

## PRELIMINARIES

## I

Some day it may be possible to deal with the actual state of anthropometry in general, and with the many individual modifications of and tendencies in the same which are outside of international agreements; but what the American student of the branch needs most are simple, practical, well tested instructions for his guidance in work which is rapidly increasing. An active interest in the various lines of research which fall within the scope of physical anthropology is rising everywhere, as witnessed by the increasingly frequent calls at our laboratories from different parts of the country for instruments help and directions, by the number and calibre of our visitors, and in the unprecedented demand for trained anthropologists.

These conditions were brought about partly by the war, which offered suddenly such great opportunities for applied as well as research anthropometry; partly by the intensification of the problems of immigration, Americanization, and conservation of child life, which are receiving a steadily increased attention; and partly by a gradually augmenting institutional demand for instruction and work in anthropology. These rapidly developing demands found anthropology unprepared to give much material help. There were few available trained men and others could not be produced in a short time. There was no adequate supply of instruments, with curtailed or lost facilities for having these made. And there was nothing in English in the way of publications that would give the indispensable information as to methods, technique and other essential aspects of anthropometric procedure on modern lines.

The results of this state of affairs, aggravated by various complications, were that anthropometric research in connection with the U. S. Army has been a failure; that even the most important places in anthropology could not be filled; and that in the absence of something better a large amount of present anthropometric work on children and older subjects is carried on with the instruments and the methods of the gymnasias and physical culture establishments rather than those of classical anthropometry, with the consequence that practically all

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this work is lost to science and even tends to create prejudice against anthropometry in general.

Evidently enough it is imperative for those who have the interests of physical anthropology in this country at heart to mend conditions as rapidly as may be possible, and one of the first and most urgently desirable steps is to furnish legitimate, readily utilizable instructions in scientific anthropometry. It was with this end in view that the AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY published the International Agreements on Anthropometry, the most binding of all of our instructions. But these alone are not sufficient. They are in certain respects incomplete and somewhat too curt. Moreover, they do not deal with descriptive characteristics and, while forming a necessary nucleus, are not all that the student wants and needs. Some good instructions in English for taking measurements and observations are to be found in the "Notes and Queries on Anthropology" of the British Association for the Advancement of Science, but the subject there is not dealt with as much in detail as desirable. The American student in anthropology, and in growing measure also the American medical investigator, asks for a readily available, as simple as possible and yet sufficiently comprehensive, strictly modern, and thoroughly correct treatise on anthropometry.

The question is how and how far these demands may be met under the present circumstances. Were American anthropologists more numerous, the best way would doubtless be for them to undertake the important task jointly and impersonally. As conditions are, however, it appears that the first steps must be individual; and in taking the same the author does so only because his extensive field as well as laboratory experience in this line gives hope that something serviceable may be accomplished. His work has been based throughout on the methods of the École d'Anthropologie in Paris and on the so far effected international agreements, with only such additions or modifications as experience on different races, classes, and ages of people and on their skeletal remains has shown to be necessary or advisable.

The procedures, instruments, etc., to be here described, are those in regular use at the Division of Physical Anthropology, U. S. National Museum and in field work for the same. They are also, in the main, in use at Harvard and elsewhere, and form the basis of instruction given to the students who apply for that purpose at the National Museum.

## II

Two of the main lessons taught by experience in anthropometry are, the need of precision, and the value of simplicity. Precision is a matter of proper well tested instruments, of good instruction, and of that something in the nature of the investigator, whether inherent or built up, which strives for accuracy and abhors looseness. Simplicity is the open road to advance. The road that is clogged by a multitude of unnecessary measurements and digressions leads generally to stagnation.

It is self-evident that in a branch of research where so much depends on accurate measurements, the objects of first importance are the instruments. The instruments should be accurate and not easily disordered; they should be in the highest degree well-balanced and "handy" or easy of manipulation, as well as of reading; they should be free from qualities that in the long run might in any way bias the determinations; and they should be easily transportable for field work. Finally their cost should not be prohibitive.

Before the war we had such instruments. The best were those made on the original patterns of Broca, the father of anthropometry, or, with useful modifications, by Collin and Mathieu in Paris; but nice sets were also made in Switzerland. During and since the war the supply of French instruments has ceased, with the resumption uncertain, while the Swiss instruments have advanced considerably in price and are not readily obtainable. Also they retain the disadvantage of a small "compas d'épaisseur," one that does not permit the measurement of the height of the head which has become of much importance. The American instrument makers could not as yet be prevailed upon to undertake the manufacture of anthropometric instruments at reasonable price. We are therefore confronted with difficulties that cannot be readily surmounted. As a result anthropometric work has already been considerably interfered with in this country and on numerous occasions the instruments used are the less adapted and less accurate ones used for gymnastic or other purposes.

With proper instruments, the next absolute necessity in scientific anthropometry is proper instruction. This point was strongly insisted upon during the conference of the International Committee on Unification of Anthropometric Procedures at Geneva (1912), and becomes more pressing as time goes on. A person who is a medical graduate, or is used to the manipulation of other instruments of precision, is not yet thereby fitted to practice anthropometry. He could con-

ceivably develop, by much reading and long practice, an efficient system of his own, but only with much loss of time and many errors. The work of self-instructed and insufficiently instructed observers has filled the earlier anthropological literature with reports in which no one is able to place full confidence, and such work has served to retard rather than favor progress, as well as to create much undeserved prejudice as to the value of anthropometry.

Today a would-be anthropologist who is not known to have received competent instruction in the generally approved methods of the science, finds it hard to publish his results in professional periodicals and hard to have it accepted by first class institutions; his efforts, in fact, are often lost and he ends by becoming discouraged.

Anthropometry deals with such a variety of conditions, and often with so small differences of proportions, that of necessity it must be reduced to a rigid system, which, while not beyond attainment from mere reading and practice, is much more readily and satisfactorily imparted to the student at a well-recognized anthropometric laboratory. Such laboratories are now available in this country as well as in France and England, besides other countries.

With proper instruments and proper instruction, and unyielding sense of honesty, the worker in anthropometry must develop a habit of minute care and accuracy, until these become automatic. Some students appear to be incapable of acquiring these habits in sufficiently effective form, and such students should give up anthropometry. In a few the needed qualities are inborn and need only a direction; but in most they must be developed. It is fortunate that the most careful and accurate work brings the most pleasure, and is the best sustainer. The student who gets tired of measuring the human form or even the skeleton, is the one who has not been careful and accurate to the limit of his possibilities.

Accuracy and endless care do not, of course, mean absolute perfection—only its highest attainable degree. Our instruments will never be so accurate or senses so precise, and our subjects or specimens will never offer such forms, that an absolute precision may be obtained. Time and again the student on repeating a most carefully made measurement, will find a slight difference, an experience which at first may be discouraging. But with the careful and well trained observer such differences remain immaterial and never develop into unconscious bias in any direction, as they are very likely to do with the less well trained or less strict worker.

The first law of anthropometry being *precision*, the second is that of *simplicity*.

The goal of rational anthropometry is the greatest possible simplicity of procedure in measurements, in the treatment of data, in publication. A profusion of measurements marks the beginner, the amateur, the absorbed impractical teacher. The experienced, clear-sighted observer will be seen to take only such measurements and observations as will most help him to describe a given people, or bring out the salient points on a collection of specimens. He has two golden rules in this connection which he follows—first, to attempt no measurements on the living which can be more easily and accurately secured on the skeleton; and second, to include no more measurements on any occasion than can be secured on the largest obtainable number of subjects or specimens.

It is self-evident that there can be little use of spending valuable time in trying to take measurements on the living for which the landmarks are uncertain or which call for resented exposures, so long as we may obtain skeletal remains of the people in question on which the problems involved may be studied with greater facility; and it would be a poor anthropological procedure which would give preference of the number of measurements to the number of subjects to be examined. The number of measurements and observations may safely be said to be as a rule subordinate to the number of subjects studied, and to interests of prompt elaboration and publication of the data.

The treatment and analysis of the secured data are naturally procedures of the greatest importance, for on them will depend, next to the accuracy of the data, the value of the report to be published.

Due to the nature of anthropological measurements and observations, their treatment must be in part mathematical and in part biological, but both of these methods are capable of unnecessary complexities. Given a completed series of trustworthy data, the objects of the student naturally will be, first, to extract out of these data their full anthropological value; and second, to present these results in the most scientific and at the same time assimilable form to the forum of his fellow anthropologists. All this calls again essentially for solidity and simplicity. The publications should be free from "unfinished business" and perplexing formulæ. They must not be an extension of the laboratory blackboard or scrap-paper. The calculations and analyses, whatever their nature may be, are parts of the preparation of the material, and except in explanatory notes

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ought not to constitute a part of the final report. No calculation in anthropometry is so abstruse that it could not be presented in the final report in plain terms, freely and unequivocally intelligible to all workers in the branch, and to other intelligent readers. Whenever a doubt arises in the mind of a conscientious worker as to what method of analysis or special presentation would be preferable—and there will be not a few of such cases—his best guides will be the relative usefulness of the procedure, and the simplicity of presentation.

Most of these points will be dealt with further on special occasions.

### III

The best and in fact the only sufficient *preparation* for scientific anthropometry, are the studies which lead to the degree of doctor of medicine. In fault of such complete courses there should be at least equivalent courses in anatomy, physiology and pathology. Being the comparative science of man, physical anthropology and its handmaid anthropometry deal with the whole range of human variation, which, while essentially structural and functional, is at every step modified or modifiable by pathological conditions. The student with a simple A.B. or Ph.D. without the special courses here mentioned, has a great and often insurmountable disadvantage for a career in physical anthropology even though he was able to receive legitimate instruction in the latter and training in anthropometry. He will remain a bird with a paralyzed wing.

Besides a suitable scientific foundation the worker-to-be in anthropometry should possess a good reading knowledge, in addition to English, of the French and German languages, at least, for the bulk of anthropological literature is still in those languages and there are very few translations. He should further possess good training in drawing as well as in photography. Moreover, if he is to make anthropology and anthropometry his life vocation he must also possess certain physical qualifications. He must have good, enduring eyesight; and large capacity for work both in the field and in the laboratory. Last but not least, he should possess those mental qualities which will enable him to follow his work with undimmed enthusiasm and vigor under smaller material compensation and perhaps other advantages than those of his friends who have remained in medical practice or chosen other vocations; for anthropology is not an industrial necessity. The compensations for this lie in the high grade of his work. He deals intimately with the highest of organisms, he

contributes to the knowledge of what is most worth while. His studies of human evolution and antiquity, of the developing child and youth, of the infinite variation of full-blown manhood and womanhood, of the laws that control all this, and of the means by which these laws may consciously and effectively be directed for future advance of humanity—all these will provide him with mental food of such an order that he will easily forget the regrets of not having chosen a more remunerative vocation.

#### IV

Granted a well qualified student presents himself at our Laboratory for a thorough instruction in anthropometry, what will be the procedure? The preliminaries may be outlined as follows:

1. *Acquaintance with Instruments.*—Anthropometry commands a number of special instruments, which in exactly the same form are used in no other branch of science. These instruments are graduated in the metric system, which must be well understood by the scholar. They are all graduated in centimeters and millimeters, and this indicates the most natural and safest way of recording the data. Their marking, however, presents certain differences and peculiarities which must be thoroughly mastered, or they will lead to errors. Therefore the first lesson and practice will relate to a thorough acquaintance with the most common instruments; while the next will be devoted to their handling.

2. The *handling of instruments* is a matter of considerable concern. They may be handled uncouthly, and in such a way that they will tire the hand and eyes, even if not conducing to errors; and they may be handled so that they completely cease to be sensed as something foreign in the hand or to the eye, and offer not the slightest impediment to work however prolonged. Even in anthropometric laboratories and text-books, however, the methods practiced or advocated are not the same throughout, wherefore the student will need a careful guidance. An interesting fact in this connection is that all hands, short or long, stout or slender, are not equally adapted to any method and will generally result in more or less individual modification in the direction of least resistance. Also a long practice with a method that in itself is not the very best may lead to fair efficiency, which with personal reasons explains why more than one method are being perpetuated.

*Attention to Instruments.*—Anthropometric instruments demand a

certain amount of careful attention, especially on expeditions. They should be well nicked, to prevent rusting. They must work smoothly but not loosely. The joints and slide boxes should be kept slightly oiled, but so as not to soil the fingers of the operator. All the instruments should be periodically tested on standards, which gives the worker due confidence. If a thermometer is used it should be an instrument with plainly legible scale and one which will without fail give the maximum record within five minutes. Rapid thermometers are not especially advantageous, they break more readily, being made of thinner glass. To keep the thermometer clean a small bottle of peroxide or other antiseptic is provided, in which the instrument is kept between use. A towel or two should be kept on hand to clean the instruments as desirable in the course of the procedure. Finally, due attention must be given the instruments in connection with storage in the laboratory between examinations, and in connection with transportation. They should have a suitable glass-door case in the laboratory, and a specially made portable box or case for outside and field work.

3. A *study of landmarks* should logically be the next step. Measurements, to be strictly comparable, must be taken in a strictly defined way and from or between the same anatomical points. These points, whether on the living or on the skeletal parts are known as the anthropometric landmarks, with which the student must become thoroughly acquainted. To facilitate this he should begin with the most needed points on a good series of dry skulls of both sexes and widely differing ages where he may learn their exact location, significance and variation. An additional skull of a young and one of adult anthropoid ape, particularly the chimpanzee, are very useful in this connection.

From dry material but with this still at hand, the student will pass to the determination of the needed landmarks on living male adults, then on females and finally on children. He should invariably now and even later mark some of the points with an aniline pencil, which will facilitate his measurements.

4. In the actual *practice of measuring*, it is necessary to impress the student with the necessity of concentration of his attention on the subject or specimen within his hands and on the scale of his instrument; the holding and handling of the instrument will rapidly become automatic. With subject in convenient position, the landmarks determined, and the instruments properly used, everything depends on the accuracy of reading of the scale. More and larger errors probably are



committed in reading the scale in a poor light, by defective eyes, on instruments the scale markings of which have become dulled, and by carelessness, than through all other agencies. One of the best rules at this period is to make a double reading of each determination, and after having finished and made records, to repeat all the measurements. Nothing at this stage teaches as effectively as errors self-detected.

## V

*Principles of Recording. Blanks.*—Every definite piece of anthropometric research calls for a well reasoned out and organized scheme. The student should be fully conscious of what he wants to ascertain. The objects of any given piece of work are such and such, and to attain them it will be most useful, or indispensable, to take such and such measurements and observations. For the records of these measurements and observations are arranged blanks on which they are placed in the order of their importance, relation and best practical sequence. Each blank is made so that it will serve, say, for twenty-five cases (two giving us 50, four 100), and is then printed or otherwise multiplied in sufficient numbers for the study at hand. A good blank facilitates greatly the whole procedure of measuring and observation, as well as the subsequent reduction of the data.

The size of the blanks is of considerable importance. The individual blanks for work on adults should not be larger than standard letter size paper (roughly 21.5 x 27 cm. or 8½ x 10½ in.). For all extensive work they should be printed. For a regular piece of anthropometric research more than one form will be required, and the separate forms should be marked with consecutive numbers or letters. Each blank bears an appropriate heading; is subdivided by seven horizontal lines so as to afford space for the legends, for the measurements of 25 subjects, and a space below where the summaries of the measurements or observations may be recorded. Each blank bears also a series of vertical lines for the records of the individual measurements or observations. The width of the resulting columns is regulated by the needs in each case, and should be ample enough to permit the making of plainly legible records without crowding. In the case of visual observations the records are of necessity and with advantage made by abbreviations. The left margin of each blank bears two perforations for binding. For a definite piece of work from four to six blanks of each number, sufficient for 100 to 150 individuals, are bound or clasped in loose-leaf covers, and each set is separated by a blotter.

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This gives a very convenient "record-book," which is easily handled during the examination, whether this is carried on in field or laboratory, which is very convenient during the work on the data, and which can not be readily lost or mislaid. Illustrations of blanks will be given later.

Subjects of only one group, one sex and one stage of life are recorded on one blank, to save copying. The measurements are recorded in centimeters and their decimals, as they are marked on the instruments. To make the record in millimeters or meters, according to the essentially German method, has the disadvantages of a greater liability to error, and of a much greater difficulty of grasping and remembering the values of the measurements. The examiner records the figures himself to further guard against error; and until his mind is so trained that it can safely retain two successive determinations, he records each measurement by itself. A constant care is exercised to make each figure so that it will not be possible to mistake it for anything else; this applies particularly to 0 and 6, 4 and 9, 1 and 7, which if written hastily may readily resemble and be mistaken for each other. The recording is done invariably in pen and with permanent ink that will not fade out in the course of years, for some of the records secured may be of value long afterwards.

Although there would be no objection to a contrary practice, it is customary and doubtless more convenient as well as time saving, to proceed in the examination and hence on the blanks first with the measurements and then with the visual observations.

In choosing a *place for examination*, it is imperative to select the best lighted spot, and at the same time one where the observer will be least subject to interruptions. Side-light is undesirable; and measuring or examining in poor light or in artificial light, except perhaps strong electric arc light, is to be avoided unless dictated by absolute necessity. No conversation with the subject or a third person should be carried on during the examination, in order that the whole attention of the observer may be concentrated on the work itself. Finally, while it is not necessary to put down on the blank each measurement separately, not more than two consecutive measurements should be carried in mind before recording them. In the examination of women it is important to retain the attitude of the methodic, abstract investigator.

If the above rules are followed, the well-trained, earnest observer will find his work reduced to a mechanical procedure of high order,

which will not tire him either mentally or physically and the precision of which will be a source of constant gratification.

## VI

*Selection of Subjects.*—In the study of any human group the value of the data—all other things being equal—will be directly proportionate to the purity of the group. With this point in view the first steps of the observer will be directed towards a proper selection. Selection by sex, age, homogeneity, pathological conditions, and occasionally also according to occupation, social status, and environmental distinctions.

As an invariable rule, each sex is to be recorded on separate blanks, and in the case of children and adolescents the same is also true of each age group.

*Subjects.*—In work among the living, and particularly in field work among primitive tribes, one of the main concerns of the student is to obtain a sufficient number of good subjects. In order to do so he generally must have some help. Conditions will differ in this respect according to the group studied. In the case of schools, institutions, and recruiting stations, matters may be easily arranged. But when groups or tribes where submission to measurements can only be voluntary, are to be studied, the investigator must secure assistance. Among our own people much can be done by the observer making known as widely as possible the objects of his work and his needs; by interesting helpful friends in the work; and by engaging one or more active individuals who will assist him for a compensation. Among primitive tribes the best policy is, in the first place, to bring influential introductions; in the second place, to acquaint the chiefs and elders honestly and plainly with the objects of the work as far as they may comprehend; and by engaging, for a compensation, the best available men and women of the tribe to bring subjects. The compensation is best arranged at so much per subject, and as a rule it is also advisable to make a regular small payment to each subject. In explaining the objects of anthropometric work to primitive men and women it is best to dwell on the medical side of the examination, *i.e.*, the desire to ascertain the state of health and strength in the tribe with the diseases and causes of death, matters which they readily understand and appreciate. It is hardly necessary to add that the success of the student in anthropometry, with civilized as well as with primitive peoples, will depend in the main on his address and general

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behaviour. The honest, friendly and able worker, with earnest, dignified procedure, will have little difficulty in succeeding among any class of people.

*Grouping by Age.*—This will be guided by precedence and what may be called the scientific sense. It may differ somewhat according to the number of available subjects. In series of ample size, the segregation up to 6 weeks of age should be by weeks, from that on up to 1 year, by months. From 1 and up to  $3\frac{1}{2}$  years, by half a year; and thereafter by the year. The months and years are counted in such a way that "6 months," for instance, will embrace everything from 5 months and 16 days to 6 months and 15 days, while "6 years" will include all subjects from  $5\frac{1}{2}$  to  $6\frac{1}{2}$  years.<sup>1</sup> The grouping of small series of subjects is difficult, but the standard scheme should be followed as far as practicable. In especially important small series it is advisable to give the exact ages. The adopted system of grouping must, of course, always be clearly outlined in the report on the observations.

It is safe to include young men from 20 and young women from 18 years onward among adults, provided these subjects are not represented disproportionately in the series examined. It would not be proper, however, to take a class of such sub-adults, especially males, as fully equivalent to the full-grown of the same racial or social group, particularly in stature, chest, and few other measurements.

In a similar way individuals from 60 to 70 years of age should not be included in a general series if represented by a larger relative number than that by which they are represented in the general population. If more are available, they should be placed in a series of their own; and this precaution should be invariably followed with those above 70. The reason for separating the old is that various features and proportions have altered and continue to alter to the end of their life. These comprise the nose, ears, jaws, chest, stature and other parts. The only dimensions that are not appreciably altered in senility are those of the head, with the length of the limbs, hands and feet, and pelvic dimensions.

*Estimation of Age.*—So long as the student deals with Whites only, there will be little difficulty about ascertaining the ages of his subjects; but among more primitive peoples records of age are seldom kept and the observer will have to take a recourse to estimates. The value of

<sup>1</sup> This method is preferable to that which would include under the "6 years" all subjects between 6 and 7. The mean of such a group would be  $6\frac{1}{2}$  years.

such estimates will be directly proportionate to the care with which they are made and the experience of the one making them in that direction. They are least reliable in childhood, and again in old age. In arriving at his conclusion the observer is guided by the general development and appearance of the subject; by the eruption of certain teeth, particularly the permanent molars; by marks of puberty and climacterium; and by signs of aging such as grayness, wrinkling, bending of the spine, loss and wear of the teeth, absorption of the jaws, changes in sight and hearing, arcus senilis, clubbing of the fingers, etc. But it must be borne in mind that none of these signs individually, nor even in combination, can be taken as precise indices of age in years. They develop at widely different ages in different individuals, and even in the same person the setting in of the different signs of ageing may be very irregular. Thus, grayness may occur even in young adults, and the same is true of certain changes in the eyes and ears. Moreover they do not appear synchronously or equally in the cultured whites and other races. The student must be guided by the sum of the manifestations, supplemented by the subject's behaviour and by such indirect information (references to certain well known events, etc.) as may be obtainable. But even thus and with ample experience he cannot hope for closer approximation to the right age than within five years, plus or minus, among adults. For anthropometric purposes, however, such an approximation will be quite sufficient.

*Admixture of Blood.*—Admixture of blood is of two main kinds: (1) That between individuals of different tribes or other groups of the same race; and (2) That between individuals of different races. In general the latter is the more important, and every effort must be made by the investigator to detect individuals who bear such mixture and exclude them from his series. This applies particularly when we deal with mixtures of the three great stocks of mankind, namely the Whites, the Yellow-browns, and the Blacks (Negro and Negrito). For the sake of greater accuracy it would be well to speak of these great groups always as "stocks" or "strains," reserving the term "races" for the primary groups within these stocks—such as for instance the Nordics, Alpines, and the Mediterraneans among the Europeans.

The progeny of mixtures between individuals within the same stock are often unrecognizable and cannot be separated except on the basis of their family history. The progeny of mixtures of individuals belonging to different stocks are in general easier to recognize, but this facility differs according to the stocks concerned, for these are

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not all anthropologically equidistant. Thus the Whites and the Yellow-browns (including native Americans) are more closely related, than the Negro or the Negrito is with either one of these two strains, and their mixtures will be correspondingly more difficult to separate. Nevertheless with experience, care and certain tests such a separation may be said to be always possible where the mixture is one half and one half, and nearly always where it is one fourth and three fourths; but when the proportion of the blood of one of the component races is less than one fourth, the identification of the mixed-blood becomes frequently a matter of considerable difficulty and in mixtures other than those of the negro and white may be impossible. The estimate of the exact amount of particular blood in a given mix-breed is always more or less a matter of conjecture.

The criteria which guide us in diagnosing mixed-bloods, are the physiognomy, the color of the skin, the character of the hair, the color of the eyes and the tinge of the mucous membranes. Features such as the mongolic fold of the upper eyelid, shovel-shaped (deeply concave) upper incisors, marked freckles, etc., may be additional helps in individual cases, particularly in mixtures of Whites and Yellow-browns. The color of the skin should be observed on the usually covered parts of the chest.

*Skin Tests for Mixed-Bloods.*—On the pectoral parts of the chest may also be made certain tests developed by the author which in many instances of doubtful mixtures between Whites and Indians or other Yellow-browns, and between Whites and other colored races, will help us to arrive at a conclusion. They are tests for the blood reaction of the skin. In a full-blood individual of the Yellow-brown or other dark races, if the chest is exposed and the observer makes three or four vertical lines over the pectoral parts by drawing his finger nail over the skin with a certain amount of pressure, there will be little or no visible reaction; but if there is any mixture with Whites the lines will show as fairly broad red marks, and the flush will be of some duration—both features being the more marked the more white blood is present in the individual under examination, provided he is in the ordinary state of health. In malarial, anaemic and phthisical subjects, where the condition and supply of blood are much altered, the value of this test does not hold good.

The exact paternal or maternal *parentage* may in some cases be determinable through heritage of special features; but the need for such identification arises only in special instances.

*Pathological Conditions.*—In examining any group for purely anthropological purposes, it is obviously desirable to avoid the inclusion of any individuals who may have been affected by some pathological condition sufficiently to suffer a material alteration in their measurements. It is in this connection that practical knowledge of human pathology by the observer becomes necessary.

The disease that is responsible for most of the alterations that constitute sufficient reason for the elimination of the subject from our series, is rachitis. The evidence of this morbid process may exist in more or less deformed limbs, in pitted or eroded-like teeth, deformities of the thorax, ribs and pelvis, in various asymmetries, and in cranial deformations due to premature occlusion of some part of the sutures. Generally we find more than one of these defects in the same person.

Markedly bowed legs, deformed thorax, or badly deformed pelvis, are sufficient reasons for excluding the subject from the examination.

Other pathological processes the results of which will often unfit the subject for anthropometric studies, are tuberculosis of the bones and joints, and various forms of paralysis. The former lead to deformities of the spine and of individual limbs, while the latter may affect directly and indirectly the whole body. The head and face in these cases may of course be unaffected and utilizable for our observations, but unless we can in addition get also a normal stature, it is better to exclude the individual.

In addition to the above the observer will meet with persons of defective constitution due to hereditary syphilis or other causes; and on the other hand he may find individuals in whom the body, the head, the facial parts, or individual limbs or features, may be overgrown (acromegaly, giantism), under-developed (dwarfing, cretinism), or seriously altered by other pathological conditions (congenital defects of individual parts or limbs, gross anomalies, microcephaly, hydrocephalus, arthritic lesions, wounds and fractures). The rule in such cases is, that wherever the condition or deformity is such that normal measurements and observations cannot be secured, the subject is not to be used for anthropological purposes. But if the deformity applies merely to one limb or part, this part alone needs to be excluded.

*Cranial Deformations.*—Cranial deformations, of whatever origin, are of especial importance to anthropometry, particularly as even in cases of skulls, where they are much more easily distinguished, they are known to have been included with or taken for normal variations.

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The *pathological deformations* of the vault most commonly met with are *scaphocephaly*, where the vault is abnormally prolonged and the sagittal region resembles more or less the keel of a boat. This deformity, which may be accompanied by an annular retrocoronal depression, is due to premature occlusion of the sagittal suture. It is particularly common among the American negroes. Another form is *acrocephaly*, or abnormal increase in the height of the fore part of the vault, due in the main to premature occlusion of parts of the coronal suture. Still another frequent deformation which, however, does not except in pronounced cases necessitate the elimination of the subject, is *plagiocephaly*, or asymmetry of the vault, produced mostly by a premature occlusion of the coronal or lamboid suture on one side. In these cases we will find one side of the forehead to protrude more forward and the opposite side of the occiput to protrude more backward than the other side, besides which there may be differences in the parietal regions. In minor cases of plagiocephaly, however, the principal measurements of the vault are not perceptibly altered and there is no need to eliminate the subject. The cause of the condition in these minor cases is frequently obscure.

*Posthumous deformations* of the skull are met with occasionally. They may be localized or diffuse, the latter being generally lateral or bilateral. They may or may not be attended by warping or fractures. The more important grades are easily diagnosed. The specimens must of course be eliminated for all the measurements that are affected.

*Artificial Deformations*.—Besides the above, the student will meet more or less frequently, according to the people he is working among, with head deformations produced by artificial means. These are divisible into *non-intentional* and *intentional*. The non-intentional kind are as a rule produced in early infancy by the head of the infant lying habitually in a certain position on a resistant cushion. They consist of occipital or occipito-parietal flattening, which may be median or lateral, slight, medium or pronounced.

Intentional artificial deformations, which are particularly common in certain parts of this continent and among certain Pacific Islanders, are designed shapings of the head of the new-born infant, as a result of a habitual or religious observance. They are produced by the continued application of direct pressure, by board and pad, bandage and pads, or by a bandage alone, to the head of the new-born. They are of three main classes, namely, fronto-occipital (flat-head), circumferential ("macrocephalous" or "Aymara"), and occipital.



The "flat-heads" are characterized by a greater or lesser flattening of the front, a corresponding flattening of the occiput, a compensatory bulging of the parietal regions, a more or less marked depression along and just posterior to the coronal suture, and occasionally a more or less marked depression along the posterior portions of the sagittal suture. When pronounced, the last named condition gives rise to the so-called bilobed crania.

The "Aymara" deformations are characterized by a more or less marked, broad, circular flattening or depression passing over the frontal bone, the temporal squammæ and the lower parts of the parietals, and over the lower portion of the occipital, while the posterior and superior portion of the parietals and the upper part of the occipital protrude in a compensatory way upward and backward. Anterior to the coronal suture in these cases there is generally an elevation, while posterior to the suture we find a more or less pronounced annular depression.

The occipital deformations resemble those produced accidentally, but in general are more marked. They may represent merely a favored and perhaps assisted incidental flattening due to the resistant head cushion, as among the Navahos and Pueblos; or they may occur, due to less effective methods, as by-products of the flat-head deformation with help of bandages, as among the old Peruvians. These deformations generally involve parts of the parietals, and may be median or lateral. They result in shortening, elevation and broadening of the vault, and in making the forehead both higher and more vertical.

Each of the above forms of head deformation presents a number of sub-varieties according to local differences in methods. And in all the deformation, if marked, affects the base, the orbits and the facial parts of the skull. Except in the minimum cases the changes in the cranial characteristics are such that the utilization of such individuals or specimens for anthropological research on the head or skull becomes very difficult, risky and often impossible. All these cases must be carefully excluded so far as measurements of the affected parts go.

Individual instances of small degree deformations of either class may, as already said, be readily mistaken for individual normal conformation, or pass undetected. The subject calls for special attention with each individual, which will be discussed more closely under "Methods."

## VII

*Photography and Cast-making.*—In anthropological investigation, whether among primitive or civilized peoples, it is often highly desirable

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and may be necessary, in addition to measurements and observations, to take photographs also, and to make facial casts. Directions for these will be given later. In this place it may merely be stated that both photography and casting may well and with advantage be attended to by the observer himself. Nothing is more gratifying and, it may well be added, trouble saving, than one's own good work in these directions. The photographing should be done preferably, if conditions permit, immediately after the measurements and observations on the subject are concluded, for he may not be available at another time. It may even be necessary to take the cast at this time also for the subject has occasionally come from a long distance; but for those who may readily be reached the casting may be postponed until after all the anthropometric work is concluded.

## VIII

## FIELD ANTHROPOMETRY

The preceding introductory considerations may be rounded up by a few remarks as to anthropometry in the field, where conditions will differ radically from those in the laboratory.

*Supplies; Transportation.*—In general it is best to secure all the supplies for the scientific work of an expedition before departure, and to secure only the best and freshest materials. This applies particularly to plaster-of-paris for facial casts, and to photographic plates and films. The number and variety of articles to be carried along on an expedition cannot be given in detail. It depends largely on the regions to be visited, the prospective length of the expedition, and the experience as well as the wants of the observer. The best rule is to take everything needed, with nothing superfluous.

The cameras and instruments should be well tested before the trip. The plaster-of-paris under ordinary conditions is carried in large tin cans or zinc lined boxes, and the photographic plates and films in their ordinary receptacles. For the tropics all such material should be carried in special light metal boxes, and in the case of the plaster every precaution must be taken against its becoming spoiled by moisture. The photographic necessities should be such as to permit under any circumstances the loading of plates and some test developments of exposures. A complete development of the plates and films and printing in the field are not advisable, unless the work is carried on in connection with some well established archeological or other exploring station.

An important item never to be neglected in connection with an expedition to primitive tribes is to take along an ample supply of small change, which is invariably rare in out-of-the-way regions; and the money should preferably be in used coin which will not be regarded with suspicion.

*Cameras.*—It is best to carry two cameras—a pocket kodak for scenes on the road and instantaneous exposures; and a larger camera, preferably with glass plates, for portrait work and larger landscapes. Both cameras should be provided with the best lenses obtainable, and be well tried out in every way before departure. A stereoscopic camera is advantageous.

*Boxes.*—The cameras, instruments, medical supplies and other articles are carried in standard canvas-covered boxes, with rounded corners and rope handles. These boxes should be of such a size that they may be conveniently carried on the backs of men, burros, horses, mules, llamas or camels, as well as in a railroad car or a wagon. They should be made of strong, light wood, preferably gum, well jointed, and have all the hinges on the inside to make robbery difficult. The best way of fastening is with strong padlocks. The size of the boxes found most convenient by the writer (except for the instrument case which should fit these) is, externally, height 18 in. (46 cm.), breadth 20.5 in. (52 cm.) and antero-posteriorly 14 in. (36 cm.). In field these boxes will serve various useful purposes, such as chairs and tables, and at night as a wind break, or base over which in case of rain may be spread a sheet of canvas converting the whole into a sort of shelter or tent; while on the return voyage they may be used to transport casts, photographic plates and specimens. In places where the examinations are carried on the boxes may again serve as chairs and tables; and if there are enough of them, at night they make a very good elevated bank on which to spread one's bed. By suitable inside partitioning one of these boxes may be fitted for medical supplies, one for kitchen utensils, one for the cast-making outfit, another for the photographic apparatus, still another for trinkets and smoking supplies for the natives, etc. The boxes are numbered or otherwise marked so that any desired one may be readily found when needed; and a duplicate set of keys is provided for a case of loss.

*Companions.*—This is a matter of much more consequence than might at first appear. In general the most satisfactory procedure is for the observer to engage only such companions as he may need in traveling from place to place. The taking along of friends, co-

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workers, or even a photographer, not only risks their exposure to sickness and greatly increases the expenses, but is often productive of much friction as to plans, food, time of starting, etc. It may further lead to difficulties in fixing blame for accidents and especially of credit for discoveries; and will frequently be productive of delays and inconveniences, for often where one can find what he needs, two or three cannot be accommodated. Free hand, freedom from anxiety for others, undivided responsibility, and undivided credit, are precious assets which should be carefully guarded by the explorer.

*Miscellaneous.*—Photographing and even measuring may have to be done by the roadside, in the field, or under other untoward circumstances which often will call for the exercise of not a little ingenuity. He may at first be received with suspicion and suffer for the faults of others. But with a fair interpreter, friendly, honest attitude, and such small gifts as may best be fitted to the occasion, the student will as a rule secure the needed observations. It is almost needless to say that his own health and strength will demand rational attention, for he will travel in and out of season, may have to endure exertions and privations, and be subject to infection through contaminated water, spoiled food, insects, and contact with diseased persons. All this can in a large measure be counteracted, and if so the field expeditions become to the worker not only a source of priceless experiences and acquisitions, but also of a deep recuperation.

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