno-frontal, greater	22		65	slows at 30 at 3.0
			38	final burst of activity
Coronal (c) 1 and 2	24			slows at 29 at 3.4
Coronal 3	26	rapid to ca. 30	41	slows at 29 at 2.1
Lambdoid (L) 1 and 2	26		42	slows at 31 at 3.4
Lambdoid 3	26		47	slows at 30 at 2.2
Masto-occipital 3	26		72	32–48 at 3.2, slow progress thereafter.
Spheno-parietal	29	slow at once		29–46 at 30
			65	slow progress thereafter.
Spheno-temporal 2	30		67	at 3.9 gradual progress
Spheno-temporal 1	31		67	at 2.4 31–62 at 0.5
			81	burst of activity at 63
Masto-occipital 1 and 2	30			32–45 at 1.25
				activity between 46 and 64.
Parieto-mastoid 1 and 2	37	almost inactive till 62		almost inactive till 50
			81	slow progress thereafter
Squamous posterior	37		81	burst of activity at 63
			81	burst of activity at 79
Squamous anterior	37			at 3.2 burst of activity at 63
				burst of activity at 79

Numbers such as 3.9, 3.0, 2.2, and the like, refer to extent of suture closure in fourths, with 0 for no suture closure, 1 for one-fourth of the total suture closure, 3 for three-fourths of the total suture closed, and 4 for complete suture closure. Age in years.

External or ectocranial suture closure exhibits much variability, but taken together with other features of the skull it provides a useful additional means of arriving at an age estimate of the skull. In Fig. 154 the age at which various parts of the cranial sutures commence to obliterate and the course and direction of the obliterative process is also shown.

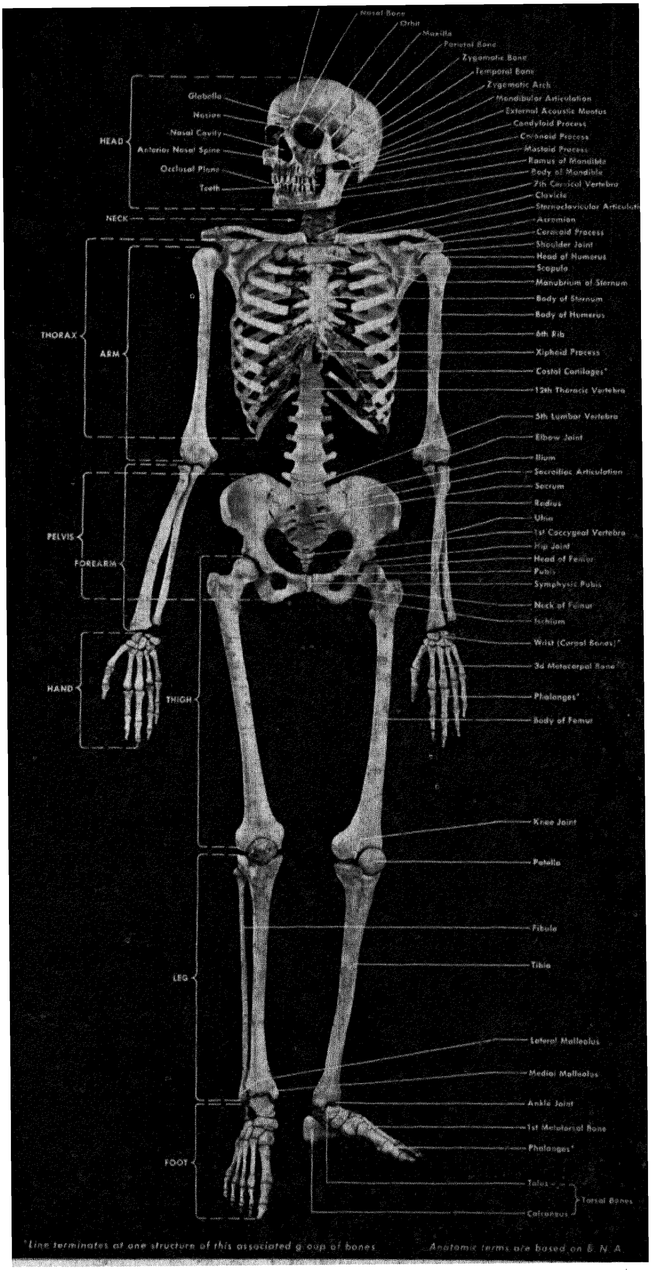
In old age the skull bones are usually somewhat thinner, and the skull tends to be appreciably lighter and more fragile owing to the absorption of spongious bone and the associated extension and enlargement of the sinuses.

The state of closure of the following ectocranial sutures gives the most reliable age assessment.

I. Vault sutures
  1. Coronal (bregmatic, complicated, and pteric portions)
  2. Sagittal (bregmatic, vertex, obelion, and lambdoid portions)
  3. Lamboid (lambdoid, medial, and asterionic portions)
II. Circum-meatal sutures
  1. Squamous (anterior and posterior parts)
  2. Parieto-mastoid (superior and inferior parts)
  3. Masto-occipital (posterior, middle, and anterior parts)
  4. Spheno-temporal
  5. Spheno-frontal (greater and lesser wings)

Sutures on the exterior of the skull (ectocranial sutures) will alone serve to give a reliable estimate of age. Sutures on the inner surface (endocranial) of the skull tend to incomplete closure, such incomplete closure is known as lapsed union. Suture closure is scored as 0 when there is no union, 1 when one-fourth of the suture has closed, 2 when one-half has closed, 3 when three-fourths of the suture is closed, and 4 when the suture is completely closed. There are no significant ethnic group or race differences in suture closure, though in prehistoric representatives of man the endocranial sutures tended to undergo closure at an earlier age.

A good rule to remember is that closure begins in S (sagittal) at 22 years, C (coronal) 24 years, L (lambdoid) 26 years; closure ends S 35 years, C 42 years, L 47 years. It is also well to remember that aging a skull by means of suture closure alone is a hazardous procedure, one may be as much as 20 years off in certain cases! Usually one can get within six years of actual age. Wherever possible as many other characteristics as possible should be used in arriving at an estimate of age.



*Line terminates at one structure of this associated group of bones   Anatomic terms are based on B. N. A.

Fig. 155. The Human skeleton. (Courtesy, Eastman Kodak Co., Rochester, New York.)

CRANIAL MEASUREMENTS and MORPHOLOGICAL OBSERVATIONS

Field number	Sex	Date	Observer
Area	Site	Group	Period
Age	Muscularity	Weight	Sex criteria
Description	Condition	Anomalies	Type

Glabello-occipital length
Nasion-occipital
Basion-bregma height
Forehead height
Nasion-bregma chord
Bregma-lambda chord
Lambda-opisthion chord
Lambda-inion chord
Inion-opisthion chord
Frontal arc
Parietal arc
Occipital arc
Sagittal arc
Horizontal circumference
Transverse arc
Porion-temporal lines
Maximum vault breadth
Maximum frontal breadth
Minimum frontal breadth
Bi-mastoid breadth
Bi-auricular breadth
Bizygomatic breadth
Bi-stylomastoid breadth
Least bi-sphenoid
Foramen magnum, L. & Br.
Left carotid foramen a–p
Left parietal thickness
Porion-mastoid height
Zygoma thickness
Articular eminence salient
Articular eminence a–p
Basion-nasion length
Basion-prosthion length

Optic foramen-nasion
Optic foramen-basion
Sphenobasion-nasion
Sphenobasion-basion
Sphenobasion-alveolon
External palate length
External palate breadth
Palate height (M_1–M_2)
Orbit height, L–R
Orbit breadth, L–R
Biorbital breadth
Interorbital breadth
Dakryon-nasion salient
Upper nasalia breadth
Lower nasalia breadth
Nose breadth
Nose height
Nasalia length
Nasion-prosthion height
Nasion-menton height
Incisor height
Incisor overlap (vertical)
Incisor overshoot (horiz.)
Chin height
Bicondylar breadth
Bigonial breadth
Bi-mental breadth
Gonion-symphysion length
Direct ramus height
Minimum ramus breadth
Corpus thickness (M_1)
Molar length
Mandibular angle

Frontal angle
Forehead slope angle
Nasalia profile angle
Facial angle
Alveolar angle
Orbit sagittal angle
Orbit droop angle
Orbit a–p axis angle
Nasal floor angle
Alveolar plane angle
Mandibular plane angle
Chin profile angle
Opisthion-lambda angle
Foramen magnum angle
Basi-occipital angle
Auricular-vertex height
Auricular-bregma height
Auricular-nasion length
Auricular-infraorbitale
Auricular-basion height
Cranial index
Mean auricular height index
Fronto-parietal index
Bi-auricular-parietal index
Basal length-breadth index

Cranio-facial index
Zygo-frontal index
Fronto-gonial index
Zygo-gonial index
Facial index
Upper facial index
Nasal index

Left orbital index
External palatal

Cranial capacity
Skull module
Vault module

Stature
Asymmetry or Deformation
Kind
Degree
Cause

- Vault
  - Ill-filled
  - Medium
  - Well-filled
- Norma verticalis
  - Spheroid
  - Ellipsoid
  - Ovoid
  - Byrsoid
  - Sphenoid
  - Square
  - Rhomboid
  - Pentagonoid
- Norma Lateralis
  - Ellipsoid
  - Ovoid
  - Pentagonoid
  - Round
  - Square
  - Sphenoid
- Norma occipitalis
  - Spheroid
  - Rounded
  - Gabled
  - Hausform
  - Hayrick
  - Barrel-vault
  - Ellipsoid
- Norma facialis
  - Rounded
  - Heart
  - Pentagonoid
  - Squat hexagon
  - Long hexagon
  - Square
  - Rectangular
  - Trapezoid
  - Triangular

FRONTAL **Browridge type** **Median** **Divided** **Continuous** **Browridge size** **Trace** **Sm.** **+** **++** **+++** **Metopism** **Traces** **Complete** **Frontal grooves** **Trace – sl.** **+ – ++**	Postorbital constr. Sl. + ++ Frontal bosses Sm. + ++ Median crest Sm. + ++ PARIETAL Postcoronal depr. Sl. + ++	Sagittal elevation None Sl. + ++ +++ Parietal bosses Sm. + ++ Pterion type Left Right H H K K X X Retourné Retourné	Parietal foramina None Sl. – + ++ TEMPORAL Fullness Flat Sl. + ++ Mastoids Sm. + ++ +++ Supramastoid crest	OCCIPUT Lambdoid flattening None Sl. + ++ Curve Flat Sl. + ++ Cerebellar bulge Sl. + ++ Transverse suture:	Inion size Trace Sm. + ++ Crest size Trace Sm. + ++ Crest shape Ridge Mound SUTURE SERRATION Coronal Sagittal Lambdoid	SUTURE CLOSURE Coronal Open Begin + ++ Complete Sagittal Open Begin + ++ Complete Squamous Open + Complete
Lambdoid **Open** **Begin** **+** **++** **Complete** **Masto-occipital** **Open** **+** **Complete** **Inca bone** **Wormian bones** **Lambdoid** **Sagittal** **Coronal** **Other**	BASE Condyle projection Sl. + ++ Pharyngeal tubercle Sm. + ++ Pharyngeal fossa Sm. + ++ Petrous depression Sl. + ++	Styloid size Sm. + ++ Tympanic plate Thin + Thick Postglenoid process Short + Long Eminence slope Sl. + ++	Auditory meatus Round Oval Ellipse Slit Angular spine Sm. + ++ Ext. pterygoid plate Sm. + ++ Pterygo-spinous for.	FACE Palate shape Parabolic Elliptical Hyperbolic (V) Small U Large U Palatine torus None Sm. + ++ Pal. torus form Ridge Mound Lump Palate height:	Postnatal spine Sm. + ++ Orbit shape Ellipsoid Square Rectangular Rhomboid Lacrimal foramen Sm. + ++ Infraorbital suture Absent Present:	Suborbital fossa None Sl. + Malar size Sm. + ++ +++ Lateral projection Compressed Sl. + ++ +++
Anterior projection **Sl.** **+** **++** **Marginal process** **Sm.** **+** **++** **Nose root height** **V. low** **Low** **+** **High** **V. high** **Nasion depression**	Nose root breadth V. narrow Narrow + Wide V. wide Bridge height V. low Low + High V. high Bridge breadth Narrow + ++	Nose profile Straight Concave Wavy Convex "Classical profile" Absent Present Nasal spine size Absent Sm. + ++ Nasal spine form Pointed Spatulate Downturned	Nasal sills None Dull + Sharp Subnasal grooves None Sl. + ++ Prognathism (total) None Sl. + ++ +++	Alveolar prognathism Maxilla Mandible None None Sl. Sl. + + ++ ++ +++ +++ Mouth region form Linear Tilted Angular Civilized Infantile Squat Primitive Other	Chin form Median Triangular Bilateral Chin projection Negative Neutral Sl. + ++ Genial tubercles None Pit Sm. + ++	Mylo-hyoid ridge Sm. + ++ Pterygoid insertion Sl. + ++ Gonia eversion None Sl. + ++ Mandibular torus Absent Present:
Tooth eruption **Incomplete:** **Complete** **Suppr. all M_3s** **Suppr.:** **Other** **Alveolar absorption** **None** **Sl.** **+** **++** **Pyorrhea** **None** **Sl.** **+** **++**	No. alveolae present No. teeth lost *p.m.* No. teeth lost *a.m.* No. teeth carious No. abscesses	Abscess size Sm. + ++ Teeth wear None Sl. + ++ +++ Crowding None Sl. + ++	Teeth quality V. poor Poor + Good Excellent Molar cusps (number) Upper Lower Molar cusp pattern Plus Dryopithecus Accessory cusps None Present:	Shovel incisors Absent Sl. + ++ Bite Under Edge Sl. over + over ++ over Central trema Absent Sl. + ++	Left Dentition Right $\bar{8}\ \bar{7}\ \bar{6}\ \bar{5}\ \bar{4}\ \bar{3}\ \bar{2}\ \bar{1}\quad \bar{1}\ \bar{2}\ \bar{3}\ \bar{4}\ \bar{5}\ \bar{6}\ \bar{7}\ \bar{8}$ /: alveolus missing *: carious m: milk tooth retained =: lost post mortem a: abscess X: lost ante mortem s: suppr. w: worn to roots Crown L. & Br.: M_1 M_2 M_3 Upper Lower	

The Sex of the Skull

It is not possible with any degree of reliability to determine the sex of the skull until after puberty. In general the female skull is smaller and lighter than the male skull. It presents a more infantile appearance, the bones are smoother, more gracile, and more delicately fashioned. The supraorbital and temporal ridges are little if at all developed, the mastoid processes are small and the supramastoid crests scarcely developed, while the occipital muscle markings are weakly developed. The facial skeleton, teeth, mandible, zygomatic arches and cheekbones are smaller and more delicate, and the margins of the orbits are sharper in the female.[14]

Cranial Recording Blanks

Recording blanks for registering measurements and observations made on the skull will be found indispensable. A typical blank of this sort is reprinted here through the courtesy of Dr. J. L. Angel.

Postcranial Osteometry

The purposes for which the postcranial skeleton may be measured are varied. But whatever the purpose, measurements should always be adapted to throw the maximum light upon the problem under investigation. The investigator should always know *why* he is making a particular measurement. Well constructed measurements can help to solve difficult problems.

Instruments. In addition to the instruments already described, larger versions of the sliding compass and spreading calipers are used, and the anthropometer sometimes used to serve the purposes of both, that is, as a rod compass and as a sliding caliper or pelvimeter. For the measurement of long bones an osteometric board is commonly used. The *osteometric board* is a flat, seasoned block of wood, some 23 inches long by 12 inches wide, and about one inch thick. Firmly and immovably attached to one end at an exact right angle is a wooden upright of some 8 inches. Inlaid or attached metric scales run the length of the board (preferably one on each side and one down the middle of the board). A free

---

[14] For the most recent study see Keen, J. A.: A study of the differences between male and female skulls. *Am. J. Phys. Anthropol.,* n.s. *8:* 65-78, 1950.

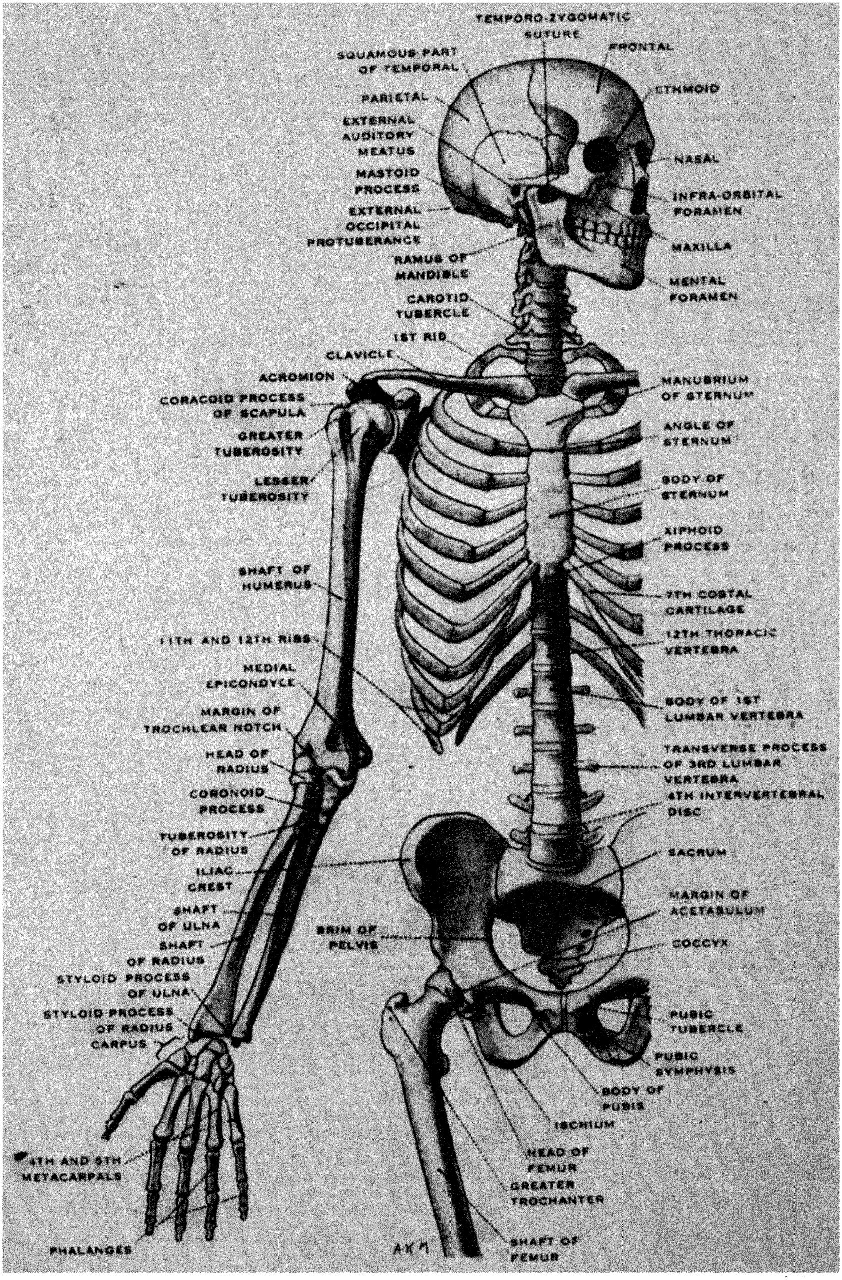


FIG. 156. The Human skeleton (anterior view). (From Appleton *et al.* Courtesy, Williams & Wilkins.)

L-shaped wooden upright completes the instrument. To measure, one end of the bone is placed against the fixed upright and the movable upright against the other, so that the bone is enclosed between the two uprights. The length is then read off the scale at the edge of the movable upright. A satisfactory osteometric board can easily be made by using a 50 cm. square sheet of graduated millimeter graph paper.

Measurements
Upper Extremity and Scapula
Humerus Radius and Ulna

1. *Maximum length* (osteometric board): Between the most proximal and most distal points, the bone being held parallel to the long axis of the board.

2. *Maximum diameter of head* (sliding compass).

3. *Antero-posterior middle shaft diameter* (sliding compass): At middle of shaft.

4. *Medio-lateral middle shaft diameter* (sliding compass): At middle of shaft.

5. *Maximum medio-lateral distal diameter* (sliding compass): At the epiphyseal end of the bone immediately above its associated processes.

6. *Radio-Humeral Index* $$\frac{\textbf{Maximum Length Radius} \times \textbf{100}}{\textbf{Maximum Length Humerus}}$$

Scapula

7. *Morphological breadth* (sliding compass): From the highest point of the superior angle to the lowest point of the inferior angle.

8. *Morphological length* (spreading calipers): From the middle of the glenoid fossa to the point on the vertebral border midway between the two ridges terminating the scapular spine; this point is here called the vertebrion.

9. *Breadth of infraspinous fossa* (sliding compass): From the inferior angle to the vertebrion.

10. *Breadth of suprasinous fossa* (sliding compass): From the superior angle to the vertebrion.

11. *Scapular Index* $$\frac{\textbf{Morphological Length} \times \textbf{100}}{\textbf{Morphological Breadth}}$$

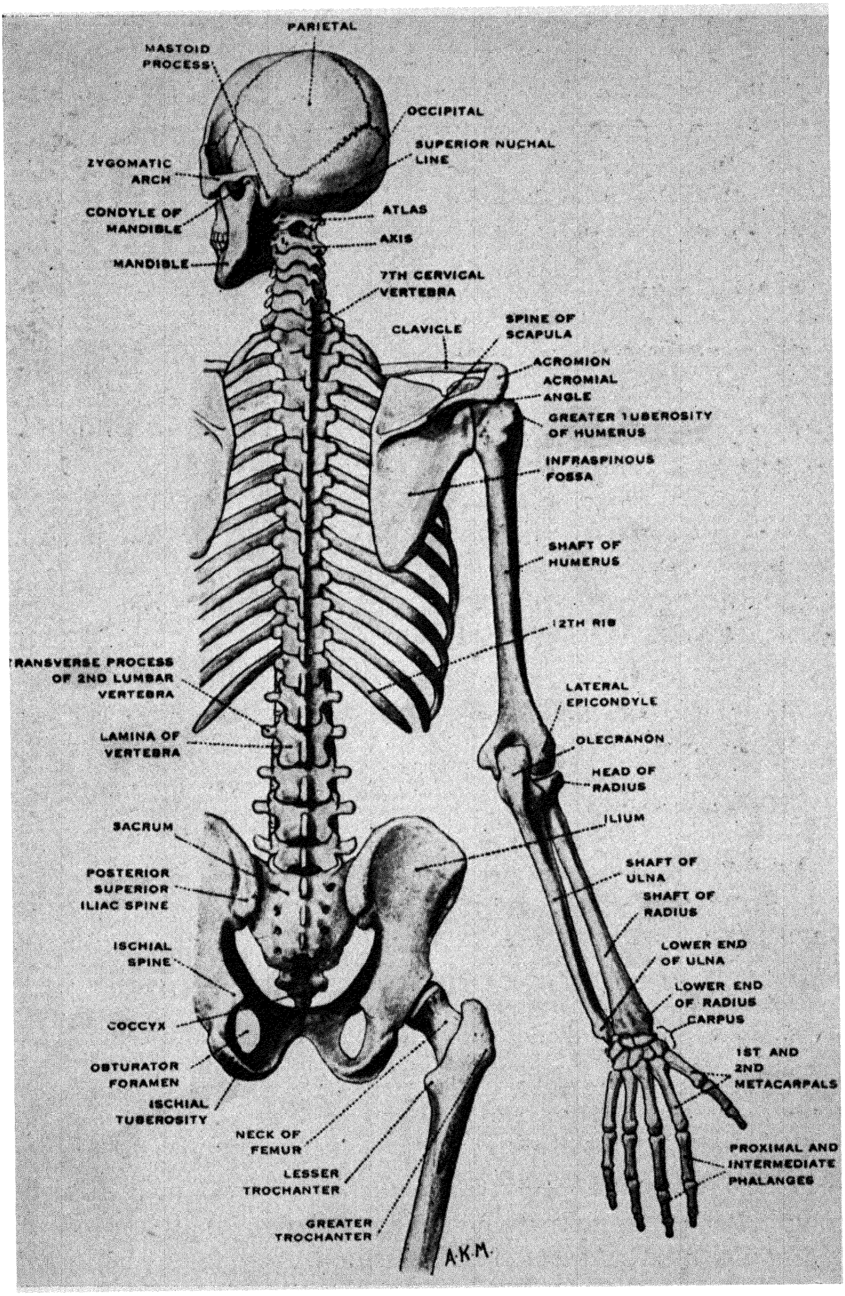


FIG. 157. The Human skeleton (posterior view). (From Appleton *et al.* Courtesy, Williams & Wilkins.)

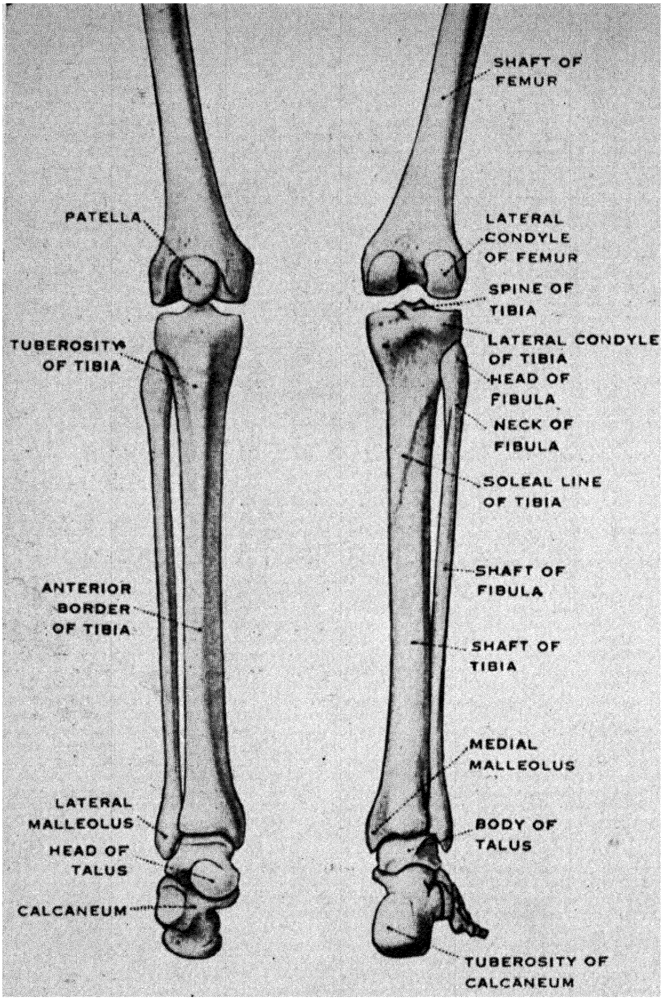


FIG. 158. Skeleton of the leg. (On left) anterior aspect with bones of foot removed except talus and calcaneum; (on right) posterior aspect. (From Appleton *et al.* Courtesy, Williams & Wilkins.)

Observations

Form of vertebral border, from superior angle: Convex, straight, concave, or any combination of these.

Scapular notch: Absent, slight, medium, deep, foramen.

Age changes: Lipping of margins of glenoid fossa, atrophic patches or rarefaction of scapular fossae.

Lower Extremity and Pelvis

Femur

13. *Maximum length:* Between the internal condyle and the head. To find this measurement it is necessary to move the bone slightly up and down and from side to side between the two uprights.

14. *Bicondylar length:* The two condyles rest up against the fixed upright and the moveable upright is brought against the femoral head, so that the whole femur rests naturally between the two uprights.

15. *Maximum diameter of head* (sliding compass).

16. *Subtrochanteric antero-posterior diameter* (sliding compass): Immediately below the lesser trochanter in the sagittal plane.

17. *Subtrochanteric medio-lateral diameter* (sliding compass): From the medial to the lateral surfaces at the level of the preceding measurements.

18. *Platymeric Index*

$$\frac{\textbf{Antero-posterior diameter} \times \textbf{100}}{\textbf{Medio-lateral diameter}}$$

Hyperplatymeric	×–74.9
Platymeric	75.0–84.9
Eurymeric	85.0–99.9
Stenomeric	100.0–×

The platymeric index may reflect and thus indicate differences in ethnic, occupational, pathological conditions, and also in such habits as sitting and squatting.

19. *Antero-posterior diameter of middle of shaft* (sliding compass).

20. *Medio-lateral diameter of middle of shaft* (sliding compass): At same level as preceding.

Pilastric Index

$$\frac{\textbf{Antero-posterior diameter of middle of shaft} \times \textbf{100}}{\textbf{Medio-lateral diameter of middle of shaft}}$$

Angles

21. *Collo-diaphyseal angle* (protactor): The angle made by the axis of the head and neck with that of the shaft.

22. *Angle of torsion* (protractor): The angle of the axis of the head projected upon the axis of the posterior surface of the condyles.

Tibia

23. *Maximum length* (osteometric board): The bone resting on its dorsal surface with the medial malleolus resting against the fixed upright. The movable upright is brought into contact with the antero-superior surface of the lateral condyle. The tibia must be parallel to the long axis of the board.

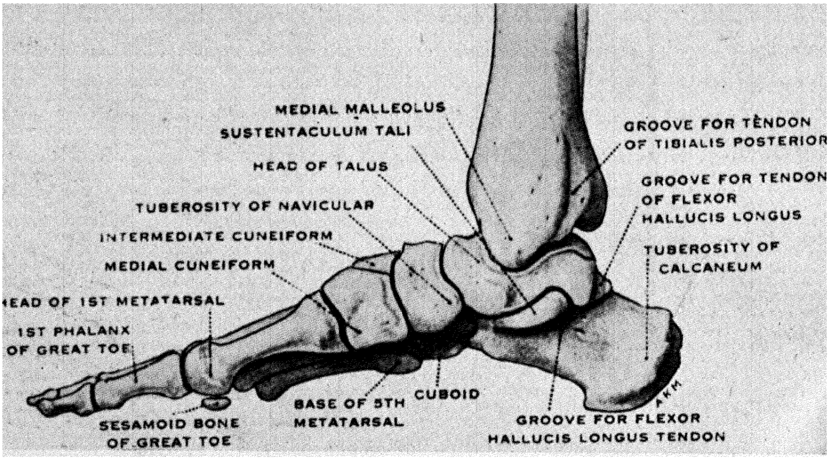


FIG. 159. Skeleton of foot. Medial aspect. (From Appleton *et al.* Courtesy, Williams & Wilkins.)

24. *Antero-posterior diameter middle of shaft* (sliding compass).
25. *Medio-lateral diameter of middle of shaft* (sliding compass).
26. *Antero-posterior nutrient foramen diameter* (sliding compass): Diameter of shaft at level of nutrient foramen.
27. *Medio-lateral nutrient foramen diameter* (sliding compass).
28. *Platycnemic Index* $\dfrac{\textbf{Medio-lateral nutrient diameter} \times \textbf{100}}{\textbf{Antero-posterior nutrient diameter}}$

Hyperplatycnemic	×–54.9
Platycnemic	55.0–62.9
Mesocnemic	63.0–69.9
Eurycnemic	70.0–×

Observations

Lateral condyle: Concave or convex.

Squatting facets: Note whether there are any extensions of the inferior articular surface above the anterior lip or medially at the distal end of tibia.

Vertebrae

29\. *Anterior height of centrum* (sliding compass): From the middle of the antero-superior lip to the middle of the antero-inferior lip of the body.

30\. *Posterior height of centrum* (sliding compass): From the middle of the postero-superior border to the middle of the postero-inferior border of the body.

Pelvis and Sacrum

31\. *Maximum pelvic height* (rod compass): From the highest point on the iliac crest to the lowest point on the ischial tuberosity.

32\. *Maximum pelvic or cristal breadth* (rod compass): Greatest diameter between the external lips of the right and left iliac crests.

33\. *Pelvic Breadth-Height Index* $\dfrac{\textbf{Maximum pelvic height} \times \textbf{100}}{\textbf{Maximum pelvic breadth}}$

34\. *Interspinous diameter* (sliding compass): The maximum diameter between the antero-lateral margins of the antero-superior iliac spines.

35\. *External conjugate diameter* (pelvimeter): From the inferior tip of the 5th lumbar spine to the antero-inferior margin of the pubic symphysis.

36\. *Diagonal conjugate diameter* (pelvimeter): From the mid-sagittal point on the antero-superior margin of the sacral promontory to the postero-inferior margin of the pubic symphysis.

37\. *Normal conjugate diameter* (sliding compass): From the postero-superior margin of the symphysis pubis to the deepest point of the third sacral vertebra.

38\. *Sagittal diameter of pelvic inlet* (sliding compass): From the postero-superior border of the pubic symphysis to the center of the sacral promontory.

39\. *Transverse diameter of pelvic inlet* (sliding compass): Maximum diameter between arcuate lines.

40. *Pelvic Inlet Index* $\frac{\textbf{Sagittal diameter of pelvic inlet} \times \textbf{100}}{\textbf{Transverse diameter of pelvic inlet}}$

Platypellic	×–89.9
Mesatipellic	90.0–94.9
Dolichopellic	95.0–×

In a study, by roentgen pelvimetry of 686 living white women, and 107 girls from five to 15 years of age, Greulich and Thoms found the following distribution of pelvic inlet indices:

	Platy-pellic per cent	*Mesati-pellic per cent*	*Doli-chopellic per cent*
582 primiparous clinic women (lower socio-economic classes)	35.2	27.5	37.3
104 nulliparous student nurses (higher socio-economic classes)	13.5	13.5	73.0
107 children	8.4	35.2	82.2

Of the 686 women studied 68.1 per cent had a pelvic inlet index of 90 or more. Only 31.9 per cent were of the platypellic type which the textbooks generally describe as typical.

In 69 male medical students at Yale the same authors found the pelvic inlet index to vary between 77.0 to 121.0, with an average index of 100.5. The frequencies were 7.2 per cent platypellic, 14.5 mesatipellic, and 78.2 dolichopellic.

41. *Inferior antero-posterior diameter* (sliding compass): From the postero-inferior border of the pubic symphysis to the postero-inferior border of the sacrum.

42. *Distance between ischial spines* (sliding compass): Minimum.

43. *Intertuberous diameter* (sliding compass): Minimum diameter between the postero-medial margins of the ischial tuberosities.

44. *True pelvic height* (sliding compass): From the lowest point on the medial margin of the ischial tuberosity to the arcuate line anterior to ileopectineal eminence.

Sacrum

45. *Anterior sacral length* (sliding compass): From the middle of sacral promontory to the middle of the antero-inferior margin of the last sacral vertebra.

46. *Anterior sacral breadth* (sliding compass): At junction with arcuate lines.

47. *Length-Breadth Sacral Index* $\dfrac{\textbf{Anterior sacral breadth} \times \textbf{100}}{\textbf{Anterior sacral length}}$

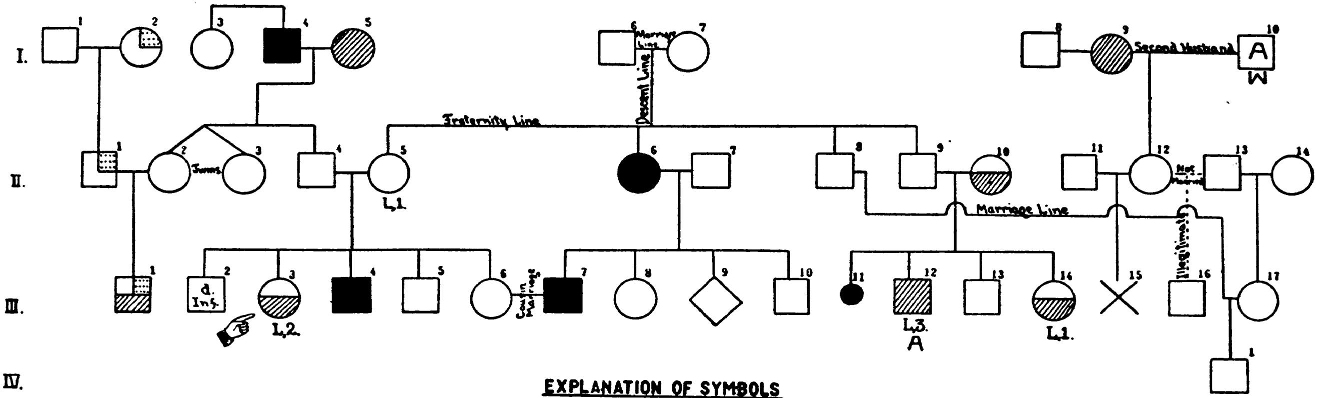
Dolichohieric	X– 99.9
Subplatyhieric	100.0–105.9
Platyhieric	106.0–X

Sexual Characters of the Pelvis

It is possible to determine the sex of the skeleton in a large percentage of cases from the characters of the pelvis. Variability is, however, very considerable. Each sex may exhibit the typical pelvic characters of the opposite sex. One can, therefore, never be quite certain that sex has been accurately determined from the characters of the pelvis. Below is given a list of 21 characters in which the female pelvis and sacrum generally differs from that of the male.

Pelvic Characters	*In the Female*
Cristal breadth	Less
Iliac crest	Less rugged
Tubercles of iliac crest	Much less marked
Anterior and posterior slopes iliac crest	Less steep
Iliac blades or bones	More vertical
Iliac part of ileopectineal line	Greater
Sagittal diameter of pelvic inlet	Greater
Transverse diameter of pelvic inlet	Greater
Symphysis pubis	Broader and lower
Symphyseal height	Less
Ischial portion of pubic bone	Lipped outward, constricted just below symphysis
Subpubic angle	Greater
Intertuberous breadth	Greater
Acetabulum	Lighter
Diameter between ischial spines	Greater
Greater sciatic notch	Broader and more shallow
Preauricular sulci or grooves	Present and well developed
Sacrum	Broader and shorter
Sacral curve	Less
Lower portion of sacrum	Bent backward and upward

SAMPLE PEDIGREE CHART SHOWING THE MANNER OF CONSTRUCTION, AND THE USE OF STANDARD AND SPECIAL SYMBOLS.



EXPLANATION OF SYMBOLS

(a). Standard for all Pedigree Charts:

□=Male; ○=Female; ◇=Sex unknown; ●=Still-birth or Miscarriage; X=Children — number and sex unknown; ○○=Twins; d. Inf.=Died in Infancy; ☞ Points to the Propositus or central figure in the pedigree.

□-○ = Parents.

□○□○○=Children.

Roman figures to the left indicate generations; Arabic figures locate individuals, (thus III.7 is the young man in the third generation who married his cousin).

The following letters, placed in or around the individual's pedigree symbol, are standard for certain traits: A, alcoholic; B, blind; D, deaf; E, epileptic, F, feebleminded, I, insane, M, migraineous; N, normal in reference to traits under consideration; Ne, neurotic; P, paralytic; Sx, sexually immoral; S, syphiletic; T, tuberculous; W, wanderer.

(b). Especially devised or selected for this particular pedigree-chart:

■ ● = Successful leaders in politics. ▨ ▨ = Extra thumb on right hand. L.1.=Highly successful author. L.3.=Little or no ability in literary efforts. ▨ ▨ = Superior in vocal music. ▨ ▨ = Medium attainment in vocal music.

To fit the particular family and traits (whether physical, mental or temperamental; good or bad) under consideration, invent special symbols, or select special letters (in addition to those standardized under (a) above) to be placed within or near the particular individual's pedigree symbol, to indicate particular traits and their degree of development.

FIG. 160. Sample genetic pedigree chart. (Courtesy. Eugenics Records Office, New York.)

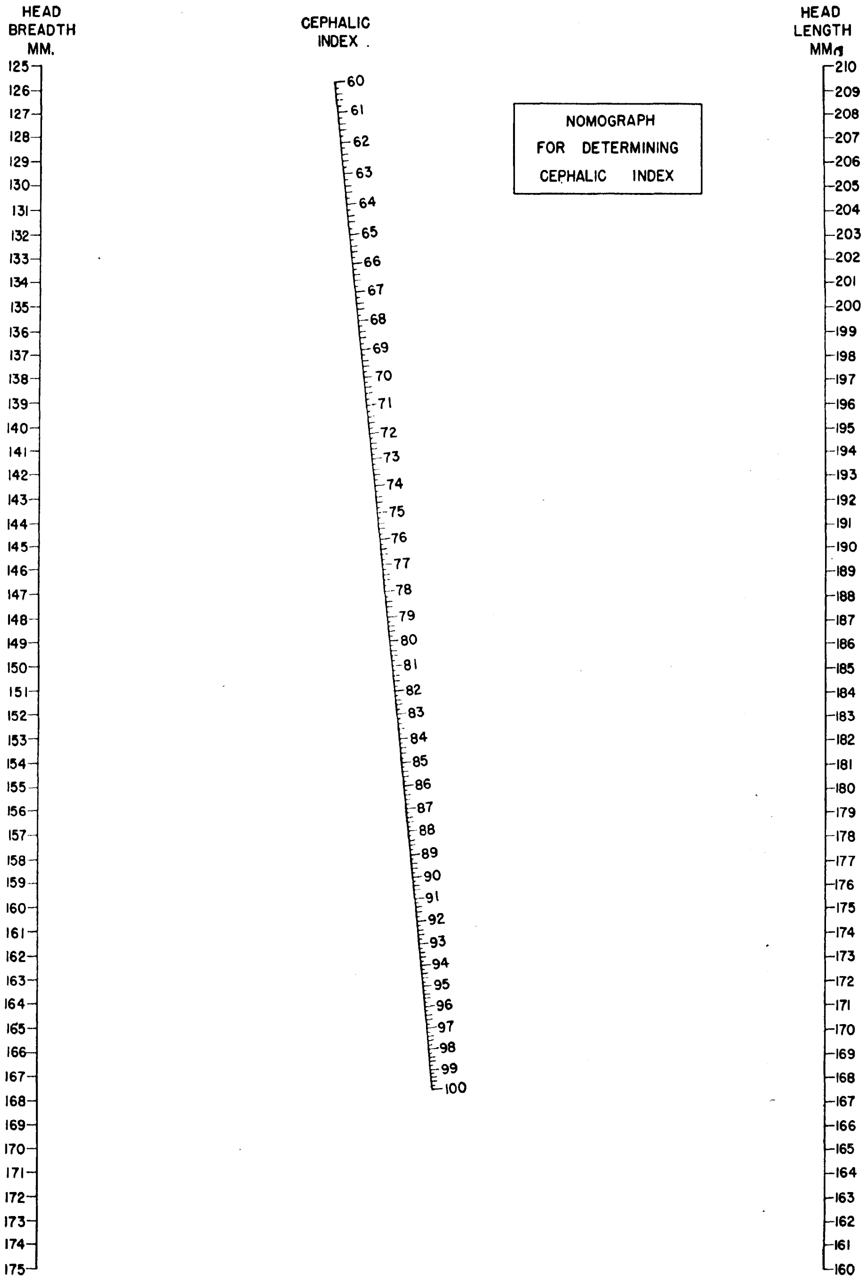


FIG. 161. Nomograph for determining cephalic index. A straight line passing from the measurement for head breadth to the measurement for head length will yield the correct reading for cephalic index in the middle column. (From the *Yearbook of Physical Anthropology for 1949.* Courtesy, Dr. G. W. Lasker and the Viking Fund, New York.)

Washburn has recently devised an ischium-pubis index which will accurately sex, according to him, over 90% of skeletons. Length of ischium are measured from the point at which ischium, pubic, and ilium meet in the acetabulum. In the adult this point can be approximately identified because: (1) there is often an irregularity present both in acetabulum and inside the pelvis, (2) holding the bone up to a light will reveal a change in thickness, and (3) there is frequently a notch in the border of the articular surface of the acetabulum. In making measurements hold calipers parallel to long axis of each bone. It is, of course, understood that sexing will be carried out on skeletons belonging to a single division of mankind. The pubic bone is absolutely and relatively larger in females than in males.

$$\frac{\textbf{Pubis Length} \times \textbf{100}}{\textbf{Ischium Length}} = \textbf{Ischium-Pubis Index}$$

The ischium-pubis index averages 15% higher in females than in males. The mean index in white males was found to be 83.6 (range 73-94) ± 4.0, for white females 99.5 (range 91-115) ± 5.1. In Negro males the comparable figures were 79.9 (range 71-88) ± 4.0, and in Negro females 95.0 (range 84-106) ± 4.6. Only 5 white males were found to fall within the range of female variation. More overlapping occurs among Negroes, probably due to ethnic mixture.

PEDIGREES FOR GENETIC STUDIES

Fig. 160 shows a sample pedigree chart together with an explanation of the symbols. For the traits listed any others may be substituted at the convenience of the investigator.

WORKS ON ANTHROPOMETRY AND ANTHROPOSCOPY

HOOTON, E. A.: Elementary Anthropometry, in *Up From the Ape,* 2nd edition, New York, Macmillan, 1946, p. 715-769.

An excellent introduction to general anthropometry on the skeleton and the living subject.

HRDLIČKA, A.: *Practical Anthropometry.* 3rd edition (edited by T. D. Stewart). Philadelphia, Wistar Inst., 1947.

May be used as a reference book to the decisions of various congresses, and as a suggestive rather than as a practical anthropometry. The recommended procedures in this work are, in general, not exact enough, particularly in the anthroposcopic sections.

MARTIN, R.: *Lehrbuch Der Anthropologie,* 2nd edition, 3 vols., Jena, Fischer, 1928.

The standard work on anthropometry and anthropometric methods, though somewhat out of date, and therefore to be used with caution. The third volume is entirely devoted to the literature of physical anthropology, and is an indispensable reference work.

SULLIVAN, L. R.: *Essentials of Anthropometry. A Handbook for Explorers and Museum Collectors.* (Revised by H. L. Shapiro). New York, American Museum of Natural History, 1928.

A useful pocketbook devoted to the anthropometry and anthroposcopy of the living; somewhat out of date.

WILDER, H. H.: *A Laboratory Manual of Anthropometry.* Philadelphia, Blakiston, 1920.

A very useful book on the anthropometry of the skeletal and living subject, but somewhat out of date.

WORKS ON STATISTICS

ARKIN, H. and COLTON, R. R.: *Statistical Methods.* 4th edition, New York, Barnes & Noble, 1950.

A most useful distillation of the essence of statistical methods.

CHAMBERS, E. G.: *Statistical Calculation for Beginners.* New York, Cambridge University Press, 1948.

An excellent introduction, on a very elementary level.

DAHLBERG, G.: *Statistical Methods for Medical and Biological Students.* New York, Norton, 1948.

An excellent book, assuming an elementary knowledge of mathematics.

FISHER, R. A.: *Statistics for Research Workers.* 10th edition, Edinburgh, Oliver & Boyd, 1946.

The most widely used practical treatise.

KURTZ, A. K. and EDGERTON, H. A.: *Statistical Dictionary of Terms and Symbols.* New York, Wiley, 1939.

An authoritative dictionary of clear and accurate definitions of statistical terms and symbols.

PEARL, R.: *Introduction to Medical Biometry and Statistics.* 3rd edition, Philadelphia, Saunders, 1940.

A standard and invaluable work, especially useful to physical anthropologists and medical men.

SIMPSON, G. G. and ROE, A.: *Quantitative Zoology.* New York, McGraw-Hill, 1939.

A work on the methodology of zoology, constituting a most attractively written introduction to the use and methodology of statistics.

SNEDECOR, G. W.: *Statistical Methods.* 4th edition. Ames, Iowa, Collegiate Press, 1948.

An excellent introduction.

YULE, G. U. and KENDALL, M. G.: *An Introduction to the Theory of Statistics.* 13th edition, New York, Hafner, 1950.

A standard work, and the most commonly used by physical anthropologists, most of whom were brought up on the earlier editions of this admirable work.

TABLE OF WEIGHTS AND MEASURES

1 Micron (μ) = 1 thousandth of a millimeter (mm)
1 Millimeter = 1 thousandth of a meter
10 millimeters = 1 centimeter (cm)
10 centimeters = 1 decimeter (dm)
10 decimeters = 1 meter (m)

$$1 \text{ meter} = \begin{cases} 10 \text{ decimeters} \\ 100 \text{ centimeters} \\ 1000 \text{ millimeters} \end{cases}$$

1 inch = 25.4 millimeters
1 foot = 30.5 centimeters (approximately), or 0.3048 meter
5½ inches = 14.0 centimeters
1 yard = 0.9144 meter
1 meter = 39.37 inches
1 mile = 1.6093 kilometers
Volume = Length x Breadth x Thickness
Area = Length x Breadth
1 cubic inch = 16.387 cubic centimeters
1 cubic centimeter (c.c. or cc) = 0.061 cubic inch
1 cubic centimeter of water at 4°C. weighs 1 gram
1 liter of water at 4°C. weighs 1000 grams and is called a kilogram
1 decigram = 1/10 gram (dgm)
1 centigram = 1/100 gram (cgm)
1 milligram = 1/1000 gram (mgm)
1 cubic decimeter (cd) = (1000 cubic centimeters) = 61.024 cubic inches
1 cubic meter (100 cubic decimeters) = 35.3148 cubic feet
1 cubic decimeter = 1 liter
1 liter = 1.81 pints
4 liters = 7 pints or 112 ounces
1 pint = 16 ounces
1 ounce = 28.350 grams
1 kilogram = 2 pounds 3¼ ounces
16 ounces = 1 pound
3.527 ounces = 100 grams
1 pound = 453.592 grams

DRY MEASURE

Pints	Quarts	Gallons	Cubic Inches	Metric
1	0.5	0.125	33.600	550.599 cu. millimeters
2	1.0	0.25	67.201	1.101 liters
8	4.0	1.0	268.803	4.405 liters
16	8.0	2.0	537.605	8.809 liters
64	32.0	8.0	2150.42	35.238 liters

Specific Gravity = The number of times a body or substance is heavier or lighter than an equal volume of water (or some other substance taken as a standard).

Some Current Anthropological Periodicals Either Wholly or in Part Devoted to Physical Anthropology

Acta Genetica et Statistica Medica

Published quarterly by S. Karger Ltd. Holbeinstrasse 22, Basel, Switzerland. Editor, Gunnar Dahlberg, State Institute of Human Genetics and Race Biology, Uppsala, Sweden. Annual subscription 44 Swiss francs.

American Anthropologist

Published quarterly by the American Anthropological Association and affiliated anthropological societies. Executive Secretary, Frederick Johnson, R. S. Peabody Foundation, Andover, Massachusetts. Annual subscription $6.00.

American Antiquity

Published quarterly by the Society for American Archeology at the Robert S. Peabody Foundation, Andover, Massachusetts. Annual subscription, $4.00.

American Journal of Human Genetics

Published quarterly by the American Society of Human Genetics, Mount Royal and Guilford Avenues, Baltimore 2, Maryland. Annual subscription $8.00.

American Journal of Physical Anthropology

Published quarterly by the Wistar Institute of Anatomy and Biology, Philadelphia, Pennsylvania. Organ of the American Association of Physical Anthropologists. Secretary Dr. Earle Reynolds, Fels Research Institute, Antioch College, Yellow Springs, Ohio. Annual subscription $7.50.

Annals of Eugenics

A journal of human genetics. Issued by the Galton Laboratory, University College, Gower Street, London, W. C. 1, England. Subscription per volume 50s. ($10.00).

Anthropos

International review of ethnology and linguistics. Published irregularly with the support of the University of Freibourg, Poisieux-Froideville, Ct. de Freibourg, Switzerland. Each issue separately priced.

Antiquity

A quarterly review of archeology, published at 24, Parkend Road, Gloucester, England. Annual subscription 20s. ($4.25).

Biological Abstracts. Section H—Human Biology

Published monthly during the months January to May, October and November; bi-monthly June to September; semi-monthly in December, by Biological Abstracts, Executive Office, University of Pennsylvania, Philadelphia, 4, Pennsylvania. Annual subscription $6.00.

Biometrika

Issued quarterly by the Biometrika Office, University College, Gower Street, London, W. C. 1, England. Annual subscription 50s. ($10.00).

Boletin Bibliografico de Antropologia Americana

Published annually by the Instituto Panamericano de Geografia e Historia, Avenida del Oservatorio Num. 192, Tacubaya, D. F. Republica Mexicana.

British Journal of Social Medicine

Published quarterly by the British Medical Association, Tavistock Square, London, W.C. 1. Annual subscription 25*s*. (4.00).

Bulletin de la Société Préhistorique Française

Published bi-monthly by the Société Préhistorique Française, Siège Social, 250, rue Saint-Jacques, Paris-Ve, France. Annual subscription 200 francs.

Bulletins et Mémoires de la Société d'Anthropologie de Paris

Published quarterly by the *Société d'Anthropologie de Paris* through Masson et Cie., 120, Boulevard Saint-Germain, 120, Paris-VIe, France. ($2.50).

Child Development Abstracts

Published February through December—6 numbers, by the Society for Research in Child Development. Editor, Dr. T. W. Richards, Fayerweather Hall, Northwestern University, Evanston, Illinois. Annual subscription $5.00.

The Eastern Anthropologist

A journal founded in 1948 devoted to the study of the physical and cultural anthropology of the peoples of India. Published quarterly by the Ethnographic and Folk Culture Society, Lucknow, India. Distributed by the Biotechnic Press, Ltd., BCM/Biotechnic, London, W.C. 1, England. Annual subscription 20*s*. ($2.80).

Evolution

Published quarterly by The Society for the Study of Evolution. Business manager Mr. K. P. Schmidt, Chicago Natural History Museum, Chicago 5, Illinois. Annual subscription $6.00.

Excerpta Medica

Fifteen sections abstracting the whole field of medicine are published. Section 1 deals with anatomy and anthropology. Published monthly. 111, Kalverstraat, Amsterdam, C. The Netherlands.

Homo

Devoted to the comparative study of man and human biology. Organ of the Deutschen Gesellschaft für Anthropologie. Published quarterly by the Ferdinand Enke Verlag, Stuttgart, Germany. Annual subscription RM 30.

Human Biology

Published quarterly by The Johns Hopkins Press, Baltimore 5, Maryland. Edited by Charles P. Winsor, 615, N. Wolfe Street, Baltimore 5, Md. Annual subscription $5.00.

Human Organization (formerly *Applied Anthropology)*

Published quarterly by the Society for Applied Anthropology. 7 Washington Place, New York 3, N.Y. Annual subscription $5.00.

Journal of the Royal Anthropological Institute

Published quarterly by the Royal Anthropological Institute, 21, Bedford Square, London, W. C. 1, England. Annual subscription 63s. (9.50).

L'Anthropologie

Published bi-monthly by the Société d'Anthropologie de Paris through Masson et cie., 120, Boulevard Saint-Germain, Paris Vle, France.

La Revue de Géographie Humaine et D'Ethnologie

A quarterly containing much valuable material of interest to the physical anthropologist. Office of publication: 5, rue Sébastien-Bottin, Paris VII, France. Annual subscription 1,740 francs ($5.50).

Man

A record of anthropological science, published monthly by the Royal Anthropological Institute, 21, Bedford Square, London, W. C. 1, England. Annual subscription 24s. ($4.00).

Mankind

Official journal of the anthropological societies of Australia. Published irregularly by the Anthropological Society of New South Wales, Sydney Municipal Library, George Street, Sydney, New South Wales, Australia. Annual subscription 7s. 6d ($1.75).

Monographs of the Society for Research in Child Development

Published irregularly by the Society for Research in Child Development. Editor, Dr. T. W. Richards, Fayerweather Hall, Northwestern University, Evanston, Illinois.

Oceania

A journal devoted to the study of the native peoples of Australia, New Guinea and the islands of the Pacific Ocean. Published quarterly by the Australian National Research Council, Science House, Gloucester Street, Sydney, New South Wales, Australia. Annual subscription 30s. ($4.50).

Rivista di Antropologia

Published irregularly by the Instituto Italiano di Antropologia, Città Universitaria, Roma, Italia.

Runa, Archivo par Las Ciencas de Hombre

A quarterly covering the whole field of anthropology. Office of publication: calle Reconquista 572, Buenos Aires, Brazil. Annual subscription $6.00.

Southwestern Journal of Anthropology

Published quarterly by the University of New Mexico Press, Albuquerque, New Mexico. Annual subscription $4.00.

Statistical Bulletin

Published monthly by the Metropolitan Life Insurance Company, 1, Madison Avenue, New York 10, New York.

The Eugenics Review

Organ of the Eugenics Society. Published quarterly by Hamish Hamilton Medical Books, 90, Great Russell Street, London, W. C. 1, England. Annual subscription 12s. ($2.25).

The Journal of Heredity

Published monthly by the American Genetic Association, Victor Building, Washington, D.C. Annual subscription $3.50.

Yearbook of Physical Anthropology

Published annually by the Wenner-Gren Foundation For Anthropological Research, Inc., 14, East 71st Street, New York 21, New York.

List of Anthropological Periodicals, Serial, and Monograph Publications

An exhaustive, though not entirely complete, list of the many university, public, private, and museum publications of this sort will be found in *The Journal of the Royal Anthropological Institute,* Vol. 76, 1946, pp. 189-210. This list is published as from June *1949.*

DIRECTORY

International Directory of Anthropologists

Third edition, 1950. Obtainable from the Secretary, Division of Anthropology and Psychology, National Research Council, 2101 Constitution Avenue, Washington 21, D.C. Price $3.00.

BIBLIOGRAPHY

Addair, J. and Snyder, L. L.: Evidence for an autosomal recessive gene for the inheritance of poliomyelitis. *J. Heredity, 33:*307-309, 1942.

Allee, Warder C.: Biology and international relations. *The New Republic, 112:*816-817, 1945.

———: *Cooperation Among Animals.* New York, Schuman, 1951.

———: Where angels fear to tread. A contribution from General Sociology to Human Ethics. *Science, 97:*518-525, 1943.

Angel, J. L.: Constitution in female obesity. *Am. J. Phys. Anthropol.,* n.s. 7:433-471, 1949.

Arkin, H. and Colton, R. R.: *Statistical Methods,* 4th edition. New York, Barnes & Noble, 1950.

Barnes, H. E. and Teeters, N. K.: *New Horizons in Criminology.* New York, Prentice-Hall, 1943.

Bendyshe, T.: The history of anthropology. *Mem. Anthropol. Soc. London, 1:*335, 1863; 1864.

Benedict, R.: *Race: Science and Politics.* New York, Viking Press, 1943.

Bews, J. W.: *Human Ecology.* New York, Oxford, 1935.

Bingham, H. C.: *Gorillas in a Native Habitat.* Washington, D.C., Carnegie Inst., Pub. No. 426, 1932.

Bird, J.: Antiquity and migrations of the early inhabitants of Patagonia. *Geographical Rev., 28:*250-275, 1938.

———: Before Magellan. *Natur. Hist., 41:*16-28, 1938.

Bissonnette, T. H.: Sexual photoperiodism. *Quart. Rev. Biol., 11:*371-386, 1936.

Black, D.: Asia and the dispersal of the primates. *Bull. Geol. Soc. Am., 4:* 1925.

Blum, H. H.: *Photodynamic Action and Diseases Caused by Light.* New York, Reinhold, 1941.

Blumenbach, J. F.: *On the Natural Variety of Mankind* (translated by Bendyshe, T.), *The Anthropological Treatises of Johann Friedrich Blumenbach.* London, Anthropological Society, 1865.

Boas, F.: *Changes in Bodily Form of Descendants of Immigrants. (Final Report.)* Washington, Government Printing Office, 1911 (61st Congress, 2nd Session, Senate Document 208), Reprinted, New York, Columbia Univ. Press., 1912.

Bonin, G. von: On the size of man's brain, as indicated by skull capacity *J. Compt. Neurol., 59:*1-28, 1934.

Boulenger, E. G.: *Apes and Monkeys.* London, Harrap, 1936.

Boyd, W. C.: Blood groups. *Tabulae Biologicae, 17:*111-240, 1939.

———: Rh blood factors; an orientation review. *Arch. Path., 40:*114-127, 1945.

———: Critique of methods of classifying mankind. *Am. J. Phys. Anthropol., 27:*333-364, 1940.

———: Gene frequencies and race mixture. *Am. J. Phys. Anthropol.,* n.s. *7:*587-593, 1949.

———: *Genetics and the Races of Man.* Boston, Little, Brown, 1950.

Braidwood, R. J.: *Prehistoric Men.* Chicago, Chicago Natural History Museum, 1948, Popular Series, No. 37.

Bransby, E. R. and Gelling, J. W.: Variations in and the effect of weather on the growth of children. *Medical Officer, 75:*213-217, 1946.

Broom, R.: *Finding the Missing Link.* London, Watts, 1950.

———: The genera and species of the South African fossil ape-men. *Am. J. Phys. Anthropol.,* n.s., *8:*1-13, 1950.

Brown, F. M.: The microscopy of mammalian hair for anthropologists. *Proc. Amer. Phil. Soc., 85:*250-274, 1942.

Candela, P. B.: The introduction of blood-group B into Europe. *Human Biol., 14:*413-443, 1942.

Carpenter, C. R.: A field study of the behavior and social relations of howling monkeys, *Compt. Psychol. Monogr., 10:* 1934, Serial no. 48.

———: A field study in Siam of the behavior and social relations of the gibbon (*Hylobates lar*). *Compt. Psychol. Monogr., 16:* 1940, Serial no. 84.

Cassirer, E.: *An Essay on Man.* New Haven, Yale University Press, 1944.

Casson, S.: *The Discovery of Man.* New York, Harper, 1940.

Castle, W. E.: Biological and social consequences of race crossing. *Am. J. Phys. Anthropol., 9:*145-156, 1926.

———: Race mixture and physical disharmonies. *Science, 71:*603-606, 1930.

CATTELL, R. B. and MOLTENO, V.: Contributions concerning mental inheritance. II. Temperament. *J. Genet. Psychol., 57*:31-42, 1940.

CAVE, A. J. E.: Report on a human calvaria of upper palaeolithic type. *Archaeologia, 92*:117-119, 1947.

CHAMBERS, E. G.: *Statistical Calculation for Beginners.* New York, Cambridge University Press, 1948.

CHALMERS, J. N. M., IKIN, E. W. and A. E. MOURANT: The ABO, MN, and Rh blood groups of the Basque people. *Am. J. Phys. Anthropol.,* n.s. *7*:529-544, 1949.

CHILDE, G. V.: *Man Makes Himself.* New York, Oxford, 1940.

———: *What Happened in History.* New York, Mentor Books, 1946.

———: *The Dawn of European Civilization.* New York, Knopf, 1947.

CLARK, W. E. LE GROS: *Early Forerunners of Man.* Baltimore, Wood, 1934.

———: Pithecanthropus in Peking. *Antiquity, 19*:1-5, 1945.

———: *History of the Primates.* London, British Museum (Natural History), 1949.

———: New palaeontological evidence bearing on the evolution of the Hominoidea. *Quart. J. Geol. Soc.,* (London), *105*:225-264, 1949.

COBB, W. M.: The physical constitution of the American Negro. *J. Negro Education, 3*:340-388, 1934.

COLBERT, E. A.: Some paleontological principles significant in human evolution. In *Early Man in the Far East* (edited by W. W. Howells), p. 103-147.

COLIN, E. C.: *Elements of Genetics.* Philadelphia, Blakiston, 1946.

CONKLIN, E. G.: *Heredity and Environment.* Princeton, Princeton University Press, 1939.

COON, C. S.: *The Races of Europe.* New York, Macmillan, 1939.

COON, C. S., GARN, S. M. and BIRDSELL, J. B.: *Races.* Springfield, Illinois, Thomas, 1950.

CORNER, G. W.: *Ourselves Unborn,* New Haven, Yale Univ. Press, 1944.

CRAVEN, B. and JOKL, E.: A note on the effect of training on the physique of adolescent boys. *Clin. Proc. J. Cape Town Post-Graduate Med. A., 5*:18-19, 1946.

CUDMORE, S. A. and NEAL, N. A.: *A Height and Weight Survey of Toronto Elementary School Children 1939.* Ottawa, Ministry of Trade and Commerce, 1942.

CUMMINS, H. and MIDLO, C.: *Finger Prints, Palms and Soles: An Introduction to Dermatoglyphics.* Philadelphia, Blakiston, 1943.

DAHLBERG, G.: An analysis of the conception of race and a new method of distinguishing races. *Human Biol., 14*:372-385, 1942.

———: *Race, Reason and Rubbish: a Primer of Race Biology.* New York, Columbia Univ. Press, 1942.

———: Environment, inheritance and random variations with special reference to investigations on twins. *Acta Genet. et Statistica Medica, Basle, 1: 1;* ·104-114, 1948.

———: *Statistical Methods for Medical and Biological Students.* New York, Norton, 1948.

DART, R. A.: Taungs and its significance. *Natural History, 26*:315-327, 1926.

———: The Makapansgat porto-human Australopithecus prometheus. *Am. J. Phys. Anthropol.,* n.s. *6*:391-411, 1948.

———: The predatory implemental technique of Australopithecus. *Am. J. Phys. Anthropol.,* n.s. *7:*1-38, 1949.

———: Innominate fragments of Australopithecus prometheus. *Am. J. Phys. Anthropol.,* n.s. *7:*301-333, 1949.

———: A second adult palate of Australopithecus prometheus. *Am. J. Phys. Anthropol.,* n.s. *7:*335-338, 1949.

———: The cranio-facial fragment of Australopithecus prometheus. *Am. J. Phys. Anthropol.,* n.s. *7:*187-214, 1949.

DARWIN, C.: *The Descent of Man.* London, Murray, 1871.

———: *The Origin of Species.* London, Murray, 1859.

DAVENPORT, C.: Heredity of hair form in man, *Am. Naturalist, 42:*341, 1908.

———: *Heredity of Skin Color in Negro-White Crosses.* Washington, Carnegie Inst., 1913, publication 188.

———: *Guide to Physical Anthropometry and Anthroposcopy.* Cold Spring Harbor, New York, Eugenics Research Association, 1927.

DAVENPORT, C. and STEGGERDA, M.: *Race Crossing in Jamaica.* Washington, Carnegie Inst., 1929.

DAVIS, A.: The distribution of the blood-groups and its bearing on the concept of race. In *Political Arithmetic* (edited by Hogben, L.), New York, Macmillan, 1941.

DAY, C. B.: *A Study of Some Negro-White Families in the United States.* Cambridge, Peabody Museum, Harvard University, 1932.

DE TERRA, H.: Geology and climate as factors of human evolution in Asia. In *Early Man in the Far East* (edited by W. W. Howells), p. 7-15, Philadelphia, The Wistar Institute, 1949.

———, ROMERO, J. and STERWART, T. D.: *Tepexpan Man. Viking Fund Publications in Anthropology,* No. 11. New York, Viking Fund, 1949.

DOBZHANSKY, TH.: *Genetics and the Origin of Species,* 3rd edition. New York, Columbia Univ. Press, 1951.

———: On species and races of living and fossil man. *Am. J. Phys. Anthropol.,* n.s. 2. 251-265, 1944.

———: Genetics and human affairs. *The Teaching Biologist, 12:*97-106, 1943.

———: The genetic basis of evolution. *Scientific American, 182:*32-41.

DORNFELDT, W.: Studien uber Schädelform und Schädelveränderung von Berliner Ostjuden und ihren Kindern. *Ztschr. Morphol. u. Anthropol., 39:*290-372, 1941.

DRAPER, G., DUPERTUIS, C. W. and CAUGHEY, J. L., JR.: *Human Constitution and Clinical Medicine.* New York, Hoeber, 1944.

DUNN, L. C. and DOBZHANSKY, TH.: *Heredity, Race, and Society.* New York, Mentor Books, 1946.

DUPERTUIS, C. W. and TANNER, J. M.: The pose of the subject for photogrammetric anthropometry, with especial reference to somatotyping. *Am. J. Phys. Anthropol.,* n.s. *8:*27:44, 1950.

EAST, E. M. and JONES, D. F.: *Inbreeding and Outbreeding.* Philadelphia, Lippincott, 1919.

EDWARDS, E. A. and DUNTLEY, S. Q.: The pigments and color of living skin. *Am. J. Anatomy, 45:*1-33, 1939.

EHRICH, R. W. and COON, C. S.: Occipital flattening among the Dinarics. *Am. J. Phys. Anthropol.,* n.s., *6:* 181-186, 1947.

ELDERTON, E. M.: Height and weight of school children in Glasgow. *Biometrika, 10:*288-340, 1914.

ELLIOT, D. G.: *A Review of the Primates,* 3 vols., New York, Am. Museum of Natur. Hist., 1913.

ENGELMANN, G. J.: Age of first menstruation on the North American continent. *Tr. Am. Gynec. Soc., 26:*77-101, 1901.

ETCHEVERRY, M. A.: El factor rhesus, su genetica e importancia clinica. *Dia Med., 17:*1237-1251, 1945.

———: El factor rhesus en Personas de Ascendencia Iberica residentes en la Argentina. *Semana Méd.,* Nov. *25:*500, 1947.

EVANS, R. D.: Quantitative inferences concerning the genetic effects of radiation on human beings. *Science, 109:*299-304, 1949.

EVANS, F. G.: The names of fossil men, *Science, 102:*16-17, 1945.

FALCONER, D. S.: Sensory threshold for solutions of Phenyl-Thio-Carbamide. *Ann. Eugen., 13:*211-222, 1947.

FINKELSTEIN, L. (editor): *The Jews.* 2 vols., New York, Harper, 1950.

FISCHER, E.: *Die Rehobother Bastards und das Bastardierungs-problem beim Menschen.* Jena, 1913.

FISHBERG, M.: *The Jews.* New York, Scribners, 1911.

FISHER, R. A.: *The Genetical Theory of Natural Selection.* Oxford, Clarendon Press, 1930.

———: *Statistical Methods for Research Workers,* 10th edition. Edinburgh, Oliver & Boyd, 1946.

——— and TAYLOR, G. L.: Scandinavian influence in Scottish Ethnology. *Nature, 145:*590, 1940.

———, FORD, E. B. and HUXLEY, J. S.: Taste-testing the anthropoid apes. *Nature, 144:*750, 1939.

FITT, A. B.: *Seasonal Influence on Growth, Function and Inheritance.* London, Oxford, 1941.

FORBES, H. O.: *Monkeys,* 2 vols. London, Shaw, 1894.

FYLEMAN, R.: *Monkeys.* New York, Nelson, 1936.

GALLOWAY, A.: Man in Africa in the light of recent discoveries. *South African J. Sc., 34:*89-120, 1937.

———: Physical Anthropology in South and East Africa. *Yearbook of Physical Anthropology, 4:*40-46, 1949.

GALTON, F.: *Inquiries Into the Human Faculty and its Development.* London, Macmillan, 1883.

GATES, R. R.: *Human Genetics,* 2 vols. New York, Macmillan, 1946.

GODLEY, E. J.: Blood group frequencies in New Zealand and Maori soldiers. *Ann. Eugenics, 13:*211-222, 1947.

GOLDSTEIN, M. S.: *Demographic and Bodily Changes in Descendants of Mexican Immigrants.* Austin, Texas, Inst. Latin-American Stud., 1943.

GRAUBARD, M.: *Man, the Slave and Master.* New York, Covici-Friede, 1938.

GREGORY, W. K.: Studies on the evolution of the primates. *Bull. Am. Museum Natur. Hist., 35:*239-255, 1916.

———: *The Origin and Evolution of the Human Dentition.* Baltimore, Williams & Wilkins, 1922.

———: *Man's Place Among the Anthropoids.* New York, Oxford Univ. Press, 1934.

GREGORY, W. K.: The bearing of the Australopithecinae upon the problem of man's place in nature. *Am. J. Phys. Anthropol.*, n.s. *7*:485-512, 1949.
GUTHE, G. E.: Notes on the cephalic index of Russian Jews in Boston. *Am. J. Phys. Anthropol., 1*:213-223, 1918.
HADDON, A. C.: *The Wanderings of Peoples.* New York, Macmillan, 1911.
———: *History of Anthropology.* London, Watts, 1934.
———: *The Races of Man.* New York, Cambridge Univ. Press, 1924.
HALDANE, J. B. S.: *The Causes of Evolution.* New York, Longmans, 1935.
———: *Heredity and Politics.* New York, Norton, 1938.
———: The blood-group frequencies of European peoples, and racial origins. *Human Biol., 12*:457-480, 1940.
——— *New Paths in Genetics.* New York, Harper, 1942.
HALLIDAY, J. L.: *Psychosocial Medicine.* New York, W. W. Norton, 1948.
HAMBLY, W. D.: Cranial capacity, a study in methods. *Fieldiana Anthropol.* (Chicago Natural History Museum), *36*:25-75, 1947.
HANKINS, F. H.: *The Racial Basis of Civilization.* New York, Knopf, 1931.
HARRIS, H. and KALMUS, H.: The measurement of taste sensitivity to phenylthiouria (P.T.C.). *Ann. Eugenics, 15*:24-31, 1949.
HERSKOVITS, M. J.: *The American Negro.* New York, Knopf, 1928.
HOGBEN, L.: The concept of race. In *Genetic Principles in Medicine and Social Science.* New York, Knopf, 1932, p. 122-144.
———: *Genetic Principles in Medicine and Social Science.* New York, Knopf, 1932.
——— (editor): *Political Arithmetic.* New York, Macmillan, 1938.
HOLMES, S. J.: *The Negro's Struggle for Survival.* Berkeley, Univ. California Press, 1937.
HOOTON, E. A.: The making and mixing of human races. In *Twilight of Man.* New York, Putnam, 1939, p. 60-192.
———: *Crime and the Man.* Cambridge, Harvard Univ. Press, 1939.
———: *The American Criminal.* Cambridge, Harvard Univ. Press, 1939.
———: *Man's Poor Relations.* New York, Doubleday, Doran, 1942.
———: *Up From the Ape,* 2nd edition. New York, Macmillan, 1946.
HOWARD, E. G.: Evidence of early man in North America. *The Museum Journal* (University of Pennsylvania), *24*:53-171, 1935.
HOPWOOD, A. T.: Miocene primates from Kenya. *J. Linnaean Soc. London,* (Zoology), *37*:437-464, 1933.
HOWELLS, W. W.: *Mankind So Far.* New York, Doubleday, 1945.
——— (editor): Early Man in the Far East. *Studies in Physical Anthropology,* No. 1, Philadelphia, Wistar Inst., 1949.
HRDLIČKA, A.: *Early Man in South America.* Smithsonian Institution, Bureau of Ethnology, Bulletin, 52, 1912.
———: *The Skeletal Remains of Early Man.* Washington, Smithsonian Miscellaneous Collections, vol. 83, 1930.
———: *The Old Americans.* Baltimore, Williams and Wilkins, 1925.
———: *Practical Anthropometry,* 3rd edition (edited by Stewart, T. D.), Philadelphia, Wistar Inst., 1947.
HUNTINGTON, E.: Mainsprings of Civilization. New York, Wiley, 1945.
HUXLEY, J. S.: *Evolution; the Modern Synthesis.* New York, Harper, 1942.
———: *Man Stands Alone.* New York, Harper, 1941.

Huxley, J. S. and Haddon, A. C.: *We Europeans.* New York, Harper, 1936.

Huxley, T. H. and Huxley, J.: *Touchstone For Ethics.* New York, Harper, 1947.

———: *Evidence as to Man's Place in Nature.* London, William & Norgate, 1863.

Ito, P. K.: Anthropometric study of new-born infants of Japanese parents in America. *Am. J. Dis. Child., 52:*321-330, 1936.

———: Comparative biometrical study of physique of Japanese women born and reared under different environments. *Human Biol., 14:*279-351, 1942.

Jacobs, M. and Stern, B. J.: *Outline of Anthropology.* New York, Barnes & Noble, 1947.

Jenness, D. (editor): *The American Aborigines, Their Origin and Antiquity.* Toronto, Univ. Toronto Press, 1933.

Jennings, H. S.: *The Biological Basis of Human Nature.* New York, Norton, 1930.

———: *Genetics.* New York, Norton, 1935.

Jepson, G. L., Mayr, E. and Simpson, G. G. (editors): *Genetics, Paleontology, and Evolution,* Princeton University Press, 1949.

Jones, F. Wood: *Man's Place Among the Mammals.* New York, Longman's, 1929.

Kallman, F. J. and Anastasio, M. M.: Twin studies in the psychopathology of suicide. *J. Heredity, 37:*179, 1946.

Keen, J. A.: A study of the differences between male and female skulls. *Am. J. Phys. Anthropol.,* n.s., *8:*65-79, 1950.

Keith, A.: *The Antiquity of Man,* 2 vols. London, Williams & Norgate, 1925.

———: *Further Discoveries Relating to the Antiquity of Man.* London, Williams and Norgate, 1931.

———: *A New Theory of Human Evolution.* New York, Philosophical Library, 1949.

Klineberg, O.: *Race Differences.* New York, Harper, 1935.

———: (editor), *Characteristics of the American Negro.* New York, Harper, 1944.

Kluckhohn, C.: *Mirror for Man.* New York, Whittlesey House, 1949.

——— and Kelly, W. H.: The conception of culture. In (R. Linton, editor) *The Science of Man in the World Crisis.* New York, Columbia Univ. Press, 1945.

Koenigswald, G. H. R. von: *The South African Man-Apes and Pithecanthropus.* Washington, Carnegie Inst., Publication 530, 1942, p. 205-222.

———: The discovery of early man in Java and South China. In *Early Man in the East* (edited by W. W. Howells), Philadelphia, The Wistar Institute, 1949.

——— and Weidenreich, F.: The relationship between Pithecanthropus and Sinanthropus. *Nature, 144:*926-927, 1939.

Krauss, W. W.: Race crossing in Hawaii. *J. Heredity, 32:*371-378, 1941.

Kretschmer, E.: *Physique and Character.* New York, Harcourt, 1925.

Krogman, W. M.: *A Bibliography of Human Morphology, 1914-1939.* Chicago, Univ. Chicago Press, 1941.

———: The growth of man. *Tabulae Biologicae, 20:*VI-963, 1942.

———: The human skeleton in legal medicine. In *Symposium on Medicolegal*

Problems, Series Two (edited by S. A. Levinson), pp. 1-106, Philadelphia, Lippincott, 1949.

Kropotkin, P.: *Mutual Aid.* London, Penguin Books, 1939.

Krzywicki, L.: *Primitive Society and Its Vital Statistics.* London, Macmillan, 1934.

Kurtz, A. K. and Edgerton, H. A.: *Statistical Dictionary of Terms and Symbols.* New York, Wiley, 1939.

Lacaille, A. D.: Châtelperron: a new survey of its palaeolithic industry. *Archaeologia, 92:*95-119, 1947.

Lasker, G. W.: The effects of partial starvation on somatotype. An analysis of material from the Minnesota starvation experiment. *Am. J. Phys. Anthropol.,* n.s., *5:*323-341, 1947.

———: Migration and physical differentiation. *Am. J. Phys. Anthropol.,* n.s. *4:*273-300, 1946.

Leakey, L. S. B.: *Adam's Ancestors.* London, Methuen, 1934.

———: A new fossil skull from Eyassi, East Africa. *Nature, 138:*1082, 1936.

Lessa, W. A.: *An Appraisal of Constitutional Typologies.* American Anthropological Association Memoir, No. 62, 1943.

Levin, G.: Racial and inferiority characters in the human brain. *Am. J. Phys. Anthropol., 22:*345-380, 1937.

Lewis, J. H.: *The Biology of the Negro.* Chicago, Univ. Chicago Press, 1942.

Linton, R. (editor): *The Science of Man in the World Crisis.* New York, Columbia University Press, 1944.

——— (editor): *Most of the World: The Peoples of Africa, Latin America, and the East Today.* New York, Columbia Universty Press, 1949.

Longhem, Jr., J. J. van.: Nomenclature of the rhesus typing sera. *Bull. World Health Organization, 2:*215-225, 1949.

Lotsy, J. P. and Goddijn, W. A.: Voyages of exploration to judge of the bearing of hybridization upon evolution. I. South Africa. *Genetica, 10:*viii-315, 1928.

Lowie, R. H.: Intellectual and cultural achievements of human races, In *Scientific Aspects of the Race Problem,* New York, Longmans, 1941, p. 189-249.

———: *The History of Ethnological Theory.* New York, Farrar & Rinehart, 1937.

MacCurdy, G. G.: *Human Origins.* 2 vols., New York, Appleton, 1924.

——— (editor): *Early Man.* Philadelphia, Lippincott, 1930.

MacInnes, D. G.: Notes on the East African miocene primates. J. *East Africa Uganda Natur. Hist. Soc., 18:*141-148, 1943.

McCown, T. D. and Keith, A.: *The Stone Age of Mount Carmel:* Oxford, The Clarendon Press, 1939.

M'Gonigle, G. C. M. and Kirby, J.: *Poverty and Public Health.* London, Victor Gollancz, 1936.

Martin, R.: *Lehrbuch der Anthropologie,* 2nd edition, 3 vols. Jena, Fischer, 1928.

Mayr, E.: *Systematics and the Origin of Species.* New York, Columbia Univ. Press, 1942.

Monge, C.: *Acclimatization in the Andes.* Baltimore, Johns Hopkins Press, 1948.

MONTAGU, M. F. ASHLEY: A cursory examination of the relations between physical and social anthropology. *Am. J. Phys. Anthropol., 26:*41-61, 1940.

———: *Edward Tyson, M.D., F.R.S. (1650-1708): and the Rise of Human and Comparative Anatomy in England.* Philadelphia, American Philosophical Society, 1943.

———: The intelligence of northern Negroes and southern whites in the first World War. *Am. J. Psychol., 48:*161-188, 1945.

———: On the relation between body size, waking activity, and the origin of social life in the primates. *Am. Anthropol., 44:*141-145, 1944.

———: Physical anthropology and anatomy. *Am. J. Phys. Anthropol., 27:*261-271, 1941.

———: The premaxilla in the primates. *Quart. Rev. Biol., 10:*182-184, 1939.

———: Genetics and the antiquity of man in the Americas. *Man, 43:*131-135.

———: *Man's Most Dangerous Myth: The Fallacy of Race,* 2nd edition. New York, Columbia Univ. Press, 1945.

———: The tarsian hypothesis and the descent of man. *J. Roy. Anthropol. Inst., 60:*335-362. 1930.

———: *Adolescent Sterility.* Springfield, Thomas, 1946.

———: The origin and nature of social life and the biological basis of cooperation. *J. Soc. Psychol., 29:*267-283, 1949.

———: *On Being Human.* New York, Schuman, 1950.

——— and MERTON, R. K.: Crime and the anthropologist. *Am. Anthropol., 42:*384-408, 1940.

——— and OAKLEY, K. P.: The antiquity of Galley Hill man. *Am. J. Phys. Anthropol.,* n.s. *7:*363-384, 1949.

MORANT, G. M.: *The Races of Central Europe.* New York, Norton, 1939.

———: Studies of Palaeolithic Man. *Ann. Eugenics, 1:*257-276, 1926; *2:*318-381, 1927; *3:*337-360; *4:*109-214, 1930.

MOVIUS, JR., H. L.: Lower paleolithic archaeology in Southern Asia and the Far East. In *Early Man in the Far East* (edited by W. W. Howells), p. 17-81, Philadelphia, The Wistar Institute, 1949.

MULLER, H. J., LITTLE, C. C. and SNYDER, L. H.: *Genetics, Medicine, and Man.* Ithaca, New York, Cornell Univ. Press, 1947.

MYRDAL, G.: *An American Dilemma: The Negro Problem and American Democracy.* 2 vols. New York, Harper, 1944.

NABOURS, R. K.: Emergent evolution and hybridism. *Science, 71:*371-375, 1930.

NASMYTH, G.: *Social Progress and the Darwinian Theory.* New York, Putnam, 1916.

NEWMAN, H. H.: *Multiple Human Births.* New York, Doubleday, Doran, 1940.

NEWMAN, H. H., FREEMAN, F. N. and HOLZINGER, K. H.: *Twins: A Study of Heredity and Environment.* Chicago, Univ. Chicago Press, 1937.

NISSEN, H. W.: A field study of the Chimpanzee. *Compt. Psychol. Monogr., 8:* serial no. 36, 1931.

OAKLEY, K. P.: *Man the Tool-Maker.* London, British Museum (Natural History), 2nd edition, 1950.

——— and HOSKINS, C. R.: New evidence on the antiquity of Piltdown Man. *Nature, 165:*379-382, 1950.

OAKLEY, K. P. and MONTAGU, M. F. ASHLEY: A reconsideration of the Galley Hill skeleton. *Bull. Brit. Museum Natur. Hist., 1*:25-48, 1949.

PATERSON, D. G.: *Physique and Intellect.* New York, Century Co., 1930.

PATTEN, W.: *The Grand Strategy of Evolution.* Boston, Badger, 1920.

PEARL, R.: *Introduction to Medical Biometry and Statistics,* 3rd edition. Philadelphia, Saunders, 1940.

———: *The Rate of Living.* New York, Knopf, 1928.

———: The search for longevity. *Scient. Monthly, 46*:462-483, 1938.

——— and MOFFET, E. W.: Bodily constitution and human longevity. *Proc. Nat. Acad. Sciences, 25*:609-616, 1939.

———: *Man the Animal.* Bloomington, Indiana, Principia Press, 1946.

PEARSON, K.: Relationship of intelligence to size and shape of the head and other mental and physical characters. *Biometrika, 5*:105-106, 1906.

PENNIMAN, T. K.: *A Hundred Years of Anthropology.* New York, Macmillan, 1937.

PERLA, D. and MARMORSTON, J.: *Natural Resistance and Clinical Medicine.* Baltimore, Williams & Wilkins, 1941.

PETERSEN, W. R.: *The Patient and the Weather,* 4 vols. Ann Arbor, Michigan, Edwards Bros., 1934-1938.

RANSON, S. W.: *The Anatomy of the Nervous System,* 7th edition. Philadelphia, Saunders, 1939.

REID, R. R. and MULLIGAN, H. H.: Relation of cranial capacity to intelligence. *J. Roy. Anthropol. Inst., 53*:322-332, 1923.

RIFE, D. C.: *Dice of Destiny.* 2nd ed., Columbus, Ohio, Long's College Book Co., 1947.

ROBERTS, J. FRASER: *An Introduction to Medical Genetics.* New York, Oxford, 1940.

RODENWALDT, E.: *Die Mestizen auf Kisar.* 2 vols, Batavia, 1927.

ROMER, A. S.: *Man and the Vertebrates,* 3rd edition. Chicago, Univ. Chicago Press, 1941.

ROWAN, W.: *The Riddle of Migration.* Baltimore, Williams & Wilkins, 1931.

RUCH, T. C.: *Bibliographica Primatologica.* Springfield, Thomas, 1941.

SANDERS, B. S.: *Environment and Growth.* Baltimore, Warwick & York, 1934.

SCHEINFELD, A.: *The New You and Heredity.* Philadelphia, Lippincott, 1950.

———: *Women and Men.* New York, Harcourt, 1944.

SCHENKE, E. T. and MCMASTERS, J. H.: *Procedures in Taxonomy.* California, Stanford Univ. Press, 1936.

SCHULTZ, A. H.: Fetal growth of man and other primates. *Quart. Rev. Biol. 1*:493-495, 1926.

———: The skeleton of the trunk and limbs of higher primates. *Human Biol., 2*:381-383, 1930.

———: Characters common to higher primates and characters specific for man. *Quart. Rev. Biol., 11*:259-283, 425-455, 1936.

SCHWESINGER, G. C.: *Heredity and Environment.* New York, Holt, 1930.

SELIGMAN, C. G.: *The Races of Africa.* New York, Holt, 1930.

SELLARDS, E. H.: Early man in America: index to localities, and selected bibliography. *Bull. Geol. Soc. Am., 51*:373-431, 1940.

SHAPIRO, H. L.: Descendants of the mutineers of the bounty. *Mem. Bernice P. Bishop Museum* (Honolulu), *9*:1-106, 1929.

———: *The Heritage of the Bounty.* New York, Simon & Schuster, Inc., 1936.

SHAPIRO, H. L. and HULSE, F.: *Migration and Environment.* New York, Oxford Univ. Press, 1940.

SHELDON, W. H.: *The Varieties of Human Physique.* New York, Harper, 1940.

———: *The Varieties of Human Temperament.* New York, Harper, 1942.

———: *Varieties of Delinquent Youth.* New York, Harper, 1949.

SHEPHERD, R. H., SHOLL, D. A. and VIZOZO, A.: The size relationships subsisting between body length, limbs and jaws in man. *J. Anat., 83:*296-302, 1949.

SHERRINGTON, C.: *Man on His Nature.* New York, Macmillan, 1941.

SIMPSON, G. G.: The principles of classification and a classification of mammals. *Bull. Am. Museum Natur. Hist., 85:*xvi-350, 1945.

———: *Tempo and Mode in Evolution.* New York, Columbia Univ. Press, 1944.

———: *The Meaning of Evolution.* New Haven, Yale University Press, 1949.

——— and ROE. A.: *Quantitative Zoology.* New York, McGraw-Hill, 1939.

SMITH, G. ELLIOT: *The Evolution of Man,* 2nd edition. New York, Oxford, 1927.

SNEDECOR, G. W.: *Statistical Methods,* 4th edition. Ames, Iowa, Collegiate Press, 1948.

SNYDER, L. L.: *Race.* Chicago, Ziff-Davis, 1939.

SONNTAG, C. F.: *The Morphology of the Apes and Man.* London, Bale, 1924.

SPIER, L.: Growth of Japanese children born in America and in Japan. *Univ. Washington Pub. Anthropol., 3:* 1929.

SPUHLER, J. N.: An estimate of the number of genes in man. *Science, 108:*279, 1948.

STEIN, L.: *The Infancy of Speech and the Speech of Infancy.* London, Methuen, 1949.

STEGGERDA, M.: The inheritance of hair form. *Eugenical News, 16:*56-57, 1931.

———: *The Maya Indians of Yucatan.* Washington, Carnegie Inst., Publication 531, 1941.

STERN, B. J.: *Society and Medical Progress.* Princeton, Princeton Univ. Press, 1941.

STERN, C.: *Principles of Human Gentics,* San Francisco, Freeman, 1949.

STRANDSKOV, H. H.: The distribution of human genes. *Scientific Monthly, 52:* 203-215, 1942.

———: The genetics of human populations. *Am. Naturalist, 76:*156-164, 1942.

STRAUS, JR., W. L.: The riddle of man's ancestry. *Quart. Rev. Biol., 24:*200-223, 1949.

SULLIVAN, L. R.: The pygmy races of man. *Natur. Hist., 19:*687-695, 1919.

———: *Essentials of Anthropometry. A handbook for Explorers and Museum Collectors.* New York, American Museum of Natural History, 1928.

SWANSCOMBE COMMITTEE: Report on the Swanscombe skull. *J. Roy. Anthropol. Inst., 58:*17-98, 1938.

THOMPSON, A. and BUXTON, L. H. D.: Man's nasal index in relation to certain climatic conditions. *J. Roy. Anthropol. Inst., 53:*92-122, 1923.

THOMPSON, CHARLES H. (editor): The physical and mental abilities of the American Negro. *J. Negro Education, 3:*317-564, 1934.

THOMPSON, E. T. (*editor*): *Race Relations and the Race Problem.* Durham, N.C., Duke Univ. Press, 1939.

THORNDIKE, E. L.: *Human Nature and the Social Order.* New York, Macmillan, 1940.

TINDALE, N. B.: Survey of the half-caste problem in South Australia. *Proc. Roy. Geographical Soc., South Australian Branch,* Session 1940-1941, p. 66-161.

TODD, T. WINGATE: Cranial capacity and linear dimensions. *Am. J. Phys. Anthropol., 6:*97-194, 1923.

——— and LINDALA, A.: Dimensions of the body, whites and American Negroes of both sexes. *Am. J. Phys. Anthropol., 12:*35-119, 1928.

——— and LYON, D. W.: Cranial suture closure; its progress and age relationship. Part IV. Ectocranial closure in adult males of Negro stock. *Am. J. Phys. Anthropol., 8:*149-168, 1925.

——— and GORDOR, L. VAN: The quantitative determination of black pigmentation in the skin of the American Negro. *Am. J. Phys. Anthropol., 4:*239-260, 1921.

——— *et al.:* The color top method of recording skin pigmentation. *Am. J. Phys. Anthropol., 11:*187-204, 1928.

TROTTER, M.: Hair growth and shaving. *Anat. Rec., 37:*373-379, 1928.

TUCKER, W. B. and LESSA, W. A.: Man: a constitutional investigation. *Quart. Rev. Biol., 15:*265-289, 1940.

TURNER, R.: *The Great Cultural Traditions,* 2 vols. New York, McGraw-Hill, 1941.

VALLOIS, H. V.: The Fontéchevade fossil men. *Am. J. Phys. Anthropol.,* n.s., *7:*339-362, 1949.

WASHBURN, S. L.: Thinking about race. *Science Education, 28:*65-76, 1944.

———: Sex differences in the pubic bone. *Am. J. Phys. Anthropol.,* n.s., *7:*425-432, 1949.

WALLIS, W. D.: *Culture and Progress.* New York, Whittlesey House, 1930.

WEIDENREICH, F.: Some problems dealing with ancient man. *Am. Anthropol., 42:*373-383, 1940.

———: The "Neanderthal man" and the ancestors of "Homo Sapiens." *Am. Anthropologist, 45:*39-48, 1943.

———: The skull of Sinanthropus Pekinensis: a comparative study on a primitive hominid skull. *Palaeontologica Sinica,* n.s., D, whole series, No. 127, 1943.

———: The Keilor skull: A Wadjak type from Southeast Australia. *Am. J. Phys. Anthropol.,* n.s., *3:*21-32, 1945.

———: Giants and early man from Java and South China. *Anthropol. Papers Am. Museum Nat. Hist., 40: 1;* 1-134, 1945, New York.

———: *Apes, Giants, and Man.* Chicago, Univ. Chicago Press, 1946.

———: The trend of human evolution. *Evolution, 1:*221-236, 1947.

———: Interpretations of the fossil material. In *Early Man In the Far East* (edited by W. W. Howells), p. 149-157, Philadelphia, The Wistar Institute, 1949.

———: *Anthropological Papers of Franz Weidenreich 1939-1948.* (Compiled by S. L. Washburn and D. Wolffson.) New York, The Viking Fund, Inc., 1950.

WEINERT, H.: Africanthropus, der neue Affenmenschfund in Ostafrika. *Ztschr. Morphol. u. Anthropol., 38:*18-24, 1939.

WIENER, A. S.: The Rh factor and racial origins. *Science, 96:*407-408, 1939.

———: *Blood Groups and Transfusion*. Springfield, Thomas, 1943.

———: Rh Glossary. *Laboratory Digest,* p. 1-6, May, 1949.

WHYTE, L. L.: *The Next Development in Man*. New York, Holt, 1948.

———: *The Unitary Principle in Physics and Biology,* Holt, 1949.

WILDER, H. H.: *A Laboratory Manual of Anthropometry*. Philadelphia, Blakiston, 1920.

———: *The Pedigree of the Human Race*. New York, Holt, 1926.

WOODWARD, A. S.: *The Earliest Englishmen*. London, Watts & Co., 1948.

WOODWORTH, R. S.: *Heredity and Environment*. New York, Social Science Research Council, 1942.

WORMINGTON, H. M.: *Prehistoric Indians of the Southwest*. Colorado Museum of Natural History, Denver, 1947.

———: *Ancient Man in North America,* 3rd ed., revised. Denver Museum of Natural History, 1949.

WRIGHT, S.: The roles of mutation, inbreeding, crossbreeding, and selection in evolution. *Proc. Sixth Int. Congress Genetics, 1:*356-366, 1932, Ithaca, New York.

WUNDERLY, J.: The Keilor fossil skull: anatomical description. *Mem. Nat. Museum,* Melbourne No. *13*; 57-69, 1943.

YERKES, R. M.: *Chimpanzees*. New Haven, Yale Univ. Press. 1943.

——— and A. W.: *The Great Apes*. New Haven, Yale Univ. Press, 1934.

YULE, G. Y. and KENDALL, M. G.: *An Introduction to the Theory of Statistics,* 11th edition. London, Griffin & Co., 1937.

ZEUNER, F. E.: *Dating the Past*. 2nd ed., New York, Longmans, 1950.

ZUCKERMAN, S.: *The Social Life of Monkeys and Apes*. New York, Harcourt, 1932.

———: *Functional Affinities of Man, Monkeys, and Apes*. New York, Harcourt, 1933.

INDEX

A

Abbevillian culture, chronology, fig. 61, 123, fig. 110, 214; artifacts, fig. 70, 147

Acheulo-Clactonian artifacts, fig. 71, 148

Acheulian culture, chronology, fig. 61, 122-123; and Neanderthal man, 158; Steinheim skull, 158, figs. 76 & 77; and Bury St. Edmund's skull, 190, fig. 97, 189.

Adapidae, widespread fossil family of lemuroids, 90

Adapis (Genus of Subfamily Adapinae), Eocene lemuroids, 90-91.

Adaptive value (Darwinian fitness), of human traits, 282, 287, 374

Addair, J., and Snyder, L. H., on genetic susceptibility to paralytic poliomyelitis, 403

Aeta, Asiatic Negritos, 314; classified, 345

Afalou Man, 213

Afghans, 327, 328

Africa, primates of, 37, 58-88, 98-121; Pleistocene men from, 104-121; Negroids, 301-312

African lemurs or Lorisiformes, 30, 37; Non-Malagasy lemurs, 37; breeding-season, 38

African Pygmies or Negrillos, 311-312; classified, fig. 133, 330, 349

Africans, North, 303

Africanthropus njarasensis, 152-155; compared with Pithecanthropus, Sinanthropus, and Neanderthal man, fig. 80, 164; a proto-Neanderthaloid with Rhodesian affinities, 154; artifacts, 154-155, fig. 107, 201, 217; craniogram, 154, 164; phylogenetic relationships, fig. 105, 203; Weinert on, 153; and Neanderthal, 184

Agglutinins, agglutinating substances found in blood of some persons, 240-243

Agglutinogens, two agglutinable properties of red corpuscles of blood, 240-243, 255

Aging, and presbyopia, 404

Ainu, Archaic Caucasoid, described, 325-326, 260-262; blood groups, 253, 247-255; M-N blood types, 252-255; and Australian aboriginal, 253, 325; classified, fig. 133. 330, 345, 350

Aleuts, classified, 350

Allee, W. C. "Where angels fear to tread: a contribution from general sociology to human ethics," 295

Allele, defined, 238

Alpine type or ethnic group, 329-331; and the introduction of brachycephalization into Europe, 329; Coon on origin, 331; Dinaric a sub-group of, 332-333; and Armenoid, 334; and East Baltic, 335; and population of United States, fig. 136, 346; classified, 349

Alouatta, Howler monkey (Platyrrhine genus), 47; tail prehensile, 49; diet, 57; position, fig. 40, 70

America, fossil primates of North, 89-92; probable origin of primates in North, 92; antiquity and migrations of man in, 218-227; sites, 224; Indian, 342, 344-345; possible Australoid contribution to Indian population, 224-226; post-glacial migrations; references, 228-231; varieties of mankind entering into formation of population of North, fig. 136, 346; head shape of children born in, 418-437

Anagale, Oligocene tupaioid, 24, 26

Anaptomorphidae, Middle paleocene family of tarsioids of N. America, 89-92

Anathana, genus of tree-shrews, 25

Andamanese, Asiatic Negritos, 312; classified, 349

Anatomy, comparative, 10; developmental, 10; of growth, 10; Ashley Montagu on the rise of in England, 20

Angel, L. J., vii, x

Angwantibo, lemur of genus Arctocebus, 31, 37

Anthropoidea (suborder), defined as comprising the monkeys, apes, and man, 29; classified, 30, 31, 43-87; relation to tarsiers, 42-43; described, 43-87; synopsis of platyrrhini, 43-47; catarrhini, 60-63; anthropomorpha, 69-71; main divisions, fig. 40, 70; phylogenetic relationships, fig. 105, 203

Anthropology, T. H. Huxley on, 18-19

Anthropology, Cultural, defined, 5; see Anthropology, Social, 5f

Anthropology, Physical, defined, 5; aims of, 6; questions asked by, 6; contribution to the social order, 13; value of, 13; history of, 20; and problems of modern life, 9; Ashley Montagu on relations to social anthropology, 20; bibliography, 20; and blood groups, 238-265; gene frequency analysis, 245-246; and classification of mankind; Appendix, methods of measurement in, 440-508
Anthropology, Social, defined, 5f; Ashley Montagu on relations to physical anthropology, 20
Anthropometric recording blanks, 474, 475
Anthropometer, 442-444
Anthropometry, the measurement of man, 440-508; instruments described, 442-444; landmarks and measurements, 440-508; figs. 146-150; indices, 454-456, 484-486, 496-503; references, 496-497
Anthropomorpha, tailless apes and man, 29, classified, 30, 31; classified and described, 67-68; distinguished from all other primates, 69; brain, posture, locomotion, 69, 83; synopsis of, 69, 71; relation to Dryopithecus, 102; fossil, 98; phylogenetic relationships, fig. 105, 203, fig. 40, 70; blood groups, 262-264; skin color, 279
Anthroposcopy, defined, 440; 457-468
Aotes, Douroucouli or night monkeys (Platyrrhine genus), figs. 21 & 22, 48; nostrils separated by narrow septum, 50; position, 47; classified, 47; the only nocturnal Cebid, 52; smallest of Cebids, largest eyes among Cebids, 52
Apes, tailless, 29, 30; classified, 67-88; and man described and classified, 67-88; Parapithecus, possible ancestor, 98-99; man not descended from existing, 104; ancestry of, 104; Tertiary, 105; Australopithecine, 106; man's origin from early, Darwin, 121; and man in superfamily Hominoidea, 121; when become men, 127; absence of chin, 127; size of brain, 135-136; separation of hominids and, 270; blood groups, 262-264; skin color, 279
Appendix, vermiform, 69
Arabians, 327
Arboreal life, shrews, 23; lemurs, 30; tarsiers, 46; marmosets, 52; Cebidae, 52;
Arboreal life—*continued*
Old World Monkeys, 58; Cercopitheques, 63; Semnopitheques, 66; gibbons, 72; orang-outang, 74; chimpanzee, 77-79; gorillas semiarboreal, 83; adoption of, 90; consequences and demands of, 92-95
Archeology, defined, 5f.
Archaic Caucasoid, and Grimaldi Man, 173; blood groups, 240-265; Australoid an, 320-322
Arctocebus (Genus of lemur), angwantibo, 31, 37
Arm, upper length, and environment, 420; lower, 420; measurement, 445; indices, 456
Armenoid type or ethnic group, 331-334; composition of, 334; and population of United States, fig. 136, 346; classified, 349
Artifacts, which may have been used by Pithecanthropus, 142, 143, 144; Sinanthropus, 141, 142, 143, 144; Homo Soloensis, 142; Africanthropus, 154-155; Châtelperron, 166; Neanderthal man, 155, 166; Fontéchevade, 160; Steinheim skull, 160; Cro-Magnon, 169; Grimaldi, 170; Piltdown, 179, 181; Swanscombe, 373; Gamble's Cave, Kanam, Elmenteita, Kanjera, 209; Pithecanthropoid, 213; associated with ground sloth, horse, great bison, camel, and mastodon in America, 220-223; Folsom, fig. 115, 223, 223-224; sites in America, 224-225; and mentality, 373; Patagonia, 227
Asia, primates of, 25, 29, 30, 39
Asian lemurs or Lorisiformes, 37; Non-Malagasy lemurs, 37
Asiatic Pygmies or Negritos, 312-314, classified, fig. 133, 330, 349
Asselar Man, 214
Asthenic, constitutional type, 392
Asymmetric evolution in Pithecanthropus, 178
Ateles, spider monkey (Platyrrhine genus), classified, 31, 47; fig. 29; prehensile tail like a fifth hand, 49; thumb absent, 49; position, 47; scanty menstruation present, 53; fig. 40, 70
Athletic, constitutional type, 392
Atlanto-Mediterranean, sub-group of Mediterranean ethnic group, 328; and Negroids, 328; affinities with Nordic

Atlanto-Mediterranean—*continued*
type, 329; and Dinarics, 332; and Armenoid, 334; and East Baltic, 335; classified, 349
Attainments, and opportunities, 356, 378-379
Auditory bulla, in lemurs, 35; Tarsius, 42; inflated in marmosets, 45; large in Cebidae, 50; absent in Old World Monkeys, 58
Auditory meatus, External, general absence in lemurs, 33; in catarrhini, 36; Tarsius, 42; abbreviated in marmosets, 45; not formed in Cebidae, 50; developed in catarrhini, 58; Ehringsdorf man, 160
Aurignac (Aurignacian Neanderthaloid), 174
Aurignacian culture, chronology, fig. 61, 123; artifacts, 170, 171; Cro-Magnon, 170; Grimaldi, 172; Gamble's Cave, 209
Australian aboriginal, skull, 145-149; resemblance to Wadjak skull, 145-149, 320; and Solo man, 49; supraorbital ridges, 175, 318; and Punin skull, 224-225; and Keilor skull, 320; blood groups, 261, 262, 247, 257; and Negroids, 260; M-N blood types, 253; Rh blood types, 257, 258; small breeding groups akin to early man, 282; primitiveness, 318-320; members of the Australoid or Archaic Caucasoid division, 301, 318-322; described, 318-322; antiquity, 320; relationship to Tasmanians, 322; possible trihybrid in origin, 320-322; and Ainu, 262; classified, 350; white crosses, 322; and cultural relativity, 376
Australoid, and Grimaldi Man, 173; traits in Předmost man, 175; phylogenetic relationships, fig. 105, 203; possible contribution to Indian population of America, 224-226; race, 232; blood groups, 252-253; Division, 301, 318, 350
Australopithecinae, Subfamily of middle pleistocene fossil apes, relationships, 105-126; phylogenetic relationships, fig. 40, 70, fig. 105, 203
Australopithecus africanus, Subfamily Australopithecinae, from middle pleistocene of S. Africa, fig. 52, 104; fig. 56, 112, fig. 57, 113; brain size, 106; locomotion and posture, 117-118
Avahi, lemur of genus Lichanotus, 37
"Aye-aye," lemur of the genus Daubentonia (Chiromys), 31, 33, 36, 37

B

Baboons, classified, 61-63; described, 64-65; terrestrial, 64; figs. 35 and 36, pp. 64 and 65
Bantu-Speaking Negroes, 306-307; classified, 349
Basal metabolism, 405-407
Basic Mediterranean, sub-group of Mediterranean, ethnic group, 325-326; classified, 349
Basques, Rh frequencies, 265
Benedict, R., *Race: Science and Politics,* 380
Berbers, 327
Bews, J. W., *Human Ecology,* 438
Biology, human, defined, 10
Bird, J., Palli Aike Cave, 227, 228
Birth, number of young at a single, in tree-shrews, 25; in lemurs, 38; Tarsius, 42; marmosets, 45; Cebidae, 52; Cercopithecidae, 59; orang, 76; chimpanzee, 79; gorilla, 84
Blood, and "racism," 352, 356-358; misuse of term, 356-358; of mother not transmitted to child, 357; and altitude, 370; preservation of, 468
Blood groups, 240-265; character unaffected by environment, not subject to mutation, and non-adaptive, agglutinogens, agglutinins, 240-241; Landsteiner rule, 241; hereditary mechanism, 243-246; and genes, 243-248; and history, 250-251; gene frequency method, 245-246, 251-252; and evolution, 269-270; and taste reaction to PTC (phenyl-thiocarbamide), 269-270; indicate great stability of genes in these two instances, 269-270; determined from skeletal and mummified tissues, 472-476; as genetic indicators, 259; geographic and ethnic distribution, 263-265; hybridization, 263; anthropoids, 263-264; Australian aborigines and other Australoids, 262
Blood types M-N, each determined by single pair of genes, 252; distribution in man, 253; Australian aborigines, 253; Europeans, 253; Ainu, 253
Blood typing technique, 468-476; skeletal material, 473-476
Blumenbach, J. F., Father of Physical

Blumenbach—*continued*
Anthropology, portrait, fig. 3, 9; 326
Boas, F., portrait, fig. 10, 18; *Anthropology and Modern Life,* 20; on descendants of immigrants into United States, 240, 410, 418-420, Table 29, 419, fig. 142, 419; on Indian-White crosses, 355; on environment and mental qualities, 360-361, 364; on changes in personality of peoples, 364; *The Mind of Primitive Man,* 380; "Racial Purity," 380; *Race, Language and Culture,* 380; quoted, 424; on height of institutionalized children, 437
Body build, in cercopitheques, 63; Semnopitheques, 66; True Negroes, 303; Nilotic Negroes, 304; Bushman-Hottentot, 307-311; Pygmies, 311-312; Negrillo, 312; Negritos, 312-316; Ainu, 325-326; Basic Mediterranean, 327-328; Atlanto Mediterranean, 328; Alpine, 329-331; Armenoid, 331-334; Polynesian, 339-340; Mongoloid, 340-341; crime, 389-391; Kretschmer's typology, 392; Sheldon's typology and somatotyping, 394-402; classification, 396; and disease, 402-409
Body size, and its relation to eyesize, social habits, and waking activity, 37; in lemurs, 37; tarsiers, 41; marmosets, in proportion to brain size largest among primates, 45; Cebidae, 52; cercopitheques, 63; semnopitheques, 66; gibbons, 72; orang, 74; chimpanzee, 77; gorilla, 81; true Negroes, 303; Nilotic Negroes, 304; Bushman-Hottentot, 307-311; Pygmies, 311-312; Negrillo, 312; Negritos, 312-316; Veddahs, 322; Ainu, 325-326; See Body Build
Bolk, L., on fetalization, 212-213
Bonin, G. von, vii; "On the size of man's brain as indicated by skull capacity," 228
Boskop man (Homo capensis), 210-211; enormous brain, 210; and Bushman-Hottentot, 309
Boulenger, E. G., *Apes and Monkeys,* 86
Boyd, W. C., vii, x; "Critique of methods of classifying mankind," 295, "Blood Groups," 295
Brachiation, defined, 72; anthropomorpha, 69; gibbon, 72; chimpanzee, 77; gorilla, 83
Brachycephaly, in gorilla, 82; in Hominidae occurs first in Krapina man, 160; in Tepexpan, 227; defined, 454-456
Brachyteles, Woolly Spider Monkey (Platyrrhine genus), tail prehensile, 47; fig. 40, 70
Brain, comparison of in eight different primates, fig. 50, 97; table of volumes by capacity of skull, Table 19, 336-337; comparison of sizes, fig. 91, 183; in treeshrews, 24, fig. 50, 97; in lemurs, 36; tarsiers, 41-42, fig. 50, 97; marmosets, 45, fig. 50, 97; Cebidae, fig. 50, 97; size by capacity of skull, 336; chimpanzee, 79; man, 84; in fossil lemurs and tarsioids, 93-94; primitive vertebrate, 93; visual area larger in Tarsioidea than in Lemuroidea, 94; pre-adaptive potentials in, 95; "revolutionary" change in structure, 95; neopallium, 95; rhinencephalon, 95; in Parapithecus, 99; size, in chimpanzee, 91; gorilla, 97; Australopithecus africanus, 106; A. prometheus, 114; Plesianthropus, robustus, 110; Paranthropus P. crassidens, 115; Pithecanthropus, 135-142, 183; in apes, man, 135-136, 336; Sinanthropus, 142, 183; Wadjak man, 146; Keilor skull, 146; South Australian aboriginal, 149; Neanderthal man, 155-158; Europeans, 156, 183, 336; internal specialization, 106; and intelligence, 157; Steinheim, 160; Ehringsdorf, 160; Cro-Magnon, 169, 170; Grimaldi, 170-175; Předmost, 175-176; Piltdown, 178; London skull, 184; Swanscombe, 188; body bulk, and size of, 204; Fontéchevade, 201; origin of size in modern man, 204-206; variability in size, 206; Boskop man, 210-213; evolutionary relationships, 206; and mental capacity, 206; and skull size, 228; size of teeth, 119, in relation to brain, 119; Levin, G., "Racial and inferiority characters in the human brain," 229; Veddah, 323
Breeding, season, lemurs, 38; Tarsius, 42; none in marmosets, 45; and seasonal influences, 425-426; groups, 167, structure small in early populations of man, 280, and isolation, 281-282
Breeds, pure, and ethnic groups, 359-360
Broca, P. P., portrait, fig. 6, 14
Broken Hill, cave in which remains of

Broken Hill—*continued*
Rhodesian man were discovered, 149
Bronze age, fig. 61, 123
Broom, R., 106, 107, 108, 109, 114, 116, 118, 119, 124, 178
Brow, see Supraorbital ridges, Forehead
Buriat, and blood group B, 260; classified, 350
Burkholder, P., on natural selection, 277
Bury St. Edmunds skull, 123, fig. 97, 189, 190, possible relations to Swanscombe and London skulls, 190
Bush babies, lemurs of genus Galago, 37; Lesser, lemurs of genus Hemigalago, 37
Bushman, low in blood group gene *B*, 248; Levalloisian flakes associated with proto, fig. 107, 207
Bushmen-Hottentots, described, 307-311; low broad orbits, 173; taurodont teeth, 204; ancestry, 213; steatopygia, 308, 309, 310; Mongoloid admixture, 248, 309, 311, also Boskop, proto-Hamitic, and Pygmoid, 309; Khoisan, 311; Veddah resemblances, 323; classified, 349; crosses, 355; blood group, 247
Buxton, L. H. D., and Thomson, A., on nose form, 275

C

Cacajao, Oukari or short-tailed monkey (Platyrrhine genus), tail nonprehensile, very short, 49; position, fig. 40, 70
Caliper, spreading, 443, 444
Callicebus, Titi monkeys (Family Cebidae), classified, 47; position, fig. 40, 70
Callimico, genus of Cebidae, by some classed with marmosets, 47; classified, 47, fig. 40, 70
Callithricidae, family of marmosets and tamarins, described, 43-46
Callosities, ischial, in Cercopithecidae, 58; widely separated in Gelada baboon, 65; in gibbons alone among the anthropomorpha, 72; occasionally present in Pongidae, 72; in orang, 74-75
Candela, P. B., x; introduction of blood group B into Europe, 251; "The introduction of blood-group B into Europe," 295
Capuchin monkey, Cebus (Platyrrhine genus), See Cebus
Carpodaptes, Upper Paleocene Primate Genus (Family Carpolestidae), 89
Carpolestes, Upper Paleocene Primate Genus (Family Carpolestidae), 89-90
Carpolestidae, Paleocene family of tarsioids of N. America, 89-90
Castle, W. E., on human crosses, "Biological and social consequences of race crossing," 356
Catarrhini ("down-pointing" + "nose") or New World Monkeys, 58; nostrils in, fig. 23, 50; classified, 58-63, fig. 40, 70; classified and described, 58-86; evolution, 98 sq.; most primitive member, 98; phylogenetic relationships, fig. 105, 203
Cattell, R. B., and Molteno, V., on temperament, 385, 514
Caucasoid Division, 301, 326-340; Grimaldi Man predominantly, 173; Australian crosses, '322; phylogenetic relationships, fig. 105, 203; race, 170-175; blood groups, 240-265; origin of term, 326; and Indonesian-Malay, 173; fig. 133, 330
Cebidae (Family of Ceboidea or Platyrrhini), described, 47-57; classified, 471; size, dentition, digits, claws, thumb, tail, big toe, limbs, vertebrae, no muzzle, nasal cavities reduced, nostrils, pterion, 47-57; auditory bulla, tympanic annulus, brain richly convoluted, most highly specialized of Primates, fovea and macula present, capable of stereoscopic and color vision, 51; fig. 40, 70
Ceboidea, superfamily, 43
Cebus, capuchin monkey (Ceboid genus), prehensile tail, 49; position, 47; scanty menstruation, 53; fig. 40, 70
Cephalic index, or relation of breadth to length of head, True Negroes, 303; Nilotic Negroes, 304; Half-Hamites, 306; Pygmies, 311-316; Negrillo, 312; Andamanese, 312; Semang, 313; Aeta, 314; New Guinea Pygmies, 315; Papuans, 317; Melanesians, 317; Australians, 320; Veddahs, 323; Pre-Dravidians, 325; Sakai, 325; Ainu, 325; Caucasoid, 326; Mediterranean, 327; Irano-Afghan Mediterranean, 328; Nordic, 328; Alpine, 329; Dinaric, 332; Armenoid, 334; East Baltic, 335; Lapp, 338; Polynesians, 339; Mongoloid, 340;

Cephalic—*continued*
American Indian, 344; Indonesian, 345; Malay, 345; Classical Mongoloid, 342; Arctic Mongoloid, 343; Eskimo, 343; Boas on, 418-420; Puerto Rican, 420; and stature, 420; Hawaiian, 422; Jews, 422; Japanese, 422; and environment, 418-420, Table 29, 419, fig. 142, 149; landmarks, 450-451, fig. 148, 452; defined and described, 455-456; and infant head form, 288
Cephalometry, 441, 452-454
Cerocoebus, Mangabeys (Subfamily Cercopithecinae), aboreal, white-lidded, 63; classified, 61; fig. 40, 70
Cercopithecidae, Family of Old World monkeys, described, 57-58; classified, 60-63; palate relatively long, 58; distribution, 58; with exception of baboons aboreal, 58
Cercopithecinae, Subfamily of Old World Monkeys, 63-65; classified, 60-63
Cercopithecoidea, superfamily, 58
Cercopithecus, Guenon (Subfamily Cercopithecinae), lightly built, long-tailed, short-faced, round-headed, 60, 68
Cerebellum, in lemurs, 36; Tarsius, 42; marmosets, 45; London Lady, 184
Chancelade skull, a possible ancestral Mongoloid, 342
Chambers, E. G., *Statistical Calculation for Beginners*, 507
Character gradients or clines, defined, 236, 344
Characters, defined, 239; the distribution of physical, 6; transmission of, 9; structural, 10, 22; significance of various, 27; in which man differs from nonhuman primates, 84-86; convergence, 50; analysis of, 127; Mount Carmel Neanderthaloids, 155-166; "advanced," "primitive," 157, 390; and genetic factors, 236; classification of man by, 235-237; phenotypical, 236; mutation resulting in new, 238-239; omelettes, 239; unaffected by environment, 240; genetic variability, 282; blood groups and physical, 259; hydridization, 283; adaptive, examples, 275; climate, 276; arbitrary selection of, 299-300; genes and origin of, 301; and fetalization, 211-213; ethnic groups and statistically averaged, 347; transitions in, 348; potentialities, genes, and, 353-354, an
Characters—*continued*
abstraction, 354; biological and mental, 359; and crime, 389-391; requirements for the comparison of, 39
Cheek, pouches, in Cercopithecinae, 58; pads in orang, 74
Cheirogaleinae (Subfamily), classified, 36
Chellean culture. See Abbevillian
Chest, in anthropomorpha, 69; orang, 74; girth in gorilla, 81; width and depth, and environment, 421; measurement of breadth and width, 446; girth, 448
Chimpanzee (Pan), classified, 69; described, 76-80; species, 76; weight, size, posture, locomotion, hair, skin, brain capacity, prognathism, nose, lips, digits, menstruation, oestrous cycle, duration of pregnancy, number of offspring at birth, 76; nursing habits, 79; social life, diet, facial expression, 79; skull low vault, no mastoid process, no sagittal crest, narrow hand, 79; phylogenetic relationships, fig. 40, 70, fig. 105, 203; taste reaction to PTC (phenyl-thio-carbamide) and gene stability, 269; blood groups, 263, 264; skin color, 77-79
Chin, in man, 85; absent in apes, 127; in Paranthropus crassidens, 115; absent in Homo heidelbergenesis, 151; absent in Neanderthal man, 156; well developed in Cro-Magnon, 169; receding in Grimaldi, 173; Forest Negro, 304; Australian aboriginal, 320; Veddahs, 323; Pre-Dravidians, 325; Sakai, 325; Ainu, 325; Caucasoid, 327; Mediterranean, 327; Nordic, 328; Alpine, 331; Dinarics, 333; East Baltic, 335; Indo-Dravidians, 339; Mongoloids, 340; American Indians, 344; form described, 461
Chinese, "buck teeth," 340; laundrymen and genes, 391
Cheirogale, mouse lemurs, 36
Chiromyoides, 90
Chiromys. See Daubentonia.
Chou K'ou Tien, skeletal remains and types, 214-215
Chromosomes, manner of transmission, 237-239; and blood groups, 244; fig. 117, 246, blood group diagram; tables of blood groups, 247, 249, 253, 258, 261; and variability of man, 353

Chuckchee, classified, 350
Clactonian culture, chronology, fig. 61, 123; artifacts, 71, 148
Clark, W. E. Le Gros. See Le Gros Clark
Classification, basis of zoology, 22, 28; of primates, 28, fig. 13, 31; termination of terms in systematics of, 25; by characters, 235-237; criteria of analysis and, 232-236; arbitrariness, 234, 299, 301; divisions and ethnic groups, 299-351; of mankind given in this book may be nonsensical, 301; convenient device, 348
Claws, in tupaias, 24; lemurs, 32; tarsiers, 39; marmosets, 45; no claws in Cebidae, 491
Climate, prehistoric, fig. 61, 123; and natural selection, 275, 276; disease, 274; skin color, 274-276; menstruation, 353; ovulation, 425, 426; puberty, 425; and breeding season, 426; growth, 427; weight, height, resistance, metabolism, dental caries, 428, seasonal incidence of some diseases, fig. 143, 427; mental abilities, muscular ability, gross mortality, suicide, abortion, conception, intelligence, 428-429; conditioning effect upon genetic development, 424-429
Cline, defined, 236
Coghill, G. E., experience and the nervous system, *Anatomy and the Problem of Behaviour*, 365
Cohunna skull, 320
Colobus, Guerezas (Subfamily Semnopithecinae), classified and described, 36; thumb reduced to tubercle, 49; fig. 40, 70
Color blindness test, 467
Combe Capelle (Aurignacian Neanderthaloid), 174; prognathism, narrow, flat-sided, long and high form of skull, 175
Compass, sliding, 443, 444
Cone cells, of retina, absent in Tarsius, 41; practically disappear in prosimii, associated with diurnal sleeping habits, 94
Confins skeleton, 226
Constitution, and crime, 389-391; defined, 392; Kretschmer's typology, 392; Sheldon's typology and somatotyping, 394-402; classification of somatotypes, Table 21, 396; and disease, 402; distinguished
Constitution—*continued*
from sex differences, body-type, 401; indices, 407
Convergence, in man, 273
Convolutions of brain, simple in lemurs, 36; tarsiers, 42; marmosets, 45; rich in Cebidae, 50; inferior and third frontal in Pithecanthropus, speech, 136-137; increase in surface area by multiplication and deepening of, 206
Coon, C. S., on Basic Mediterranean subgroup, 327; on head form, 332; on Lapps, 338; *The Races of Europe*, 350
Co-operation, principle of, and natural selection, 276-278; unwarrantably neglected, 278
Cranial capacity. See Table 19, 336-337; formulae for estimating in living, 457; in skull, 484; measurement of, 483-484
Craniometry, 441, 476-494
Craven, D., and Jokl, E., on nutrition and growth, 436, 514
Cretaceous, Upper, time scale, fig. 47, 91; insectivores, 92
Crime, in twins, 387-389; and constitution, 389-391 and genes bear no significant relation to one another, 391
Cro-Magnon Man, chronological-cultural level, fig. 61, 123; and Neanderthal man, 158, 169; figure 82, 169; Paviland Cave, 170; variability, height, 170; brain size, tools, art, 170; and Grimaldi Man, 173; and neanthropic man, 175; and Předmost, 175; phylogenetic relationships, fig. 105, 203
Crossing, see Hybridization
Crossing over, defined, 238, 412
Cudmore, S. A., and N. A. Neal, *A Height and Weight Survey of Toronto Elementary School Children, 1939*, 436
Cummins, H. C., and H. C. Midlo, *Finger Prints, Palms and Soles: An Introduction to Dermatoglyphics*, 462-464
Cultural traditions of early man, fig. 110, 214
Culture, defined, 5f; human, 86; periods, fig. 61, 122-123; and morphology, 204; spiritual qualities and genes, 358-364; biology and, 360; and variability, 361-362, 378; Jews, 362; and behavior, 361-364, 365-367; and heredity, 363; man pre-eminently a creature of, 367; and

Culture—*continued*
mentality, 378; diversity, 376; and experience, 365, 376-389; changing, 371; and learning, 377; and the organization of basic urges, 377; relativity of, 377-378; rate of change, 371; and time, 378-379; determined by accidental factors, 376-380, 379-380; hybridization of, 378-380; and isolation, 377

Cynopithecus, Celebes ape (Subfamily Cercopithecinae) only non-African genus, 61, 63; extremely reduced tail, 63; baboon-like appearance, 63

D

Dahlberg, G., on twins, 383; "An analysis of the conception of race and a new method of distinguishing races," 295, *Race, Reason and Rubbish*, 295

Dart, R., on Australopithecus, 113-114, 117, 514-515

Darwin, C., *The Descent of Man*, 12, 124, that man originated from early anthropoid ape, 105, 121; on race, 235; *Origin of Species by Means of Natural Selection; Or, the Preservation of Favoured Races in the Struggle for Life*, 27, 274, resemblance to Ainu, 326; point, 451

Daubenton, Louis-Jean-Marie, portrait, fig. 2, 8

Davenport, C. B., and M. Steggerda, on Negro-white crosses, 355; C. B. Davenport, *Heredity of Skin Color in Negro-White Crosses*, 515; *Guide to Physical Anthropometry and Anthroposcopy*, 515

Davidson, D. S., x

Davis, A., "The distribution of the blood-groups and its bearing on the concept of race," 515

Dentition, in tree shrews, 24; in lemurs, 32-33; Tarsius, 42; marmosets, 45; Cebidae, 47; catarrhini, 58, 98-99; gorilla, 82; ancestral placental mammalian, 98-99; Notharctinae, 99; Gregory and Hellman on primate, 103, 106, 108, 109, 114, of Australopithecinae, 115, 116, 117, 119; Pithecanthropus, 135, 137, 140; Gigantopithecus, 134; Sinanthropus, 142, 149, 151; Rhodesian man, 151; Heidelberg man, 151; Africanthropus, 153; Piltdown, 178, 179; Mongoloid, 340; description, 461

Dermatoglyphics, 462-464

De Terra, H., on Tepexpan man, 226-227

Diet, in tree-shrews, 25; in lemurs, 38; Tarsius, 22; marmosets, 46; Cebidae, 52; Cercopithecidae, 60; gibbon, 74; orang, 76; chimpanzee, 79; gorilla, 83; and individual and group variability, 429; and longevity, 430; and height, 434

Digits, in tree-shrews, 24; in lemurs, 33; tarsiers, 39; Cebidae, 49; tips reach level knee-joint in chimpanzee, 79; specialization of, 95; see Fingers

Dinaric type or ethnic group (Adriatic or Illyrian), 331-334; subgroup of Alpine type, 334; and Armenoid, 334; and population of United States, fig. 136, 346; classified, 349; "soul-color," 358

Disease, and constitution, 402-407; and climate, 424-430; seasonal incidence of some, fig. 143, 426; and nutrition, 429-438; and income, 430-438; growth, 427

Divisions, mechanism of differentiation, 271-291; defined, 294, 292-295; genetic distinction between ethnic groups and, 292; an abstraction, 299; and ethnic group classification, 300-301, 299-351; Negroid, 302; Australoid or Archaic Caucasoid, 318; Caucasoid, 326; Mongoloid, 340-345; synoptic classification, 348-350; and genes, 352

Dobzhansky, Th., vii, x, *Genetics and the Origin of Species*, 296; on hybridization, 290, 291; "A re-examination of the problem of manifold effects of genes in Drosophila melanogaster," 354

Dolichocephaly, in gorilla, 82; defined, 456

Dornfeldt, W., on head changes, 240

Draper, G., on constitutional types in susceptibility to poliomyelitis, 403; —Dupertuis, C. W., and J. L. Caughey, Jr., *Human Constitution and Clinical Medicine*, 438

Drennan, M. R., on fetalization, 211

Drill (Genus Mandrillus), black-faced, short-tailed, 63, 65

Dryopithecus, Miocene fossil genus of ape, relationships, 102-104;—Sivapithecus stock ancestral to great apes and

Dryopithecus—*continued*
man, 102; relationship to Australopithecinae, 106; phylogenetic relationships, fig. 105, 203
Dublin, L., quoted on life expectancy, 430-431
Dubois, E., discoverer of Pithecanthropus, 135; Wadjak man, 145
Dwarf Lemurs (Microcebus), 31
Dynamometric strength, 464

E

Ears, small in gorilla, 82; Negroid, 302; silk purse out of sows, 385; landmarks, 451, fig. 148, 452; measurement, 453-454; description, 460
East Baltic type or ethnic group, 335; and population of United States, fig. 136, 346; classified, 349
East Indians, See IndoDravidians
Ecology, Human, the study of man in relation to his total environment, 429; J. W. Bews, *Human Ecology*, 438.
Ectomorphic type, Sheldon's, 394, fig. 140, 395; tuberculosis, 402, diseases of gastrointestinal tract, 402; non-infant mortality, 404
Egypt, primates of, 98
Egyptians, 303, 378
Ehrich, R. W., on head form, 332
Ehringsdorf, 160; and Neanderthal man, 202, 217
Elephas meridionalis, 179, fig. 89, 181
Elderton, E. M., "Height and weight of school children in Glasgow," 435
Elliot, D. G., 27; *A Review of the Primates*, 124
Elliot Smith, G., *The Evolution of Man*, 125
Elliott, R., and Galley Hill, 190
Elmenteita Man, from Kenya, E. Africa, associated with Mesolithic industry, 209
Elphidotarsius, Middle Paleocene Primate Genus (Family Carpolestidae), 89
Embryology, 12
Emergence, of new types, 165
Endomorphic type, Sheldon's, 394, fig. 137, 393; osteoarthritis, infantile paralysis, 403; pancreatic diabetes, 403; infant mortality, 404
Endrinas, Indris (lemurs), 37
Engle, E. T. & M. C. Shelesnyak, quoted on the pubertal girl, 425
Engis (Aurignacian Neanderthaloid), 74
English, 20; "blood," 357; and culture, 362; example of cultural relativity, 378; children and nutrition, 436
Environment, man, 4, 386; and genes, 359; factors unaffected by, 240; and hybridization, 284; and skin color, 285, 287; characters and natural selection, 274-278; genes in interaction, 353; and head shape, 240; and menstruation, 425; and biology, 356; and humanity, 359; and potentialities, 240; socializing effect of human, 359; Boas on mental qualities and, 360-361; and heredity, 365; temperament, 359, 384; in prenatal development, 383; intelligence, 359, 367, 386; genetic, uterine, family, socio-economic, and physical, 354, 383, 430; Boas on, 359; Newman *et allii* on, 386; Jennings on, 386; Thorndike on, 386; Woodworth on, 386; and temperament, 385, affords potentialities opportunities, 356; and crime, 386-387, 389; and constitution, 389-391; and growth, 434; defined, 418; and modification of bodily form, 418-424; and head form, 418-424, 429, 477; regulation, 430
Eoanthropus dawsoni. See Piltdown man
Eocene, primates, 89-92; time-scale, fig. 47, 91, fig. 105, 203; lemuroids, 89-92 and later primates, 95
Eoliths, chronological-cultural scale, fig. 61, 123; Piltdown, 179
Epicanthic fold, see Mongolian fold
Erythrocebus, Patas monkeys (Subfamily Cercopithecinae), slender, long-tailed, 61; classified, 61
Eskimo, taurodont teeth, 204; characters of Chancelade skull, 342; Paleoasiatic, 343; nose, 343; Mongoloid fold, 343; Neoasiatic, 343
Ethnic group, defined, 292; differences in each, 6; differentiation, criteria and mechanism of, 232-298, 374; criteria of classification, 233-234; language, nationality, and heredity in classification, 233-234; no clear-cut differences between, 234-235, 348; arbitrary classification, 234-236, 299; origins and blood group analysis, 240; mixture and blood groups, 240-265; mechanism of differentiation, 271-291, 287-295; sexual and social selection, 285-287; defined, 292-

Ethnic group—*continued*
295; genetic distinction between division and, 292-295; intergradations, 348; a temporary expression of variations in the relative frequencies of genes, 289, 294-295; an isolate more or less distinguished from other isolates, 272; classification, 299; account of, 299-351; comprising population of United States, fig. 136, 346; and statistically averaged characters, 347; transitions between, 348; synoptic classification, 348-350; hybridization, 289-290; Sewall Wright on, 290, 348; attainments and opportunities, 201; mental characters, 204, 366-375, 379; range of inherited capacities in, 367; and culture, 215; explanation of mental and cultural differences, 378; potential equivalence of all, 379; food, 429-438

Ethnography, defined, 5f

Ethnology, defined, 5f

Europe, fossil primates of, 102, culture periods, fig. 61, 123

Evans, F. G., "The names of fossil men," 228

Evenki or True Tungus, Palaeoasiatics, classified, 350

Evolution, end effects of, 5; convergence, 50, 273; of Primates, 89-126; of vision, 92-98; catarrhine dental formula, 56; parallel, 61; man, 65-113; "scale" or "ladder," "higher" and "lower," 89; a reticulate process, 216, 290; maelstrom, 216; linear, 215-216; geographic and social isolation, 281; and hybridization, 208; role of mutation, 278-281; materials of, 208; mutation and recombination, 278-281; fetalization in, 211-213; mechanism of, 271; man's mental characters, 368-375

Ewing, F. J., on cradling and headform, 332

Eyes, color, 6; in lemurs, 30, 37; size of, relation to waking activity, 37-38; enormous in Tarsius, 41, 94; large in marmosets, 45; among Cebidae, largest in Aotes, 52; Tarsioidea, 94; hand, 95; Bushman-Hottentot, 308; Pygmies, 311; -lashes and -brows in Veddahs, 323; Nordic, 328; Dinaric, 334; brows, Armenoid, 334; East Baltic, 335; Lapps, 338; Polynesian, 340; Mongoloid fold, 459, 460; American Indian, 344; Indonesian-Malay, 345; landmarks, 453, figs. 148, 452; measurement, 453; color standard, 458, 460; anthroposcopy, folds described, fig. 150, 459, 460

F

Face, relatively flat in tarsiers, 41, and in marmosets, 45; black in drill, highly colored in mandrill, 65; sinognathic in orang, 75; chimpanzees, 79; man, 85; short in Parapithecus, 99; reconstruction of in early types of man, 157; short in Cro-Magnon, 170; short, broad, and narrow in Grimaldi, 173; skin color chimpanzee, 77; Semang, 313; Australian aboriginal, short, 320; Ainu, short broad, 325; Caucasoid, 326, Mediterranean, 327, Irano-Afghan Mediterranean, 328, Nordic, 328, Alpine, 331, Dinaric, 333; Indo-Dravidian, 339; Polynesians, 339; Armenoid, 334; American Indian, 342; Lapp, 338; total height and environment, fig. 144, 430, 434; measurement, 452-454, fig. 148, 452; landmarks, 449-451

Facial expression, in lemurs, 39; Tarsius, 42; marmosets, 39; Cebidae, 57; orang, 76; chimpanzee, 80; gorilla, 84; prejudiced reconstruction of in early types of man, 157

Families, number of Primate, fig. 13, 31; terminate in "idae," 25; for number in each Suborder, see Species

Fat-tailed lemur (Opolemur), 37

Femur, thigh-bone, in Pithecanthropus, 135, 137; Grimaldi, 173; of *Elephas meridionalis* associated with Piltdown man, 179, fig. 89, 181

Fetalization, 211-213, Drennan on, 211; Mongoloid, 311, 342; African Negroes, 316; and development of advanced characters, 341-342

Fibula, See Legbones, Tibio-femoral index

Figures and Tables, list of, xi-xii

Filipinos, 355

Finger, and palm prints, 462-464; see Digits

Fischer, E., on Dutch-Hottentot crosses, 355

Fisher, R. A., on Rh genes, 257; quoted, 369; et al., "Taste-testing the anthropoid apes," 269
Fish Hock Skull, 211, 214
Fitt, A. B., *Seasonal Influence on Growth, Function and Inheritance,* 438
Florisbad Skull, 211; fig. 109, 212
Fluorine content of bones as indicator of age, 174; in Piltdown, 179-183; Galley Hill, 190-196
Folsom points, 222-223, fig. 115, 223, 225
Fontéchevade Skulls, fig. 104, 201; described, 200-202; chronology, fig. 61, 123, fig. 110, 214; Vallois on, 201
Food, See Diet
Foot (pes), in lemurs, 32; tarsiers, 40; Marmosets, 43; gorilla, 83; man, 84; Grimaldi, 173; skin color of in chimpanzee, 77; measurement, 449; index, 456
Forbes, H. O., *Monkeys,* 124
Forehead, form of, marmosets, 45; Cercopithecidae, 58; orang, 75; chimpanzee, 79; gorilla, 82; Pithecanthropus, fig. 62, 136; Sinanthropus, 142; Africanthropus, 153; Neanderthal man, 156; and relation to mind, 156; Steinheim skull, 160; Krapina man, 158; Ehringsdorf man, 158; Australian aboriginal, Caucasoid, in hybrids, 322; Galley Hill man, 192; Forest Negro, 304; Nilotic Negroes, 304; Bantu-Speaking Negroes, 306; Bushman-Hottentot, 309; Pygmies, 311; Oceanic Negroids, 316; Papuans, 316, 317, Melanesians, 316, 317; Australian aborigines, 320, Veddahs, 323; Pre-Dravidians, 325; Caucasoid, 326; Mediterranean, 327; Alpine, 331; Dinaric, 181; Armenoid, 333, 334; East Baltic, 335; Lapps, 338; Indo-Dravidians, 339; Polynesians, 339; Mongoloid, 340; measurement, 266-271; landmarks, 265-266, figs. 148 A & B, 452
Forest Negro described, 304; related to Pygmies, 304; classified, 348
Formula, dental, tree-shrews, 24; in lemurs, 32-33; explained, 24; Tarsius, 42; marmosets, 45; Cebidae, 47; Catarrhini, 58, 98-99; Parapithecus, type of catarrhine, 98-99
Fossil record, 27
Fovea centralis, absent in lemurs, 39; absent in tarsiers, 41; present in marmosets, 45; well developed in Cebidae, 51
Frankfurt horizontal (F.H., or plane), defined, 451, 483; and photography, 462
Frenchmen, good example of Alpine type, 331
Fyleman, R., *Monkeys,* 87

G

Galagidae (Family of lorises), classified, 37
Galago (Genus of lemurs), bush babies, 37
Galilee (Neanderthaloid), 217
Galley Hill Man, figs. 98 & 99 described, 190-196; discovery, 190; excavation in 1948, 193; and Swanscombe man, 194; Duckworth on, 193-194; fluorine analysis, 195-196; thickness of skull bones, 194; alleged primitive features of, 194; of postglacial age, 196
Galloway, A., on South African fossil men, 211, 228
Galton, F., quoted, *"Inquiries Into Human Faculty and Its Development,"* 382; on twins, 382
Gamble's Cave crania, from Upper Kenya, E. Africa, associated with Aurignacian industry, 209
Genera, number of Primate, 31; given as proper names, 25; italicized, 25
Genes, variability, 163, 236-239; introduction of new, 163, 236-239, 354, 355; nature, 237; number, 237; and characters, 236; linkage, 238, 409-414; expressivity, 414; penetrance, 414; viability, 414; lethal, 414-415; frequencies must be studied in order to understand variety of man, 240, potentialities and environment, 236, 358-366; and chromosomes, 353, 409-415; and blood groups, 240-265; tables of blood group, 240-265; frequency method described, 245-246; stability and taste reaction to PTC (phenyl-thio-carbamide) in chimpanzees and man, 269; selective value, 270; blood group and ethnic paternity, 252, 270; drift, 284; random variation and recombination, 238, 239, 284; hair form, 279; heterozygosity and introduction of new, 163-

Genes—*continued*
164, 282; frequency in division and ethnic group, 292; diversity of and collective achievement, 347; and plasticity, 371; and variability of man, 289, 353; and environment, 236, 240; and characters, 353-354; and divisional characters, 348; and heredity, 353-354; spiritual qualities, culture, and, 358, 367; intelligence, 368; mental characters, 369; controlling, 376; and development, 383; and crime, 387; sex-limited, 409, 413-414; sex-linked, 409-413; sex-influenced, 413
Genetic drift, discussed, 282-283, 288, 290; and blood groups, 282, 283; and stature, 116
Genetics, application of methods of to solutions of problems of human variability, 6-10; 163-164; principles, 236-240; of blood groups, 240-265; and language, 250; primate evolutionary relationships, 263; blood groups as genetic indicators, 245; genetic drift, 282-283; and variability, 353-354; genetic susceptibility to poliomyelitis, 403; and physiological conditions, 425
Genotype, defined, and classification, 236; and isolation, 281-282; and hybridization, 283-285; differentiation of populations and, 282; environment, 437
Gentle lemurs (Hapalemur), 36
Geographic race, defined, 292
Geology, time-scale, fig. 47, 91; Primate time scale, fig. 105, 203
Gibbon (Hylobatinae), classified 69; distinguished from great apes, 73; from siamang, 73; intermediate between Old World monkeys and great apes, 73; described, 72-74; phylogenetic relationships, 40, 70, fig. 105, 203, fig. 41, 71; blood groups, 263
Gibraltar II (Neanderthaloid), 161
Gigantopithecus blacki, early giant form of man, 134-135
Gilyak, classified, 350
Girth measurements, 448
Glabrousness, See Hair
Glacial period, fig. 61, 123; See Interglacial periods
Glands, sweat in Negroids, 302
Gloger's Rule, 274, 309
Goldstein, M. S., on descendants of Mexican immigrants, 423-424, 437
Gorilla (Family Pongidae), classified, 69; described, 81-84, fig. 46, 80; habitat, subspecies, 81; limbs, hands, trunk, neck, skull, palate, pelage, size, weight, 81; chest girth, nasal bones, nostrils, lips, teeth, sagittal crest, skull, temporal muscles, 81; crown-pad, 82; orbits, small mastoid, dolcho- and brachycephaly, forelimbs, big toe, thumb, locomotion, posture, laryngeal sacs, 82-83; diet, brachiation, social groups, reproductive life, temperament, facial expression, 82; phylogenetic relationships, fig. 40, 70, fig. 105, 203; blood groups, 263
Greeks, 327
Gregory, W. K., vi, viii; and Hellman, on dental characters of Sivapithecus, 103; "Studies on the Evolution of the Primates," 124; *The Origin and Evolution of the Human Dentition,* 124; *Man's Place Among the Anthropoids,* 125
Greulich, W. W. and H. Thoms, on male and female pelvis, 502
Grimaldi Man, 170-175; chronological-cultural level, fig. 61, 123
Grimaldi Man, chronological-cultural level, fig. 61, 123; described, 170-175; skull, 173; leg bones, alleged Negroid traits, 173; predominantly Caucasoid, 173; and Cro-Magnon, 173, 174; and Archaic Caucasoids, Pre-Dravidian, Australian, 173
Growth, defined, 434; duration greatest in man, 13; and environment, 434-437; and climate, 426-430; and socio-economic factors, 434-437
Guerezas, See Colobus, fig. 40, 70
Guthe, C. E., on cephalic index, 420
Gypsies or Romanics, an offshoot of Indo-Dravidians, 339; fundamentally East Indian Mediterraneans, 339; resisted assimilation, 363

H

Haddon, A. C., portrait, fig. 8, 16; Huxley to, 18; *History of Anthropology,* 20; *The Wanderings of Peoples,* 351; *The Races of Man,* 351
Hair, color, 4; in gibbons, 72, 73; orang, 74; chimpanzee, 79; gorilla, 81; man, 85; form genes, 280; form of Negroid

Hair—*continued*
almost certainly arose by mutation, 280; Negroid a divisional character, 302; form in True Negroes, 161; Nilotic Negroes, 304; Half-Hamites, 303; Bantu-Speaking-Negroes, 306; Bushman-Hottentot, 308, 178; Pygmies, 311; Negrillo, 312; Andamanese, 312; Semang, 312; Aeta, 314; New Guinea Pygmies, 311; Oceanic Negroes, 316, Papuans, 316; Melanesians, 317; Australian aborigines, 318; Tasmanians, 322; Veddahs, 322-323; Pre-Dravidians, 324; Sakai, 325; Ainu, 325-326; Caucasoid, 326; Mediterranean, 327; Irano-Afghan Mediterranean, 328; Nordic, 328; Alpine, 331; Dinaric, 333-334; Armenoid, 334; East Baltic, 335; Indo-Dravidian, 339; Polynesians, 340; Mongoloid, 340; American Indian, 344; Indonesian-Malay, 345; classification, 458, 468; sex differences, 413

Haldane, J. B. S., "The blood-group frequencies of European peoples, and racial origins," 296.

Half-caste, anomalous position, 355-366

Half-Hamites, origin, 306; classified, 349

Hallowell, A. I., x; on personality and evolution, 20

Hallux, See Toe, big

Hamites, mixture with Negroes resulted in Half-Hamites, 303

Hand (manus), in tree-shrews, 24; in lemurs, 30; tail a fifth in tarsiers, 42-43; Atelinae, 49; gibbons, 72; orang, 76; chimpanzee, 79; gorilla, 81; freeing of, 93-94; australopithecines, 110; measurement, 449; indices, 456

Hapalemur (Genus), gentle lemurs, 36

Haplorhini, all of the primates with the exception of the lemurs and lorises, 45

Hartman, C. G., and influence of season upon ovulation, 425

Hattock lemur (Mixocebus), 36

Hawaii, changes in bodily form of descendants of Japanese in, 420

Head, measurement, 449-455, landmarks, figs. 450-454, figs. 147B, 447, 148, 452; girth, 454; cephalic index, 454, 455-456; spanner, 452; and environment, 354, 477; See Skull

Hearing, Sense of, more highly developed in Tarsiers than in lemurs, 95; and nocturnal life, 95

Heidelberg man, See Homo heidelbergensis

Height, 6; orang, 74; chimpanzee, 77; gorilla, 81; Pithecanthropus, 137; Cro-Magnon, 170; Předmost, 175; Boskop, 210; True Negroes, 303; New World Negroes, 304; Nilotic Negroes, 304; Hamites, 303; Half-Hamites, 306; Bantu-Speaking Negroes, 306; Bushman-Hottentot, 307; Pygmies, 311; Negrillo, 312; Andamanese, 312; Semang, 312; Aeta, 314; New Guinea Pygmies, 315; Papuans, 316-317; Melanesians, 317; Veddahs, 322; Pre-Dravidians, 324; Sakai, 325; Ainu, 325; Mediterranean, 327; Basic Mediterranean, 328, Atlanto-Mediterranean, 328, Irano-Afghan Mediterranean, 328, Nordic, 328, Alpine, 331, Dinaric, 334, Armenoid, 334, Lapps, 338; Indo-Dravidian, 339; Polynesians, 340; American Indian, 344; Mongoloid, 341, Indonesian-Malay, 345, Japanese, 422-423; and environment, 434-436; and constitution, 404; sitting, 449; climate, 430; socio-economic factors, 434-436; Table 32, 435; and height, 420; Boas on height of institutionalized children, 436; measurement of sitting, 449, 455, standing, suprasternal, right acromion, right radiale, 445, right stylion, right dactylion, right iliocristale, iliospinale, right trochanterion, right tibiale, right sphyrion, 444-446; indices, 455

Hemigalago (Genus of lemurs), lesser bush babies, 37

Henri-Martin, G., discoverer of Fontéchevade skulls, 200

Heredity, and race, 233; genes and chromosomes, 237-240; blood groups, 240-265; and taste reactions to PTC (phenyl-thio-carbamide), 269-271; and blood, 357-358; family lines, 205; culture, 352-380; change in personality does not imply change in, 364; and environment, 384-385, 386; importance of, 226; potentialities limited by, 386; and crime, 387-389; and tuberculosis, 402; and sexual differences, 407-417; the blending of two, social, 437; pedigree chart, fig. 160, 504

Herskovits, M. J., x; on American Negro, 355

Heterozygosity, how produced in man, 163-164, 282; blood groups, 245; for taste reaction retained over 800,000 generations, 269; of original species population, 273; introduction of new genes, and, 163, 236-239, 354, 355; and mental characters, 368

Hindenburg, von, good example of "square-head" East Baltic type, 335

Hip, see Pelvis, measurement of, 501-502; sexing of, 503; girth, 448

Hogben, L., "The concept of race," 296

Hominidae, classified, 71, 84-86; relation to Tarsioidea and other Primates, 42; ancestry, 99 sq; phylogenetic relationships, fig. 105, 203

Hominoidea, Superfamily comprising man and the anthropoid apes, 30, 31, 67, 69

Homo heidelbergensis, lower jaw from lower pleistocene, 151-152, fig. 73, 152; relation to Neanderthal man, 152; and Steinheim skull, 158; phylogenetic relationships, fig. 105, 203; chronological-cultural level, fig. 61, 123

Homo modjokertensis (Genus Pithecanthropus), fossil skull of child from lower pleistocene of Java, described, 138-140

Homo rhodesiensis, 149-151, fig. 72, 150; and Homo soloensis, 149, 150; and Neanderthal man, 149, 150; and Homo sapiens, 150; Keith on, 150; mastoiditis, rheumatoid, badly decayed teeth, 151; during Neanderthal phase, 164; phylogenetic relationships fig. 105, 203

Homo sapiens, "man the wise," Linnaeus on, 22; classified, 71; described, 84-86; and Homo rhodesiensis, 150; and Neanderthal man, 156-157, 158, 164; evidence of mixture with Neanderthal man, 164; fossil type of, not found in Palestine, 161-164; Piltdown, Swanscombe, Rhodesian man type of, 150; during Pithecanthropoid phase, 164; hybridization, 164, 165; Cro-Magnon a true, 169; Grimaldi a true, 173; existence of type prior to appearance of Neanderthal man, 217; Piltdown, 176-184; great antiquity, 202; not latest type to be evolved, 102; phylogenetic relationships, fig. 105, 203; brain size compared with Neanderthal man, 155-157; early type culturally less advanced than Neanderthal man, 204;

Homo sapiens—*continued*
taurodont teeth, 204; and lower pleistocene African types, 209-211; Boskop, 210-211; evolutionary relationships, 203; evolution of divisions and ethnic groups, 271-295; skin color and mutation, 280

Homo soloensis, fossil skull from upper pleistocene of Java, described, 140-142; associated with paleolithic tools, 142; and Homo rhodesiensis, 149-151; fig. 72, 150; and Neanderthal man, 152; Wadjak man, Australian aboriginal, 145-149; and Piltdown in relation to Neanderthal man, 184; phylogenetic relationships, fig. 105, 203

Homozygosity, how produced in man, 163; blood groups, 245; and inbreeding, 251-252, 284

Homunculus, New World fossil monkey from lower miocene of Patagonia, 98

Hooton, E. A., x; *Man's Poor Relations,* 125; *Up from the Ape,* 125; on Chou K'ou Tien type, 215; "The making and mixing of human races," in *Twilight of Man,* 517; on constitution and crime, 389-391, *Crime and the Man,* and *The American Criminal;* quoted, 389-390; and Lombroso, 390

Howard, E. B., "Evidence of early man in North America," 228

Howler monkey, See Alouatta

Hrdlička, A., *Practical Anthropometry,* 21, 506; *The Skeletal Remains of Early Man,* 228; *Early Man in South America,* 114

Human biology, defined, 5

Huxley, J. S., on taxonomy, 129; on race, 239, 293; and A. C. Haddon *We Europeans: A Survey of Racial Problems,* 296; on hybridization, 290

Huxley, T. H., on anthropology, 18-19; on race, 234; portrait, fig. 7, 15; *Evidence as to Man's Place in Nature,* 20; quoted, "On the methods and results of ethnology" (in preceding volume), 234

Hybrid, genetic qualities of, 284; vigor or heterosis, 284; of White-Australian mixture, 322; European-Indo-Dravidian, 339; Stereotypes concerning, 355; the human, 355-356; anomalous position, 355-356

Hybridization in Neanderthaloids, 161-166; in man, 143, 146-147, 283-285,

Hybridization—*continued*
356, 360; Cro-Magnon, 169; Předmost, 175; Mount Carmel, 217; and brain size, 206-208; and migration, 208; variation, 215; at Chou K'ou Tien, 215; and blood groups, 251; defined, 283; and isolation, 282, 289; mechanism of, 283-285, 289-290; Bushman-Hottentot, 309; Negroid, 315, 318; stereotypes concerning, 355; effects of, 354-356, W. E. Castle on, 356; of culture, 376
Hylobates, Common Gibbons (Genus of Pongidae), figs. *41*, 71, *42*, 73; classified, 69; described, 72-74
Hylobatinae, Gibbons (Subfamily of Pongidae), fig. 40, 70; classified, 69, 72-74; distinguished from Ponginae, 72-73; intermediate between Old World monkeys and Ponginae, 73; phylogenetic relationships, fig. 105, 203

I

Inbreeding, factor in evolution of man, 279; and scattering of variability, 282; genotype and phenotype, 282
Independent Assortment, principle of, 237, 328
Index, in anthropometry, defined, 455; cephalic, 455-456
India, primates, 37, 98, 101, 103
Indian, North American, described, 344-345; possible Australoid contribution to, 226
Indo-Dravidians, 338-339, 350
Indonesian-Malay or Oceanic Mongoloid strain, 345; Caucasoid and Negroid admixture, 188; classified, 350
Indonesian, see Indonesian-Malay, 345; and population of United States, fig. 136, 346; classified, 349
Indris (lemur genus), endrinas, 37
Indrisidae (Family of lemurs), classified, 37
Ingwavuma Skull, 213
Insectivores, 23, 97, origin of prosimii from, 92; brain of, fig. 50, 97; phylogenetic relationships, fig. 40, 70, fig. 105, 203
Intelligence, Cebidae, 57; man, 86; and form of head, 157; and brain size, 157, 106; and genes, 359; environment and, 359, 367; temperament of monozygotic twins, 382; of dizygotic, 383; climate, 428
Interglacial periods, 122-123
Iodine, deficiency and disease, 429, 430
Iranians, 327
Irano-Afghan Mediterranean, subgroup of Mediterranean ethnic group, 328; and Dinarics, 334; and Armenoid, 334; and population of United States, fig. 136, 346
Iron age, fig. 61, 123
Ischial callosities, See Callosities
Isolates, defined, 272; a division a complex of, 293-294; Nordic, 328; Mediterranean color, 329; Jews, 272; Negroes, 363; in cultural differentiation, 375-380
Isolation, Geographic, important factor in evolution of man, 208, 272; and genetic variability, 281-282, 236-239; ethnic variation, 272; and scattering of variability, 163, 282; and hybridization, 282; and phenotype, 282, genotype, 282; and division, 292-295; and mixed populations, 347
Isolation, Social, important factor in evolution of man, 208; and ethnic differentiation, 281-282; and scattering of variability, 163, 282, 380; discussed, 281-282; and phenotype, 282; genotype, 282; and social selection, 287; and division, 292, 295; half-caste, 355-356; Jews, 272, 362; Negroes, 363; and culture, 375sq
Italians, 327; changes in head form of children of immigrants in the United States, 418-420
Ito, P. K., on growth of Japanese, 422-423

J

Japanese, a Mongoloid, 232; race, language, nationality, 233; descendants of, 240, 420; prognathism and "buck teeth," 340; crosses, 355; Europeanized, 364; immigrants into Hawaii and bodily form of their descendants, 420-422; to on growth of, 422-423
Jaw, in lemurs, 33; gorilla, 82; Meganthropus, 133; Gigantopithecus, 134; Pithecanthropus, 138, 139; Heidelberg man, 151-152; Neanderthal man, 156; Piltdown, 177, 178, 180; angles widely separated in East Baltics, 335; shallow mandibular fossa for reception of condyles in Mongoloids, 341; landmarks, 450-452; fig. 148, 452; measurement, 450-452; Paranthropus crassidens, 116, 119; Telanthropus capensis, 116
Jenness, D. (editor), *The American Abo-*

Jenness—*continued*
rigines, Their Origin and Antiquity, 228
Jennings, H. S., quoted, 386
Jepsenella; Middle Paleocene Primate Genus (Family Apatemyidae), 89
Jews, Dornfeldt on head form in Berlin, 422; religious and class isolates, 272; Palestinian, 327; a cultural isolate, not an ethnic group or race, 362; and head form, 419-420

K

Kallman, F. J., on suicide in twins, 389
Kamtchadales, classified, 350
Kanjera Man, middle pleistocene Negroid type, associated with Chellean artifacts, 209
Kanam Man, from Kenya, E. Africa, 209, fig. 108, 210
Keilor skull, description, 145-149; relation to Wadjak and Australian aboriginal, 145-149, 320; evolutionary relationships, 145; and Florisbad, 211; Weidenreich "The Keilor Skull: A Wadjak type from Southeast Australia," 230; Wunderly, "The Keilor Fossil Skull: Anatomical Description," 230
Keith, A., portrait, fig. 11, 19; on relationships of *Homo Rhodesiensis,* 150; on the London skull, 186; on Swanscombe, 189; *The Antiquity of Man,* 114; *New Discoveries Relating to the Antiquity of Man,* 115
Klineberg, O., quoted, "Mental testing of racial and national groups," 368
Kluckhohn, C., x, 20
Koenigswald, J. H. R., von, on teeth of Australopithecinae, 119; "The South African Man-Apes and Pithecanthropus," 125; Meganthropus palaeojavanicus, Gigantopithecus blacki, 133-135; discovered skull of second Pithecanthropus, 137; and Weidenreich, F., "The relationship between Pithecanthropus and Sinanthropus," 202; "The South African Man-Apes and Pithecanthropus," 125
Koreans, 330
Koryak, classified, 350
Kranz, H., on crime in twins, 387
Krapina Man (Neanderthaloid), described, 158-160; brachycephaly occurs in Hominidae for first time in this group, 160
Kretschmer, E., constitutional types, 392; and Sheldon's types compared, 392
Kroeber, A. L., on terms, 132-133
Krogman, W. M., x; *A Bibliography of Human Morphology, 1914-1939,* 21
Kropotkin, P., on mutual aid, 277
Krzywicki, L., on size of primitive populations, 282

L

Lagothrix, Woolly monkey (Platyrrhine genus), tail prehensile, 37, fig. 30, 57; position, fig. 40, 70
Landmarks of the body, 444-454, fig. 147, 447; head, 449-454, figs. 148A, 148B, 452; of skull, 478-480
Lange, J. on crime in twins, 387
Langurs, See Semnopithecus
Language, and race, 233-234; and genetics, 250; and culture, 377
Lapps, component of East Baltic type, 335; described, 335-336; classified, 349
Laryngeal sac, in orang, 74; gorilla, 83
Lasker, G. W., vii; on somatotype changes 401; changes in Chinese immigrants, 421
Lawrence, W., portrait, fig. 4, 11
Leakey, L. S. B., E. African primates on antiquity of neanthropic type, 164, 88; Kanam mandible, 209; Kanjera man, Elmenteita man, 209; Gamble cave crania, 209; Elmenteita, 209
Leg, total, length, lower, and environment, 420; measurement, 446; indices, 456
Leg bones, in tarsiers, 39; marmosets, 43; Homo rhodesiensis, 151; australopithecines, 106
Le Gros Clark, W. E., on tree-shrews, 26
Legras, A. M., on crime in twins, 38
Lehman and Raper, on sickling, 267-268
Lemuriformes, or Malagasy lemurs of Madagascar and Comoro Islands, 36-37; breeding-season, 38
Lemurs, See Lemuriformes; classified, described, 30-36, 37-39; tail in, 33; nose or rhinarium in, 33; tear-duct, 33; palatine bone in wall of orbit, 33; no external auditory meatus, 36; vertebrae, 36; brain, 36; synoptic classification, 36-37; body size, eye size, social habits, waking-sleeping habits, food, pregnancy, number of young at birth, nursing habits, menstruation absent, 37-38; stereoscopic and color vision

Lemurs—*continued*
probably absent, 39; not in direct line of man's ancestry, 39; incapable facial expression, 39; eocene, 92; phylogenetic relationships, fig. 105, 203

Lemur (Genus), the true lemurs, 36

Lemuridae (Family), classified, 36

Lemurinae (Subfamily), classified, 36

Leontocebus, Tamarins (Platyrrhine genus), classified, 43

Lesser Bush Babies, lemurs of the genus Hemigalago, 37

Lepilemur (Genus), sportive lemurs, 36

Lichanotus (Genus of lemurs), woolly avahi, 37

Life expectancy, increase in, 430-432

Limbs, in lemurs, 32; tarsiers, 39; marmosets, 43; cebids, 49; Cercopithecidae, 58; gibbons, 72; chimpanzee, 77; gorilla, 81; man, 84; australopithecines, 110; specialization of, 93; Grimaldi, 173; True Negroes, 304; Forest Negro, 304; Nilotic Negroes, 304; Bushman-Hottentot, 309; Negrillo, 312; Andamanese, 312; Semang, 314; environment and change in proportion, 420

Limnopithecus, from Lower Miocene of Kenya, 100

Lindenmeier site, 223, 224, 225

Linkage, defined, 238

Linnaeus, on the Primates, 22

Lips, in lemurs, 33; tarsiers, 41; chimpanzee, 79; gorilla, 82; man, 85; Negroid, 302; True Negroes, 303; Forest Negro, 304; Hamites, 303; Half-Hamites, 306; Pygmies, 311, 312; Andamanese, 312; Bushman-Hottentot, 308; Semang, 313; Aeta, 314; New Guinea Pygmies, 315; Oceanic Negroids, 316; Papuans, 317; Australian aborigines, 320; Veddahs, 323; Pre-Dravidians, 325; Sakai, 325; Caucasoid, 326; Mediterranean, 327; Dinaric, 333; Armenoid, 334; Indo-Dravidian, 339; Polynesians, 339; Mongoloids, 340; American Indian, 344; landmarks, 450, 451; fig. 148, 152; classified, 460

Locomotion, in lemurs, 321; tarsiers, 41; marmosets, 45; cebidae, 52; Cercopithecidae, 63; gibbons, 72; chimpanzee, 77; gorilla, 83; man, 84; australopithecines, 117-118; Pithecanthropus, 69-70

Lombroso, C., Italian school of criminology, 390

London Skull (London Lady), described, 184-187; possible relations to Neanderthal and Piltdown man, 186; thickness of cranial bones, 186; and Swanscombe man, 190; Bury St. Edmunds, 190; and Wallbrook skull, 147

Longevity, 404; and rate of living, 404; and constitution, 404, 430-432, Table 30, 431, fig. 145, 432

Lorenc, M., x

Loris, (Genus of lemurs), Slender loris, 37; breeding, 20

Lorisidae (Family of lemurs), classified, 37

Lorisiformes or African or Asian lemurs, 37

Lotsy, J. P., and W. A. Goddijn, on crosses between Bushmen, Basutoes, Fingoes, Kaffirs, Zulus, Mongoloids, and Indians, "Voyages of exploration to judge of the bearing of hybridization upon evolution. I. South Africa," 355

Lumbar curve, in man, 85

Lund, P. W., on Lagôa Santa skeletal remains, 225-226

Lyell, C., and the Natchez pelvis, 222

M

Macaca, Macaque (Subfamily Cercopithecinae), live in trees and in rocky regions, 63; classified, 61

Macroscelidae, family of jumping-shrews, brain, 97

Macula lutea ("yellow spot"), absent in lemurs, 39; absent in tarsiers, 41; present in marmosets, 45; well developed in Cebidae, 51

MacCurdy, G. G. (editor), *Early Man,* 229

Madagascar lemurs, See Malagasy lemurs

Malagasy lemurs, or Lemuriformes, 36-37; breeding-season, 38; living fossils, 90

Malar bone, See Zygomatic

Malay, See Indonesian-Malay, 345; and population of United States, fig. 136, 346; classified, 351

Mammals, Orders of, 22; defined, 22

Man, a complex of effects of past causes and operation of present ones, 6; questions which physical anthropology asks concerning, 6; environment of, 6; closest kinship with apes, 10; causes producing his variety, 10; studies

Man—*continued*
throwing light upon the evolution of, 10; prehistoric, 13; fossil, 13; origins and relationships of existing varieties of, 13; no variety of superior or inferior to any other, 13; natural unity of the basis for the social unity of, 13; past and present, 13; classified, 30, 31, 71; lemurs not in direct line of ancestry, 39; described, 84-86; distinguishing features, 84-86; neopallium, 95-96, fig. 50, 97; Parapithecus, possible ancestor, 99, 102; Propliopithecus, possible ancestor, 104; relation to Australopithecinae, 106; morphological variability, 130; lateral incisor, 106; origin from early ape, Darwin, 105; and apes superfamily Hominoidea, 69; origin and evolution, 127-231; giant forms, 116; brain size, 204-208; hybridization, 283; polygenesis, monogenesis, 273; origin of living varieties from single species, 273; Meganthropus, 133; Gigantopithecus, 134; Pithecanthropus, 135, figure 62, 136, figure 63, 139; Modjokerto, 138; Solo, 140; Sinanthropus, 142, figure 66, 143; Wadjak, 145; Rhodesian, 149; Heidelberg, 151; Africanthropus, 152; Neanderthal, 155; Steinheim, 158; Krapina, 158; Ehringsdorf, 160; Spy, Galilee, Gibraltar, 161; Tabūn, Skhül, 162; Châtelperron, 166; Cro-Magnon, 169; Grimaldi, 170; Předmost, 175; Piltdown, 176; London, 184; Bury St. Edmunds, 190; Swanscombe, 187; Wallbrook, 197; Galley Hill, 190; new conception of evolution, 202; phylogenetic relationships, fig. 105, 203; evolution of brain size, 204; natural, social, sexual selection, isolation, migration, mutation, hybridization, 273; evolutionary relationships, 203; in Americas, 218-227; names of fossil, 228; cultural traditions, fig. 110, 214; criteria and mechanism of differentiation, 232-298; arbitrary classification, 299; gene variability, 236-238; recombination, 236-238; gene frequency method in study of variety, 239-240; blood groups, 240-265; divisions and ethnic groups of, 299-351; differentiation, 271; skin color and mutation, 280; primary processes in evolution, 273; natural selection, 274; mutation,

Man—*continued*
278; isolation, 281; sexual selection, 286; social selection, 287; drift, 282; hybridization, 283; inbreeding, 282; hair form, 280; mutation and size of population, 240; a single species, 290-291; physical anthropology and classification of, 300; pigmentation, 300; divisions and ethnic groups classified, 299-351; unity, 348; hybridization, 283; no purebreed, 300; and culture, 358; uniqueness, 366, 378; plasticity of, 369-375; evolution of mental characters, 368; roles born a culturally indifferent animal, 379; as an individual, 379; roles of heredity and environment, 382; heredity, 386; environment, 386, 418; climate, 426; nutrition, 429; measurement of, 440-508
Mandible, see Jaw, Lower
Mandibular Torus, 461
Mandrillus, Mandrill and Drill, highly colored muzzle in mandrill, 65; classified, 65
Manus, See Hand
Maori, bloodgroups, 219, 220; a progressive people, and influence of culture contact, 207
Marmosets (Platyrrhine family Callithricidae), described, 43-46; range, 43; tail, limbs, digits, claws, nails, locomotion, thumb not opposable, big toe capable of considerable degree of mobility, macula and fovea present, presumed capable of some stereoscopic vision, very large brain, well marked sylvian fissure, no snout, nose, lips, bulla inflated, tympanic ring external, postorbital wall, 43-46; zygomaticoparietal contact at pterion, dental formula, vertebrae, produces 2 or 3 at a birth, duration of pregnancy, no restricted breeding period, non-menstrual bleeding, sexual skin occurs, nursing, social habits, diurnal and arboreal, climbers, diet, capable wide range facial expression, 45; classified, 43
Marston, A. T., 194
Martin, R., *Lehrbuch der Anthropologie*, 21; landmarks of body, fig. 147, 447; landmarks of the head, figs. 148A & B, 452
Mastoid process, absent in orang, 76; chimpanzee, 79; present in gorilla, 83

Matjes River Skull, 211

Mauer jaw, See Homo heidelbergensis

Mayr, E., *Systematics and the Origin of Species,* 297

McGregor, J. H., x; on Piltdown, 179

Mediterranean ethnic group, 327, fig. 133, 330; sub-groups, Basic, 327-328; Atlanto, 328; Irano-Afghan, 328; Nordic type a color-isolate of, 329; gypsies or Romanies, 339; Polynesians, 340; and population of United States, fig. 136, 346; classified, 349

Meganthropus palaeojavanicus, possibly earliest type of fossil man known, 273; teeth, 119; relationships, 119

Melanesians, Oceanic Negroids, 317; classified, 349

Menarche (the first menstruation), in chimpanzee, 79, 353, 425; in Japanese, 423

Menstruation, absent in lemurs, 38; Tarsius absent, 42; absent in marmosets, 46; among Cebidae present in Ateles and Cebus, 53; present in Cercopithecidae, 59; regularly in orang, 76; gibbon, 73; chimpanzee, 79; gorilla, 84; climate, 353; age at first (menarche), 425; and seasonal influences, 425, 428; and constitution, 403-404

Mental traits, evolution of in man, 368-375

Mesolithic culture, 209

Mesomorphic type, Sheldon's, 394, 396

Mexico, bodily changes in descendants of immigrants from, 423-424

Migration, of early man, 208; in America, 218, fig. 112, 219

Microcebus (Genus), dwarf lemurs, 37

Mills, C. A., on age at menarche of females in United States, 425

Mind, and "race," 364; in individuals and groups, 367; organization, 364-365; genes, 364-366; socialization and, 364-366; and development of nervous system, 364-366; a social product, 365-366; brain and, 367; experience, 375sq

Minnesota Man, 224

Miocene, primates, time-scale, fig. 47, 91, fig. 105, 203; 98-102

Missing Links, 215-216

Mixocebus (Genus), lemur, the hattock, 36

MN blood types, 252-254; linked with sicklemia, 259

Mongoloid fold, 340, sexual differences in, 344; fig. 150, 459

Mongoloid spot, 309, 311, 458; phylogenetic relationships, fig. 105, 203; first prehistoric migration into America, 218; cheek pads, 287; race, 232; blood groups, 247, 248, 253, 254, 256, 257, 258, 260-262; Polynesians admixture with, 340; Division, 340; shovel-shaped incisors, prognathism and "buck teeth," 340; a fetalized type, 341; glabrousness, 340, 341; and Weidenreich on Sinanthropoid origins, 342; Chancelade skull, 342; and population of United States, fig. 136, 346; classified, 342; Paleoasiatic, 343; Neoasiatic, 343; crosses, 355

Monogenesis, 166; more in accordance with facts, 273

Montagu, M. F. Ashley, "A cursory examination of the relations between physical and social anthropology," 18; "Physical anthropology and anatomy," 18; *Edward Tyson, M.D., F.R.S., and the Rise of Human and Comparative Anatomy in England,* 18; "The tarsian hypothesis and the descent of man," 125; "Genetics and the antiquity of man in the Americas," 229; *Man's Most Dangerous Myth: The Fallacy of Race,* 297

Muller, H. J., on racial genetic differences, 375

Morant, G. M., on Swanscombe skull, 198-199

Mouse-lemur, Cheirogale, 31, 36

Mousterian culture, artifacts, fig. 75, 159; chronology, fig. 61, 123, and Neanderthal man, 157-158; in England and Jersey, 183

Muscle, palmaris longus, 468

Mutation, 278; and Mount Carmel Neanderthaloids, 162; defined, 238, 278; nature, 278; and recombination, 208, 239-240, 279; and characters, 236-239; discontinuous and continuous, 239; species formation, 239; blood groups not subject to, 240; rate, 278; skin color, 278-279; hair form, 279; takes place in individuals not in groups, 280; in small populations, 280; and action of secondary factors, 279; survival and diffusion of, 276; and Nordic type, 329

Muzzle, in lemurs, 33; Tarsius, 41; none in marmosets, 45; absent in Cebidae, 45, 50; in Cercopithecinae, 63; reaches greatest length in baboons, 64, 65

N

Nails, in Anagale, 24; in lemurs, 32; tarsiers, 39; marmosets, 43; all digits bear nails in Cebidae, 49; picking food with, 93

Names of fossil forms, 128

Nasal, bones, markedly reduced in width in orang, 76; short and flat in chimpanzee, 79; elevated in gorilla, 82; gutters in Grimaldi skulls, 173; Piltdown, 177

Nasalis, Proboscis monkey (Subfamily Semnopithecinae), remarkable development of nose, 66; classified, 63

Natchez pelvis, 222

Natural selection, factor in evolution of man, 218; defined, 274; and mutation, 276-277; and cooperation, 276-278; and plasticity, 370-375; Darwin, C., *Origin of Species by Means of Natural Selection; Or, the Preservation of Favoured Races in the Struggle for Life*, 274, 276

Nationality and race, 233

Navaisha skull, 154

Navicular, in tarsiers, 39

Neanderthal Man, chronological-cultural level, fig. 61, 123; and Homo rhodesiensis, 150; Homo heidelbergensis, Sinanthropus, Africanthropus njarensis, 155; described, 155-166, fig. 74, 156; Paleanthropic man, last form of, brain size, 183, 184, 206; Acheulian and Mousterian culture, 158; flint ball typically associated with, 158; religion, 158; Chapelle-aux-Saints, 156; relation to Cro-Magnons, 169; variety of different types, 158; craniogram, fig. 80, 164; widespread distribution, 169, 208; compared with Cro-Magnon, craniogram, 174; and neanthropic types, 183, 204; and Předmost, 175; and Piltdown, 183; in England and Jersey, 183; hybrid type, 184; possible ancestry, 184; and London skull, 184-187; teeth, 204-205; phylogenetic relationships, fig. 105, 203; size of brain compared with Sapiens type, 183, 204-206, 208; migrations, 169; and Fontéchevade, 202; and

Neanderthal man—*continued*
Ehringsdorf, 202; and Florisbad, 211; and modern man, 212

Neanderthaloids, Steinheim, 158; Krapina, 158; Ehringsdorf, 160; Spy II, 161; Galilee, Gibraltar, II, 161; evidence of hybridization in, 161-164, 174; Tabūn Skhūl, 161-161; Engis, Aurignac, Combe Capelle, 174; possible evidence of strain in Homo sapiens, 217; migrations, 208; phylogenetic relationships, fig. 105, 203

Neanthropic man, defined, 132; forehead, 153, Ehringsdorf, 161; and Neanderthaloids, 184, 212, 217; possible origin, 217; Steinheim and, 158; Mount Carmel and, 161; and hybridization, 165, 174; Předmost, 175; Pithecanthropoid stock, 164; earliest practically identical with Europeans of today, 204; evolutionary relationships, 202sq

Neck, in orang, 74; gorilla, 83; Africanthropus, 154; measurement, girth, 454

Neel, J. V., on sicklemia, 266

Negrillo, or African Pygmy, 312; described, 312

Negroes, American distinguishable from African progenitors, 208, 304; white ancestry and differences, 234; skin color and mutation, 278; hair-form genes, 279; form of hair almost certainly arose by mutation, 280; processes in production of new ethnic group, 281; example of sexual selection among Negroes, 286; skin color and form of nose possible examples of adaptive characters, 302; in process of becoming ethnic group, 294; African, 302-303; True, 303-304; Forest, 304; Nilotic, 304-306; Bantu-Speaking, 306-307; Bushman-Hottentot, 307; Pygmies, 311-312; Half-Hamites, 306; Negrillos, 312; Asiatic Pygmies or Negritos, 312-314; Andamanese, 312; Semang, 312; Aeta, 314; Ocean Pygmies or Negritos, 315-316; New Guinea Pygmies, 315-316; Oceanic, 315-316; Papuans, 316-317; distribution, 302-303, 318; white admixture, 318, 347, 355; "blood," 357; adoption of Western culture, 362-363; social isolates, 363; potentialities and opportunities, 356; skin colors in—white crosses, 234

Negroid, alleged characters of Grimaldi man, 73; of Předmost man, 175; phylogenetic relationships, fig. 105, 203; early type from Kanjera, 209; sickling in, 266-268; blood groups, 247; skin color possible example of adaptive character, form of nose, 275; Division, described, 301, 302-318; classified, 302-318, 348-349; skin color, 302; hair form, 302; dolichocephalic, 302; prognathism, 302; sweat glands, 302; African, 302-303; True, 303-304, 349; Forest, 348-349; Nilotic, 304-306; Bantu-Speaking, 306-307; Bushman-Hottentot, 307-311; Pygmies, 311-312; Half-Hamites, 306; Negrillos, 312; Asiatic Pygmies or Negritos, 312-314; Andamanese, 312; Semang, 312; Aeta, 314; Oceanic Pygmies or Negritos, 315-316; New Guinea Pygmies, 315-316; Oceanic, 315-316; Papuans, 316-317; distribution, 302-303, 318; intermixture, 318; and Atlanto-Mediterraneans, 328; and Indo-Dravidians, 338; and Indonesian-Malay, 345; many Caucasoids could fit into group and vice versa, 347; C. G. Seligman, *The Races of Africa,* 351

Neolithic culture, chronology, fig. 61, 123

Neopallium, nature of, 95

Neoteny, See Fetalization

Nervous System, experience and the development of, 364; S. W. Ranson quoted, 364; G. E. Coghill, *Anatomy and the Problem of Behaviour,* 365; in different ethnic groups, 365; and mental characters, 366

New Guinea Pygmies, 315-316

Newman, H. H., F. N. Freeman, and K. J. Holzinger, quoted, *Twins: A Study of Heredity and Environment,* 383-387; H. H. Newman, *Multiple Human Births,* 438

New World Monkeys, See Platyrrhini; Ceboidea; classified, 43, 47; evolution of, 98

Night monkey, See Aotes

Nilotic Negroes, or Nilotes, described, 304-306; Hamitic admixture, 306; classified, 349

Nocturnal, lemurs mostly, 37; Aotes alone among Cebidae, 52; prosimii, 94; life and auditory acuity, 95

Non-Malagasy Lemurs of Africa and Asia, Series Lorisiformes, 37

Nordic type, not really an ethnic group, but a color-isolate of Mediterranean stock, 293, 329; described, 328-329; cult of, 329; and East Baltic, 335; and population of United States, fig. 136, 346; classified, 349

Nose, in tree-shrews, 24; in lemurs, 33; rhinarium, in lemurs, 33; tarsiers, 41; distinctive primate type in marmosets, 45; Cebidae, fig. 23, 50; Cercopithecidae, 65; Semnopithecinae, 66; remarkable development of nose in Nasilis, 66; orang, 76; chimpanzee, 79; gorilla, 82; man, 85; broad in Grimaldi man, 173; genes for shape, 238; of Negro possible example of adaptive character favored by natural selection, 275, 288; Negroid, 301; True Negroes, 303; New World Negroes, 304; Nilotic Negroes, 305; Half-Hamites, 306; Bantu-Speaking Negroes, 307; Bushman-Hottentot, 308; Pygmies, 311, 315; Andamanese, 312; Semang, 312; Aeta, 313; Oceanic Negroes, 316; Papuans, 316, 317; Melanesians, 316, 317; Australian aborigines, 320; Veddahs, 323; Pre-Dravidians, 325; Sakai, 325; Ainu, 325; Caucasoid, 326; Mediterranean, 327; Basic Mediterranean, 328; Atlanto-Mediterranean, 328; Irano-Afghan Mediterranean, 328; Nordic, 328; Alpine, 331; Dinaric, 333; Armenoid, 334; East Baltic, 333; Indo-Dravidian, 339; Lapps, 338; Polynesians, 339; Mongoloid, 340; in babies, 341; American Indian, 345; Indonesian-Malay, 345; breadth and environment, 275; landmarks, 450; fig. 148, 452; measurement, 451, 482; forms classified, 460

Nostrils, incompletely ringed in lemurs, 33; widely separated in Tarsius, 41; widely separated in marmosets, 45; generally widely separated in Cebidae, fig. 23, 50; close together in Cercopithecidae, 58; set far back on muzzle in Gelada baboon, 65; "V"-shaped in gorilla, 82; Negroid, 301; Negrillo, 312; roundish in East Baltic, 333; Polynesians, 339; Mongoloids, 340; American Indian, 344; classified, 460

Notharctus, eocene fossil lemuroid, 92, fig. 48, 92
Nursing habits, lemurs, 38; Tarsius, 42; marmosets, 45; Cebidae, 52; Cercopithecidae, 59-60; orang, 76; chimpanzee, 79; gorilla, 84
Nycticebus (Genus of Lemur), slow loris, 37
Nutrition, differences in individual and group, 429-438; and longevity, 430

O

Oakley, K. P., on fluorine content of Piltdown, 179-183; of Galley Hill, 190-194, 196; Swanscombe, 196; on Kanam man, 209; on cultural traditions of early man, fig. 110, 214
Occipital lobes, in lemurs, 36; Tarsius, 41; marmosets, fig. 50, 97
Occiput, in Australopithecus, 113; Pithecanthropus, 138; Sinanthropus, 142; projecting in Neanderthal, 156; Steinheim skull, 158; Piltdown, 177; London skull, 184; Swanscombe, 187; Alpine, 331; Dinaric, 331-332; Armenoid, 331-332; Polynesians, 339; Mongoloid, 340; landmarks, 451, fig. 148B, 452
Oceanic Negroids, 316; classified, 349
Oceanic Pygmies or Negritos, 315-316; classified, 349, fig. 133, 330
Ocular-inter, width, and environment, 420
Oedipomidas, Pinché marmosets (Platyrrhine genus), classified, 43
Oestrus cycle, in lemurs, 38; Tarsius, 42; marmosets, 45; Cebidae, 53; Cercopithecidae, 30; gibbon, 73; orang, 76; chimpanzee, 79; gorilla, 84
Old World monkeys, See Catarrhini, fig. 40, 70; Cercopithecidae, evolution of, 98; distribution of fossil, 98
Olfactory region, in tree-shrews, 24; lemurs, 36; beginning retrogression in Tarsius, 42; portion of brain in Tarsius shows considerable reduction, 41; markedly reduced in marmosets, 45; in fossil lemurs; increase in importance of vision directly related to reduction of, 94, See fig. 50, 97
Oligocene, primates, time-scale, fig. 47, 91, fig. 105, 203, 98
Opolemur (Genus), fat-tailed lemurs, 31, 36
Opposability, of thumb and big toe, in lemurs, 30; tarsiers, 39; absent in Cebidae, 49; of big toe present in all Cebidae, 49; present in Cercopithecidae, 58; present in Anthropomorpha, 69; development of, 95
Orang-Outang, See Pongo
Orbits, in lemurs directed forward, 35; marmosets, 45; low and broad in Grimaldi and Bushmen-Hottentots, 173
Orthogenetic evolution, 215
Orthognathism, in Caucasoids, 326; Mediterranean, 327; Alpine, 331
Os calcis, in tarsiers, 39; Grimaldi, 173
Ovulation, 425, 426
Osteometry, 441

P

Palaechthon, Middle Paleocene Primate Genus (Family Anaptomorphidae), 89-90
Palate, comparatively short in Cebidae, 50; relatively long in Cercopithecidae, 58; in Pithecanthropus robustus, 138; torus of, in Grimaldi man, 173; Australian aboriginal, 318; Caucasoid, 326; described, 461
Palatine bone, in lemurs, 33
Palenochtha, Middle Paleocene Primate Genus (Family Anaptomorphidae), 89-90
Paleoanthropology, the study of prehistoric man, the tracing of the origins and relationships of mankind, 12
Paleocene, Primates of North America, 89-90; time-scale, fig. 47, 91; tarsioids ancestral to later primates, 90-92
Paleolithic, Old Stone Age, chronology, fig. 61, 123; tools Solo man, 73; Pithecanthropoid forms, 73; Neanderthal man, 82; upper survivors, blood group, 137
Paleontology, primate, 10
Pan, Chimpanzee (Family Catarrhini), classified, 69, figs. 44 and 45, 77, 78; described, 76-80; See Chimpanzee
Papuans, Oceanic Negroids, 316-317; classified, 349
Paramomys, Middle Paleocene Primate Genus (Family Anaptomorphidae), 89-90

Paranthropus robustus, Subfamily Australopithecinae, from middle pleistocene of S. Africa, 108-110; fig. 54, 109

Paranthropus crassidens, Subfamily of Australopithecinae, from middle pleistocene of S. Africa, 114-117

Parapithecus, most primitive catarrhine, 98; reduction of premolar teeth in, 98; relation to Propliopithecus, 99; phylogenetic relationships, fig. 105, 203

Pauling, L., on sicklemia, 266

Paviland Cave, southwestern Wales, Cro-Magnon man discovered in, 170

Pearl, R., on longevity, 404-405, 434; *An Introduction to Medical Biometry and Statistics,* 507

Pedigree, chart, fig. 160, 504

Pedomorphosis. See Fetalization

Pelvis, Anthropomorpha, 69; of Plesianthropus, fig. 53 C & D, 108, 110; of Australopithecus, 117, fig. 58, 118; Grimaldi, 173; Natchez, 222; measurement of, 501-502; sexing of, 503, 506. See Hip

Pelycodus (Genus of Subfamily Notharctinae), Eocene lemuroids, 92

Penniman, T. K., *A Hundred Years of Anthropology,* 19

Perla, D., and J. Marmorston, *Natural Resistance and Clinical Medicine,* 427, 439

Perodicticus (Genus of lemur), the potto, 37

Pes, See Foot

Petersen, W. F., *The Patient and the Weather,* 402

Phenotype, defined, and classification, 236; blood groups, 244, 245; and isolation, 281-282

Phenyl-thio-carbamide, tasting, 269-271; method of testing ability to taste, 465-466; in apes, 269

Philtrum, of upper lip, in man, 85

Physical fitness test, 464

Photographs, in anthropometry, 461-462

Physiology, 8

Physiometry, 441

Pigmentation, in chimpanzee, 77; classification by, 234; environment, 274-275; New World Negroes, 304; man, fig. 133, 330; feeble in East Baltics, 335

Piltdown Man (Eoanthropus dawsoni), described, 176-184; chronological-cultural level, fig. 61, 123; during Neanderthal phase, 183; doubtful character of associated teeth, 178; fig. 87, 177; Homo sapiens type, 178; Broom on, 178; canine tooth, 177-178; simian shelf, 178; mandible, 178-179, fig. 88, 180; fluorine content, 179; and Neanderthal, thickness of skull bones, 179, 184; and Swanscombe man, 184; and phylogenetic relationships, fig. 105, 203; size of brain, 179; taurodont teeth, 206; a third skull, 175

Pithecanthropus erectus, chronological-cultural level, fig. 61, 123; first discovered, 135; brain size, 135; teeth, described, 135-140; figures 62 and 63, 136, 139; antiquity, 135; speech, 137; femur, manlike, 137, 178; locomotion, 137; second discovery, 137; diastemata, canine, reduction, 138; chin wanting, 137; Homo modjokertensis close relative, 140; Homo soloensis, affinities, 141; Sinanthropus a Chinese variant of, 142; occiput, 138; phylogenetic relationships, fig. 105, 203; W. E. Le Gros Clark, "Pithecanthropus in Peking," 229

Pithecanthropus robustus, 137; possesses premaxillary diastema, 137-138; described, 137-138; relation to Modjokerto, 140

Pithecanthropus, I, II, III, IV, described, 137

Pithecia, Saki monkeys (Family Cebidae) classified, 47; position, fig. 40, 70

Pithecoidea, the monkeys as distinguished from the Prosimii and the Anthropomorpha, 29; not a separate suborder, 29; classified, 30, 31

Plasticity or educability, a species character of man, 368-375

Platyrrhini ("broad" + "nose") or New World Monkeys, 29; nostrils in, fig. 23, 50, fig. 40, 70; classified, 43, 47; described 43-57; independent origin of catarrhini, 50; evolution of, 98; phylogenetic relationships, fig. 105, 203

Pleistocene, time-scale, fig. 47, 91; primates, 104sq

Plesiadapidae, Middle and upper paleocene family of tree-shrews of N. America, 80, 90

Plesiadapis, Upper Paleocene Primate Genus (Family Plesiadapidae), 90

Plesianthropus robustus, 108-110; fig. 53, 105
Plesianthropus transvaalensis, subfamily Australopithecinae, from middle pleistocene of S. Africa, discussed, 106-120; fig. 53, 107, 108
Plesiolestes, Middle Paleocene Primate Genus (Family Anaptomorphidae), 89-90
Plettenberg Bay skeleton, 211
Pliocene, time-scale, fig. 47, 91, fig. 105, 203; probability of finding men of, 166; *Elephas meridionalis* and Piltdown finds, 179, 181
Pliopithecus, gibbon-like fossil apes from Lower Pliocene of Gascony, 99
Pollex, See Thumb
Polygenesis, 166, 273
Polynesians, ethnic group of essentially Mediterranean character, 339-340; Mongoloid and Negroid admixture, 340; and population of United States, fig. 136, 346; classified, 350; white crosses, 355
Pongidae, Great Apes (Family of Hominoidea), classified, 69; described, 72-84; fig. 40, 70, fig. 105, 203
Pongo, Orang-Utan (Family of Pongidae), classified, 69; described, 74-76, fig. 43, 75; relation to Sivapithecus, 103; and Pithecanthropus teeth, 135; phylogenetic relationships, fig. 105, 203; blood groups, 263
Population, mobility of, 208; Indian of Americas, 218; genetic variability, 236, 238; linkage and crossing over, 238; gene frequency method of studying, 239, 269; genes present in any, 238; variability of isolated, 28, 251, 272, 367; blood groups, 252; isolates, defined, 272; hominid ancestral relatively heterogeneous, 273; small breeding groups in early, 280; mutation in small, 280-281, 282, 288; sexual selection, 285-286; social selection, 287; natural selection, 287-288; differentiation, 292; impossible to define in terms of external characters, 299; dynamic not static, 300; varieties of mankind entering into formation of United States, fig. 136, 346; mixing, 347; and social isolation of Negro, 363; range of variability in hybridizing, 368
Portuguese, 327
Position, of subject in making anthropometric measurements, 444
Postorbital wall, absent in lemurs, 33; present in tarsiers, 42; marmosets, 45
Posture, in Anthropomorpha, 69; gibbons, 72; orang, 76; chimpanzee, 77; gorilla, 83; man, 84; Pithecanthropus, 137
Potto, lemur of genus Perodicticus, 37
Pre-Chellean (Strepyan) culture, 123
Předmost Man, chronological-cultural level, fig. 61, 123; described, 175-176; phylogenetic relationships, fig. 105, 203, fig. 106, 205
Pre-Dravidians, and Grimaldi Man, 173; described, 323-325; classified, 350
Preface, viii, ix
Pregnancy, duration in lemurs, 38; tree-shrews, 25; marmosets, 45; gibbon, 74; orang, 76; chimpanzee, 79; gorilla, 84
Prehistory, divisions of, fig. 61, 123
Premaxilla, early closure in man, 85; in Australopithecus africanus, 106; in Plesianthropus, 106; Paranthropus crassidens, 115; in man, fig. 59, 118, fig. 60, 120, 120-121; Pithecanthropus robustus, 137-138
Prichard, J. C., portrait, fig. 5, 12
Primates, Order of, 10; paleontology of, 10; as a zoological group, 22; Linnaeus on the, 22; defined, 26-27; purpose of studying, 27; evolutionary relationships, 27, 89-126; number of species, 27-28; confused state of taxonomy, 27; classification, 31, 28-88, 127; suborders, 29; scheme of, 30; number of species of, 27; origin and evolution, 89-126; relationships of paleocene to eocene, 89-92; eocene, 90; birthplace probably N. America, 92; importance of vision in development of, 93-96; neopallium, 95; rhinencephalon, 95; bibliography, 124; taxonomy, 22-87, 89-126; figures illustrating phylogenetic relationships, fig. 40, 70, fig. 105, 203; oligocene and miocene, 98-102; Central South America, Homunculus of Patagonia, 98; Siwalik, India, 102-103; Egyptian Fayum, 98-99; Europe, 92, 102
Primatology, defined, 10; part of the equipment of physical anthropologist, 10; Edward Tyson founder of, portrait, 7; much work remains to be done, 27

Proboscis monkey, See Nasalis
Proconsul africanus, 100-102; fig. 51, 101
Proconsul major, 100-101; Proconsul nyanzae, 101
Prognathism, Cebidae, 25; Cercopithecidae, 63; extreme in baboons, 64; chimpanzee, 79; gorilla, 82; man, 85; reduction, 138; and size of teeth, 138; Pithecanthropus, 138; in Paranthropus, 114; Homo rhodesiensis, 149; Grimaldi, 173; Předmost, Combe Capelle, 174; Negroid, 302; Forest Negro, 304; Nilotic Negroes, 304; Half-Hamites, 306; Bantu-Speaking-Negroes, 307; Bushman-Hottentot, 308; Pygmies, 312; Negrillo, 312; Andamanese, 312; Semang, 314; Oceanic Negroids, 316; Veddahs, 323; Pre-Dravidians, 325; Indo-Dravidians, 339; Mediterranean, 327; Alpine, 331; Lapps, 338; Mongoloid, 340; Australian, 320; American Indian, 344
Prohylobates, 99
Ptilocercinae, subfamily of tree-shrews, 24, 25
Ptilocercus, genus of tree-shrews, 25
Public health, and life expectancy, 430-432
Puerto Rico, changes in head form in descendants of Spaniards, 420
Punin skull, 224-225
Pyknic, constitutional type, 392
Pygmies, described, 311-316; African or Negrillos, 312, classified, fig. 133, 330, 349; Asiatic or Negritos, 312-314, classified, 349; Oceanic or Negritos, 315-316, classified, 349, fig. 133, 330; New Guinea, 315-316; Andaman, 312, Semang, 312, Aeta, 314
Pygmoids, 311-316; and Bushman-Hottentot, 307; distribution, 311-312

R

Race, defined, 13, 292, 293-294, 301; "higher and lower," "primitive," 165; living, members of single species, 166; Levin, G., "Racial and inferiority characters in the human brain," 229; the term, political misuse, 232; geographic, 28, 72, 76, 128, 129, 284, 291, 292, 293, 311; environment, heredity, nationality, 233; T. H. Huxley on term, "On methods and results of Ethnology," 234; individual definitions, 234-235; no
Race—*continued*
clear-cut differences between, 235-236; Darwin on, 236; arbitrary classification, 234-236, 299; differentiation of, 271-291, 374, and isolates, 272; genetical theory of, 232-298, 301; "Favoured," 276; all-or-none conception, 295; an abstraction, 299; typical definition, 300; a dynamic process, 300; genetic definition, 301, 293-294; no "pure," 317; and groups, 348; likenesses and differences, 348; synoptic classification, 348-350; the racist view, 352; crossing, 355; "blood" 356; attainments and opportunities, 356; and color of "soul"! 358; mental characters, 366-380; range of inherited capacities in, 367; culture, 359-381; explanation of mental and cultural differences, 378
Radiocarbon dating, described, 228
Ranson, S. W., quoted, on experience and the development of the nervous system, 364, *The Anatomy of the Nervous System*, 364
Reckless, W., quoted, on crime in twins, 388-389
Refuge areas, 265, 316, 320
Retina, marmosets, 45; more highly developed in Cercocebus than man, 58; development of, 94; prosimii, 94
Rh blood types, described, 254-265
Rhinarium, in tree-shrews, 24; lemurs, 33; absent in Tarsius, 41
Rhinencephalon, "smell brain," involution of, 95, fig. 50, 97
Rhinopithecus, Snub-nosed langurs (Subfamily semnopithecinae), classified and described, 63, 66
Roberts, Jr., F. H., "Developments in the problem of the North American Paleo-Indian," 230
Rods, of retina, in tarsius, 41; prosimii, 94
Romer, A. S., *Man and the Vertebrates*, 125
Rosanoff, A. J., et al., on crime in twins, 387
Ruch, T. C., *Bibliographia Primatologica*, 125

S

Sagittal crest, in male orang, 76; absent in chimpanzee, 79; present in male

Sagittal crest—*continued*
gorilla, 82; in Paranthropus crassidens, 115
Saimiri, Squirrel monkeys (Family Cebidae), fig. 26, 53; classified, 47
Sakai or Senois, of Malay Peninsula, 325
Saki monkeys, See Pithecia, fig. 24, 51
Samoyedes, 338, 343; classified, 350
Sanders, B. S., *Environment and Growth,* 434, 439
Sandia Cave, 223, 224, 225
Scheinfeld, A., *Women and Men,* 439; *The New You and Heredity,* 297
Schenck, E. T., and J. H. McMasters, *Procedures in Taxonomy,* 87
Schultz, A. H., "Characters Common to Higher Primates and Characters Specific for Man," 87
Schwesinger, G., *Heredity and Environment,* 439
Secreting factor, 265-266
Segregation, or principle of gametic purity, 237
Seibert, on constitution and infant mortality, 404
Seligman, C. G., *The Races of Africa,* 351
Sellards, E. H., "Early man in America: Index to localities, and selected bibliography," 230
Seltzer, C., on constitution, 405
Semang, Asiatic Negritos, 313; classified, 349
Semnopithecinae, Subfamily of Old World Monkeys, fig. 40, 70; classified and described, 63, 65-67
Semnopithecus, Langurs (Subfamily Semnopithecinae), fig. 40, 70; classified, short faced, slender tailed, 66
Sexual differences, gibbon, 73; orang, 74; chimpanzee, 77; gorilla, 84; cranial impressions of muscles, 184; in Mongolian fold, 344; and constitution, 407-409; susceptibility to disease, 407-409; in life-expectancy, 407, 430-432; sex-linked and sex-limited genetic effects, 407-414; in mortality rates, 407; social consequences of, 415-417
Sexual selection, factor in evolution of man, 285-286; and mutation, 279; as factor in differentiation of ethnic groups, 285; defined, 285-286; doubtful importance, 286; requires investigation, 290; in evolution of Nordic type, 329
Sexual skin, in Tarsius, 42; marmosets, 46; Cebidae, 53; present in most Cercopithecidae, 59; gibbon, 74; orang, 74; chimpanzee, 76; gorilla, 84
Shapiro, H. L., on Polynesian-White crosses, 355; on descendants of Japanese in Hawaii, 240, 420-422; *Migration and Environment,* 420-422
Sheldon, W. H., viii; constitutional types, 394-402; and Kretschmer's types compared, 392; somatotypes, 394-397; *The Varieties of Human Physique; The Varieties of Human Temperament,* 439
Short-tailed monkey, See Cacajao
Shoulder width, and environment, 420; hip index, 421; measurement of breadth, bi-acromial breadth, 446
Shrews, described, 23-25; fig. 12, 23, fig. 49, 93; brain in, fig. 50, 97
Sickling, of red blood corpuscles, 266-269
Sifakas, lemurs (Propithecus), 37
Simian shelf, not present in any of early apes, 199; in Piltdown man, 178; late specialization, 178-179
Simpson, G. G., on tree-shrews, 26; 87, 89
Sinanthropus, chronological-cultural level, fig. 61, 123; described, 142-145; fig. 66, 143; brain size, 142; relation to Pithecanthropus, Africanthropus, Homo heidelbergensis, 145; craniogram, 80, 164; phylogenetic relationships, fig. 105, 203; Weidenreich, F., "The skull of Sinanthropus pekinensis: a comparative study on a primitive hominid skull," 230
Sinuses, Pithecanthropus, Sinanthropus, 142
Sitting Height, and environment, 420; measurement of, 449; indices, 455, 456
Sivapithecus, Miocene fossil genus of ape, relationships, 102-103; phylogenetic relationships, fig. 105, 203
Siwalik, deposits in India, 98
Size, of lemurs, 30; eyes and waking activity, 30, 37; and social habits, 37; tarsiers, 39; marmosets, 43; of Cebidae, 47; gibbons, 72; orang, 74; chimpanzee, 76; gorilla, 81; Parapithecus, 99
Skhül (Mount Carmel, Palestine, Neanderthaloid group), 161-164, fig. 79, 163

Skin, color, 4; sexual, in Tarsius, 42; sexual in marmosets, 46; color in orang, 74; chimpanzee, 77; gorilla, 81; 278-279; and mutation, 278-279; Primates, 279; possible example of adaptive character, 274; and sexual selection, 286; color and sweat glands, 302; True Negroes, 304; New World Negroes, 304; Nilotic Negroes, 304; Half-Hamites, 306; Bantu-Speaking Negroes, 306-307; Bushman-Hottentot, 309; Pygmies, 311; Negrillo, 312; Negritos, 312-316; Andamanese, 312, fig. 124, 313; Semang, 312; Aeta, 314; New Guinea Pygmies, 315; Oceanic Negroids, 316; Papuans, 316-317; Melanesians, 317; Australian aborigines, 320; Veddahs, 323; Pre-Dravidians, 324; Ainu, 325; Caucasoid, 326; Mediterranean, 327; Nordic, 328, 329; Alpine, 329-331, 331-334; Armenoid, 331-334; East Baltic, 335; Indo-Dravidians, 339; Polynesians, 340; Mongoloid, 340-343; American Indian, 344; Indonesian-Malay, 345; Sakai, 325; Caucasoid, 326; Mediterranean, 327; Basic Mediterranean, 328; Atlanto Mediterranean, 328; Irano-Afghan Mediterranean, 328; Nordic, 328; Alpine, 331; Dinaric, 334; East Baltic, 335; Lapps, 338; Indo-Dravidian, 339; Mongoloid, 340; American Indian, 344; genes and, 353; and environment, 274-275; a superficial character, 379; anthroposcopy, method of determining, 458; in Negro-white crosses, 515

Skull, defined, 476-477; in tree-shrews, 24; in lemurs, 33-36; Tarsius, 42; human-like in marmosets, 45; Cebidae, 50; peculiar form in orang, 76; low vault in chimpanzee, 79; gorilla, 81-82; thickness of bones in early forms of man, 135; Pithecanthropus, 135-140; Homo modjokertensis, 138-140; Homo soloensis, 140-142; Sinanthropus, 142-145; Wadjak man, 145-149; Australian aboriginal, 146; resemblance between Wadjak and Australian, 146; Keilor, resemblances, 146; Rhodesian, 149; Heidelberg, 151; Africanthropus njarasensis, 152; Steinheim skull, 158; Krapina, 160; Ehringsdorf, 160; neanthropic and Neanderthaloid, 161; Tabūn, 162; Skhül, 163; Châtelperron, 166; Cro-Magnon, 169; Grimaldi, 170; Předmost, 175; Combe Capelle, 175; Piltdown, 176; London skull, 184; Gibraltar II, Spy II, Galilee, 161; Bury St. Edmunds, 187; Swanscombe, 190; Engis, Aurignac, 174; Chapelle-aux-Saints, 190; Galley Hill, 156; Punin, 224; Lagôa Santa, 226; and brain size, 228; Tepexpan, 227; genes and shape, 239; environment and shape, 418; Negroid, 302; Forest Negro, 304; Nilotic Negroes, 304; Half-Hamites, 306; Bantu-Speaking Negroes, 307; Australian aborigines, 320; and Veddah, 323; Pre-Dravidian, 325; Caucasoid, 326; Mediterranean, 327; Alpine, 331; Nordic, 329; Dinaric, 332-334; Armenoid, 332, 334; East Baltic, 335; Mongoloid, 340; shape and environment, 418; landmarks, 478-480; measurement, 480-494, figs. 148, 149, 152, 153, 154; estimating age of, 486-490; sutures, 487-490; Frankfurt Horizontal, 266; Why measure? 476-477; recording blanks, 492-493

Slender loris, lemur of the genus Loris, 37

Slow loris, lemur of genus Nycticebus, 37

Smell, in early lemuroids, 93; increase in importance of vision related to reduction in sense of, 93-95, See fig. 50, 97

Snodgrass, R. M., x

Snub-nose langurs, See Rhinopithecus

Snyder, L. H., linkage between M-N types and sicklemia, 259

Social groups, size of, lemurs, 37; tarsiers, 42; marmosets, 46; Cebidae, 53; gibbons, 74; Cercopithecidae, 58; orang, 76; chimpanzee, 79; gorilla, 83

Social habits, of lemurs, 37; and size, 30, 37; marmosets, 46; Cebidae, 53; Cercopithecidae, 58; gibbons, 74; orang, 76; chimpanzee, 79; gorilla, 83; man, 86

Socialization, of human beings, 359-368; and mind, 364; of potentialities, 365 sq; of biological urges, 365 sq

Social selection, factor in evolution of man, 287; and mutation, 279; as a factor in differentiation of ethnic

Social selection—*continued*
  groups, 287; defined, 287; in evolution of Nordic type, 177
Society, defined, 5 f
Socio-Economic factors, 430-438; and ethnic differences in intelligence, 368; individual in part an expression of, 384-385; and physical factors, 417-418; and environmental effects, 418, 430-438; psycho-physical history of individual, 430-432; public health, 430; and growth, 434-437; height and weight, Table 32, 435, Table 33, 436
Solo man, and Neanderthal, 184, 217
Solutrean, period, chronology, fig. 61, 123; post-glacial late pleistocene, and commencing migration of man into America, 227
Somatotypes, Sheldon's, 394-402; position for photographing, 461-462
Sonntag, C. F., *The Morphology and Evolution of the Apes and Man,* 87; Somatometry, 441, 444-457
"Soul," alleged "racial" differences in color, 358; and genes, 361
South America, primates of, 43-60, 98
Spaniards, 327; head form, and in their Puerto Rican descendants, 420
Spanner, head, 444
Species, described and defined, 28, 129-130; defined, 291; number in Order of Primates, 27; Lemuriformes, 30; names, 27; Tarsiformes, 39; Platyrrhini, 43; Cebidae, 43, 47; Callithricidae, 43; Catarrhini, 58; Cercopithecidae, 58; Semnopithecinae, 63; Anthropomorpha, 69-70; Hylobatidae, 72; Pongidae, 69; Hominidae, 70; living varieties of man belong to single, 290-291; genera and "races," 300
Spectral Tarsier, See Tarsius spectrum
Speech, 86; in Pithecanthropus, 137; and race, 233; and culture, 233
Spider monkey, Ateles (Platyrrhine genus), See Ateles
Spier, L., on growth of Japanese, 422
Spiritual qualities, 358-364
Sportive lemurs (Lepilemur), 36
Springbok Flats skeleton, 211
Spuhler, J. N., viii, on number of genes in man, 237, 298
Spy II (Neanderthaloid), 161
Squirrel monkey, See Saimiri
Statistics, 507
Stature, See Height
Steatopygia, 308, 309, 310
Steel age, fig. 61, 123
Steggerda, M., x; and C. B. Davenport, on Negro-white crosses, 355; weight scale, 442; compass and calipers, 443
Steinheim Man, described, 158, fig. 76, 160, fig. 77, 161
Stereoscopic vision, in lemurs probably absent, 39; probably absent in Tarsius, 41; present in marmosets, 45; present in Cebidae, 51
Stern, B. J., *Society and Medical Progress,* 439
Stomach, sacculated, in Semnopithecinae, 58
Straus, Jr., W. L., on tree-shrews, 26; on man's ancestry, 125
Struggle for existence, 276-277
Stumpfl, F., on crime in twins, 387
Sub-Families, number of Primate, fig. 13, 31; terminate in "inae," 25
Sub-Orders, number of Primate, 29; terminate in "oidea," 25
Sullivan, L. R., *Essentials of Anthropometry: A Handbook for Explorers and Museum Collectors,* 507
Supraorbital, ridges, not confluent in orang, 75-76; arches well developed in chimpanzee, 79; gorilla, 82; Pithecanthropus, 135; Homo modjokertensis, 140; Sinanthropus, 142; Africanthropus njarasensis, 153; Neanderthal man, 156; Steinheim skull, 160; Krapina, 158; Ehringsdorf, 160; Předmost, 175; in Australian-Caucasoid crosses, 322; Galley Hill, 192; Melanesians, 317; Australian aboriginal, 320; Veddahs, 323; Pre-Dravidians, 325; Alpine, 331; Dinaric, 333; East Baltic, 335; Lapps, 336; Indo-Dravidians, 339; classified, 460
Sutures, closure of, 487-490, fig. 154; Mongoloid skull, 341
Swanscombe Man, chronological-cultural level, fig. 61, 123; figs. 92, 94, 95, 96, 102, 103; during Neanderthal phase, 190; described, 187-190; Middle Acheulian artifacts, fig. 93, 186, 187-188; earlier find of skull at Swanscombe, 188; cranial capacity, 188; and Piltdown, 189; phylogenetic relationships, fig. 105, 203; fluorine content, 196; and Wallbrook skull, 197-200

Sylvian fissure, marmosets, 45

Symphalangus, Siamang Gibbons (Family of Ponginae), classified, 69; described, 72

T

Tabūn (Mount Carmel, Palestine, Neanderthaloid group), 161-164; fig. 78, 162 .

Tail, in tree shrews, 24; in lemurs, 33; tarsiers, 39; marmosets, 43; a "fifth hand" in *Atles,* 49; prehensile in only half the Cebidae, 49; not prehensile in Cercopithecidae, 58, 63

Talgai skull, 320

Tamarins (Family Callithricidae), classified, 43-46

Tarsiiformes, 39; classified, 39; range, description, 39-43; completely nocturnal and aboreal, 41; generalized early primates from which higher primates may have taken origin, 42; Wood Jones on, 42-43, 96; relation to Hominidae, 42; in Oligocene gave origin to platyrrhini and catarrhini, 98; fossil, 90-92; visual area of brain larger than in lemurs, 94; origin, 92; brain of, fig. 50, 97; ancestral to all later primates, 96; phylogenetic relationships, fig. 105, 203

Tarsius spectrum, spectral tarsier, fig. 18, 40, 39; classified, 39; description, 39-43; completely nocturnal and arboreal, 41; nose, 41; eyes, no fovea or macula, though to be incapable of stereoscopic vision, 41; rods of retina, 41; no cone cells, 41; limerick on, 41; brain, palate bone, temporal fossa, orbits, postorbital wall, dental formula, tympanic annulus external, 42; auditory bulla vertebrae, 42; relation to other Primates, 42; oestrus cycle, sexual skin, but no menstruation, single offspring at birth, nursing, social, habits, diet, limited range facial expression, 42; largest eyes in proportion to head among primates, 41; brain of, fig. 50, 97

Tasmanians, 321, 322

Taste reaction, to P.T.C. (phenylthiocarbamide), 269-271, same proportion of tasters in chimpanzees as in man, 269-270

Taungs, See Australopithecus

Taurodont, molar teeth, 204-206

Tayacian industry, chronology, fig. 61,

Tayacian industry—*continued*
123; artifacts, fig. 71, 148; and Fontéchevade skull, 200

Teeth, in orang and chimpanzee, 204; in tree-shrews, 24; in lemurs, 32-33; Tarsius, 42; marmosets, 45; Cebidae, 47; Cercopithecidae, 58; early eruption in gibbons, 72; catarrhini, 58; gorilla, 82; man, 85; diastema, in man, 85; fossil, 127-231; Gregory and Hellman's studies on, 119; in Australopithecinae, 119; diastemata in apes, 115; size and prognathism, 115; size, 61, in relation to brain, 61; Gigantopithecus blacki, 134; Pithecanthropus, 135, 137; reduction of canine in Pithecanthropus, 138; diastemata in Pithecanthropus, 137-138; in Rhodesian man, 149; badly decayed in Rhodesian man, 151; Homo heidelbergensis, 151; Africanthropus, 153; Grimaldi, 173; Piltdown, 206; taurodontism, 204-206; Australian aboriginal, 318; Caucasoid, 326; Mongoloid, shovel-shaped incisor, 340, "buck," 340; constitution, 403; description, 461; eruption of, 486-487

Temperament, gibbon, 74; Old World Monkeys, 60; orang, 76; chimpanzee, 79; gorilla, 83; heredity and environment, 384; and physique, 397

Temporal fossa, confluent with orbit in leumrs, 33-35

Temporal muscles, in gorilla, 82

Temperature, and skin color, 274

Teshik-Tash cave, in Uzbekistan, Neanderthal child found in, 155

Theropithecus, Gelada baboon (Subfamily Cercopithecinae), described, 61-65, fig. 35, 64

Thigh, measurement, 448; indices, 272; see Femur

Thomas, C. C., x

Thomas, P., x

Thorndike, E. L., quoted on the improvement of the environment, 386

Thumb (pollex), intree-shrews, 24; in lemurs, 30; tarsiers, 39; marmosets, 33; never opposable in Cebidae, 49; absent in *Ateles,* 49, *Colobus,* 66; opposable in Cercopithecidae, 58; oppossable in Anthropomorpha, 69; gorilla, 83; development of opposability, 95; prints, 462

Tibia, See Leg bones

Tibio-femoral index, and environment, 421; defined, 456

Tindale, N. B., on Australian-White crosses, "Survey of the half-caste problem in South Australia," 355

Titi monkeys, See Callicebus

Toe, big, in lemurs, 32; tarsiers, 39; marmosets, 45; opposable in Cercopithecidae, 30; opposable in anthropomorphous apes, 69; gorilla, 83; nonopposable in man, 43

Tongue, genetic observations on, 466, 467

Torus palatinus, in Grimaldi man, 173; described, 461

Torus mandibularis, 461

Tree-shrews. See Tupaiidae

True lemur (Lemur), 36

True Negroes, 303-304; described, 133; classified, fig. 330

Trunk, gorilla, 81; height and environment, 420; measurement of—waist girth, 448, index, 456

Tuberculosis, and ectomorphic habitus, 402; in monozygotic twins, 402; sexual differences in susceptibility, 408; and income, Table 31, 433

Tucker, W. B., and W. A. Lessa, "Man: a constitutional investigation," 439

Tungus, classified, 343, 350; True, See Evenki

Tupaiidae, Family of tree shrews (Order Insectivora), 23-26; *Tupaia ferruginea*, fig. 49, 93; Urogale, fig. 12, 23

Tupaioidea, Suborder admitted by some into Primates, classified, 25; described, 23-26

Turner, R., *The Greatest Cultural Traditions*, 220

Twins, methods of studying relative effects of environment and heredity, 382 sq., not all likenesses in identical genetically determined, 382-383; monozygotic or identical, 382-383; criminality in, 387-389; tuberculosis in, 402; "identical" objectionable term, 283; Newman, Freeman, and Holzinger, quoted, 383, 384; criminality in, 387-388; H. H. Newman, *Multiple Human Births;* H. H. Newman, F. N. Freeman, K. J. Holzinger, *Twins: A Study of Heredity and Environment,* 438-439

Tympanic annulus, lies within bulla in lemurs, 33; external in Tarsius, 42; external in marmosets, 45; external in

Tympanic annulus—*continued*
Cebidae, 50; elongate to form ext. auditory meatus in Old World Monkeys, 58

Tyson, Edward, portrait, fig. 1, 7; book on, 20

U

Ultra-violet ray burning, 464

United States, evolutionary processes at work before our eyes in, 272; variety of populations and social selection, 287; varieties of mankind comprising population of, fig. 136, 346; changes in bodily form of children of immigrants born in, 418 sq., Table 29, 419; children and nutrition, 436

Uzbekistan, Neanderthal find, 155

V

Vallois, H., on Fontéchevade skull, 201

Variation, defined, 353; of lemurs, 30; accumulation of, 94; of genes, 163; scattering of, 163; Neanderthaloids, 163-164; Cro-Magnon, 170; of brain size in modern man, 206; and genetic analysis, 238; continuous and discontinuous meristic, qualitative, quantitative, 239; fundamental nature of, 238; of populations, 28; isolated populations, 282, 288-289, 291; and mutation, 279; random, 283; introduction of new genes and, 289-290; biological basis of, and inheritance, 353

Veddahs, 318, 322-323; fig. 133, 330; Australian aborigines and Pre-Dravidians, Bushman, 323; classified, 350

Vertebrae, in lemurs, 36; tree-shrews, 24; Tarsius, 42; marmosets, 45; Cebidae, 50; Cercopithecidae, 59; orang, 75; chimpanzee, 77; gorilla, 81

Vision, in lemurs, 37, 39; marmosets, 45; tarsiers, 41; Cebidae, 51; Cercopithecidae, 58; and sense of smell, 92-98; importance in development of primates, 92-98

W

Wadjak Man, described, 145-149; brain size, 146; resemblance to Australian aboriginal skull, 145-149; and Keilor skull, 146, 147, 149; probable admixture with Negroid type, 149; and peopling of Australia, 149; and Solo

Wadjak Man—*continued*
man, 149; phylogenetic relationships, fig. 105, 203; and antiquity of Australian aborigines, 320
Wallbrook Skull, figs. 100, 101, 103; described, 197-200; and Swanscombe skull, 198-199
Washburn, S. L., on sexing the pelvis, 506, 523
Weather, and disease, fig. 143, 427, 427-428
Weidenreich, F., x; on Pithecanthropus, Solo, Wadjak, and Australian aboriginal, 149; on Archanthropinae and Neanthropinae, 132-133; on Africanthropus, 158; on man as single species, 130; on australopithecines, 119; on Pithecanthropus and Sinanthropus, 202; and Koenigswald, G. H. R. von, "The relationship between Pithecanthropus and Sinanthropus," 202; on Chou K'ou Tien types, 215; "Some problems dealing with ancient man," 230; "The 'Neanderthal Man' and the ancestors of 'Homo Sapiens,'" 230; "The skull of Sinanthropus pekinesis; a comparative study on a primitive hominid skull," 230; "Giant early man from Java and South China," 230; "The Keilor skull: a Wadjak type from Southeast Australia," 230; on Heidelberg jaw, 151; on origin of Mongoloids, 342
Weight, 6; orang, 74; chimpanzee, 77; gorilla, 81; Pithecanthropus, 137; and environment, 435; climate, 428; and socio-economic status, Table 32, 435, Table 33, 436, 434-437; scale, 444
Weinert, H., on Africanthropus njarasensis, 152-155; craniograms after, fig. 80, 164; on Piltdown man, 183; "Africanthropus, der neue Affenmenschfund in Ostafrika," 231
Wiener, A. S., viii, 231; on distribution of Rh genes, 254, 259; "The Rh factor and racial origins," 298; *Blood Groups and Transfusion,"* 298
Welsh, 250
Wilder, H. H., *The Pedigree of the Human Race,* 126; *A Laboratory Manual of Anthropometry,* 507
Wood Jones, F., on tree-shrews, 26; *Man's Place Among the Mammals,* 125; on Tarsius, 42; on premaxilla, 120
Woodworth, R. S., quoted, 386; *Heredity and Environment,* 439
Woolly avahi, lemur (Lichanotus), 37
Woolly monkey, See Lagothrix, fig. 30, 57
Woolly spider monkey, See Brachyteles
Wormington, H. M., viii, 225
Wright, Sewall, effect, See Genetic Drift; on evolution, 290

X

Xenopithecus, from Lower Miocene of Kenya, 100

Y

Yerkes, R. M., and A. W., *The Great Apes,* 88

Z

Zirkle, C., x
Zitzikama Skull, 211
Zuckerman, S., *The Social Life of Monkeys and Apes,* 88; *Functional Affinities of Man, Monkeys, and Apes,* 88
Zygomatic bone, markedly developed in marmosets, 45; articulates with parietal bone in Cebidae, 50; never articulates with parietal in Cercopithecidae, 58; gibbons, 72-73; landmarks, figs. 148A and 148B, 452

This Book

An Introduction to

Physical Anthropology

By M. F. ASHLEY MONTAGU

was set, printed, and bound by The Collegiate Press of Menasha, Wisconsin. The engravings were made by The Northwestern Engraving Company, Menasha, Wisconsin. The page size is 6 x 9 inches. The type page is 26 x 43 picas. The type face is Linotype Baskerville set 11 point on 13 point. The text paper is 70-lb. White Deepfalls Enamel. The cover is Bancroft Bookcloth Linen Finish No. 25.

With THOMAS BOOKS *careful attention is given to all details of manufacturing and design. It is the Publisher's desire to present books that are satisfactory as to their physical qualities and artistic possibilities and appropriate for their particular use.* THOMAS BOOKS *will be true to those laws of quality that assure a good name and good will.*