Proportions of the Body

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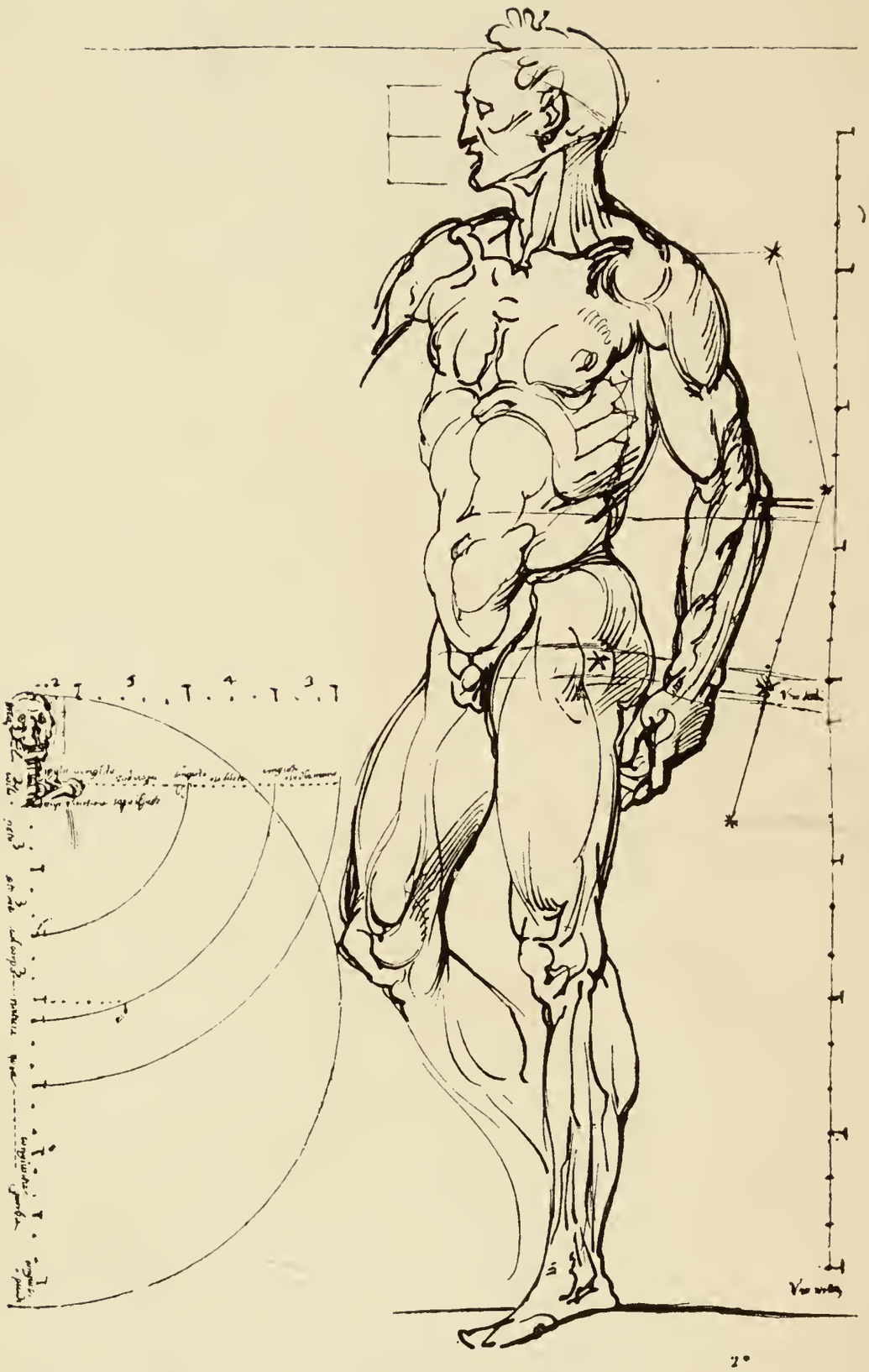


Fig. 1.—Drawing by Michel Angelo Buonarrotti, from the copper engraving by Giov. Fabbri (Choulant).

THE PROPORTIONS

OF

THE HUMAN BODY.

BY

BERTRAM C. A. WINDLE, M.A., M.D., D.Sc.,
QUEEN'S PROFESSOR OF ANATOMY IN THE MASON COLLEGE,
PROFESSOR OF ANATOMY TO THE ROYAL SOCIETY OF ARTISTS,
AND LECTURER IN THE MUNICIPAL SCHOOL OF ART,
BIRMINGHAM.

LONDON:
BAILLIÈRE, TINDALL AND COX,
20 & 21, King William Street, Strand.
1892.

To

THE PRESIDENT AND MEMBERS

OF THE

ROYAL BIRMINGHAM SOCIETY OF ARTISTS.

PREFACE.

The following pages were prepared and delivered as a course of lectures for the members of the Royal Birmingham Society of Artists. I have expressed my obligations to various books from which my information has been drawn, and should like here also to add the names of the following works, of which, as will be seen, I have made much use: Marshall, 'Proportions of the Human Body'; Duval, 'Artistic Anatomy' (English translation by Frederick E. Fenton; Cassell and Co.). I have to thank the publisher of the last work for permission to reproduce some illustrations. The subject of the proportions of the human body is one of great interest to artists, and if I have been able, by bringing together in one place the observations which have appeared upon it, to assist them in any way, I shall be well pleased.

BERTRAM C. A. WINDLE.

Mason College, Birmingham,
October 1, 1892.

LIST OF FIGURES.

THE PROPORTIONS OF THE HUMAN BODY.

INTRODUCTORY.

In the course of lectures which, by the courtesy of the members of this society, I am permitted to commence this evening, I propose, so far as is possible to me, to lay before you an historical account of the various methods which have been invented in successive ages and by diverse nations, to establish a rule of proportion for the human body. So far as I am able I shall endeavour to criticise these various methods, and in conclusion I shall supply you with the best authenticated information as to the proportions of the human body, with the varieties which are due to differences of age, sex, or race. I do not know whether in this place, and to such an audience as this, any defence is necessary for one who presumes to offer hard definite scientific facts to those interested in the study of art alone. Is science, using the term now in a restricted sense, really of any use to the true artist? or is the true artist he or she who is from power of observation and force of genius able to grasp so completely and reproduce so fully all the characters of the human body, in their constantly varying complexity, as to be independent of all outside knowledge of cognate subjects? The question has been so well dealt with by one who is at the same time one of the most charming of writers and a skilled artist, that you will, I am sure, pardon me if I give you his words instead

of any of my own. 'The sciences of perspective, optics and anatomy,' he says, 'are useful to artists just as the science of geography is useful to a traveller. Take the very best of maps; what does it tell you of the countries you intend to explore? It is not a substitute for your observation as a traveller, but simply a reliable informant as to where the places lie, where you will find them, and a help to your topographic memory. After having studied the map you must observe the country itself in all its detail if you want to know its life. But the map has helped you, nevertheless, in the arrangement of the work before you. It has saved you time and trouble; it has prevented you from missing your way. What a map is to the traveller, scientific study wisely pursued is to the artist. It can never serve him as a substitute for his own observation, but it may tell him when to apply his power as an observer and guard him against innumerable mistakes. If artists could always have nature before them exactly as they desired to paint it, they might dispense with the help of science altogether. Any artist who sees quite clearly in the artistic sense, sees also as much of organic structure as is necessary to his perfect performance. But when nature is not present, or is constantly changing, which very nearly amounts to the same thing, artists need everything which may counteract the natural infirmities of the memory.'

Anatomy, rightly understood, whether for the artist or for the scientific student, is not merely the study of dry bones and the muscular masses which put them in motion, it is, or should be, far more. It includes the knowledge of the peculiarities of infancy, youth, or age; of sickness or robust health; of the contrasts between manly and muscular strength and feminine delicacy; of the appearances which pain or death presents. Such knowledge belongs to its province as much as the study of the muscles of the face when affected with emotion. And, as the writer just quoted proceeds, viewed in this comprehensive light, anatomy forms a science, not only of great interest, but one which will be sure to give the artist a true spirit of observation,

teach him to distinguish what is essential to just expression, and direct his attention to appearances on which the effect and force, as well as the delicacy of his delineations will be found to depend. But whilst anatomy is, to use Bell's phrase, the grammar of art, a complete knowledge of anatomy will no more make an artist than deep learning in grammar will make a master of composition. The trained observation of the artist will sometimes discover facts which have been missed by the anatomist. I may perhaps be permitted to make mention of an instance of this. An attack made upon the accuracy of the sculptor of the Venus of Milo on account of certain asymmetries in the face of that statue, led a German anatomist to examine the figure carefully. He found that whilst the portion lying below the nose was comparatively symmetrical, the upper part presented various deviations. Thus the nose deviates to the left, the left ear stands higher than the right, and the left eye is higher and nearer the middle line than the right. Struck by these facts, he was led to make careful observations of the measurements of skulls and of the heads of living persons. As a result he found that whilst symmetry of the lower half of the face is the rule, deviations such as those occurring in the statue commonly occur in the upper half. Anatomy can supply the artist with hard and fast rules arrived at from the study of averages. It is the truly great sculptor or painter who, appreciating that

> 'Variety's the very spice of life,
> That gives it all its flavour,'

and employing it,

> 'Not chaos-like together crushed and bruised,
> But as the world harmoniously confused,
> Where order in variety we see,
> And where, though all things differ, all agree,'

produces the masterpiece of art to be a joy to all succeeding generations. The quest for the ideal human figure upon which, as upon a scaffolding, the artist may build up the creature of his imagination, is one which has exercised many minds, some approaching it from what I may be

allowed to call the æsthetic direction, others from that of pure science. Hogarth, who states that there is no practicable rule by lines for minutely setting out proportions for the human body, and that if there were, the eye alone must determine us in our choice of what is most pleasing to itself, was yet desirous of showing the importance of appreciating the just proportions of the ideal human figure. 'I fear,' he says, 'it will be difficult to raise a very clear idea of what constitutes or composes the utmost beauty of proportion, such as is seen in the Antinous, which is allowed to be the most perfect in this respect of any of the antique statues, and, though the lovely likewise seems to have been as much the sculptor's aim as in the Venus, yet a manly strength in its proportion is equally expressed from head to foot in it. Let us try, however, and as this masterpiece of art is so well known, we will set it up before us as a pattern, and endeavour to fabricate, or put together in the mind, such kind of parts as shall seem to build another figure like it. In doing which we shall soon find that it is chiefly to be effected by means of the nice sensation we naturally have of what certain quantities or dimensions of parts are fittest to produce the utmost strength for moving or supporting great weights; and of what are most fit for the utmost light agility, as also for every degree, between these two extremes. He who hath best perfected his ideas of these matters by common observations, and by the assistance of arts relative thereto, will probably be most precisely just and clear in conceiving the application of the various parts and dimensions that will occur to him, in the following descriptive manner of disposing of them, in order to form the idea of a fine-proportioned figure. Having set up the Antinous as our pattern, we will suppose there were placed on one side of it the unwieldy elephant-like figure of an Atlas, made up of such thick bones and muscles as would best fit him for supporting a vast weight, according to his character of extreme heavy strength; and on the other side, imagine the slim figure of a Mercury, everywhere

neatly formed for the utmost light agility, with slender bones and taper muscles fit for his nimble bounding from the ground. Both these figures must be supposed of equal height, and not exceeding six feet. Our extremes thus placed, now imagine the Atlas throwing off by degrees certain portions of bone and muscle proper for the attainment of light agility, as if aiming at the Mercury's airy form and quality, whilst, on the other hand, see the Mercury augmenting his taper figure by equal degrees, and growing towards an Atlas in equal time, by receiving to the like places from whence they came the very quantities that the other had been casting off, when, as they approach each other in weight, their forms of course may be imagined to grow more and more alike, till, at a certain point of time, they meet in just similitude; which, being an exact medium between the two extremes, we may thence conclude it to be the precise form of exact proportion fittest for perfect active strength or graceful movement, such as the Antinous we proposed to imitate and figure in the mind.' It is with more exact methods than this that I have in these lectures to deal, yet would I crave your permission, before proceeding to them, to lay before you those luminous passages in which Sir Joshua Reynolds showed his appreciation of the existence of a type-form of the human body, together with his knowledge of the order which really exists under the seemingly indefinite variations from that type. 'All the objects,' he says, 'which are exhibited to our view by Nature, upon close examination will be found to have their blemishes and defects. The most beautiful forms have something about them like weakness, minuteness, or imperfection. But it is not every eye that perceives these blemishes. It must be an eye long used to the comparison of these forms, and which, by a long habit of observing what any set of objects of the same kind have in common, has acquired the power of discerning what each wants in particular. By this means we acquire a just idea of beautiful forms; we correct Nature by herself, her imperfect state by her more

perfect, and make out an abstract idea of forms more perfect than any one original. From reiterated experience and a close comparison of the objects of Nature, the artist becomes possessed of a central form from which every deviation is deformity. To the principle I have laid down, that the idea of beauty in each species of being is an invariable one, it may be objected that in every particular species there are various central forms, which are separate and distinct from each other, and yet are undoubtedly beautiful; that in the human figure, for instance, the beauty of Hercules is one, of the Gladiator another, of Apollo another, which make so many different ideas of beauty. It is true, indeed, that these figures are each perfect in their kind; but still, none of them is the representation of an individual, but of a class. And as there is one general form which belongs to the human kind at large, so in each of these classes there is one common idea and central form which is the abstract of the various individual forms belonging to that class. Thus, though the forms of childhood and age differ exceedingly, there is a common form in childhood and a common form in age which is the more perfect as it is more remote from peculiarities. But I must add further, that though the most perfect forms of each of the general divisions of the human figure are ideal, and superior to any individual form of that class, yet the highest perfection of the human figure is not to be found in any one of them. It is not in Hercules, nor in the Gladiator, nor in the Apollo, but in that form which is taken from them all, and which partakes equally of the activity of the Gladiator, of the delicacy of the Apollo, and the muscular strength of the Hercules. There is, likewise, a kind of symmetry or proportion which may properly be said to belong to deformity. A figure lean or corpulent, tall or short, though deviating from the type, may still have a certain union of the various parts which may contribute to make them, on the whole, not unpleasing.'

PART I.—HISTORICAL.

In considering the various systems of proportion it will be convenient to deal with them under the headings of the nations amongst whom they were originated or used. One of the earliest known canons is that given in an early Sanscrit work, the 'Silpa Sastra,' or 'of the fine arts.' In this canon a vertical line is divided into 480 parts, which are thus distributed throughout the body:

Upper part of Head	15
Face	55
Neck	25
Chest	55
To umbilicus	55
Lower part of Abdomen	53
To knee	90
Knee	30
Leg	102

If this canon be estimated in terms of the head, it will be found that the entire body is made to contain a little less than seven and a half heads. According to Quetelet, this scheme of proportion is met with in several of the paintings of Raphael.

The earliest information which we possess as to the canon of the wonderful Egyptian people is due to Diodorus Siculus. Unfortunately, this writer, who was a contemporary of Julius Cæsar and Augustus, though he travelled over a great part of Europe and Asia to collect materials for his 'Bibliotheca Historica,' is far from being reliable, and I only mention his stories because they find a place in most works on the subject with which we are concerned. According to this writer, the Egyptians divided the body

into twenty-one and a half parts, and worked under rules so rigid that the height of the statue once decided upon, the stones from which it was to be constructed were distributed to different workmen to be finally fitted together when all had completed their tasks. In illustration of this he tells a probably apocryphal story respecting the two sons of a certain Phœcus, of Samos, Taleclos and Theodorus by name, who, having studied art in Egypt, and employing the canon of that country, constructed a statue of Apollo Pythius in two halves. The height having been agreed upon, one half of the figure was executed by one brother in Samos, and the remainder by the other in Ephesus. On being placed together, when completed, it was found that they accurately fitted to one another. To understand the Egyptian works, certain points require to be borne in mind, the first of which is the conventionality by which they were, to a certain extent, bound down. Thus, in their sculptures in relief, the head was almost always represented in profile, but with a full-face eye, the bust was also full-face, the trunk three-quarters, and the legs profile. Again, the gods were represented larger than men, kings than subjects, and the dead than the living. The same conventionality of treatment was observed in the colours with which their sculptures were overlaid. The flesh tints of men were of a dark reddish-brown, and those of women a pale yellow. This scheme of colour is, however, occasionally departed from. Thus, at Sakharah, under the fifteenth dynasty, and at Aboo Sumbel under the nineteenth, there are represented men with skins as yellow as those of women, and in tombs at Thebes and Abydos, about the time of Thothmes IV. at Horenheb, and also at Bayt-el-Wely, flesh tints of rose-colour and crimson are met with. Then, in the second place, it must be remembered that the peculiar religious views of the Egyptians had an important bearing upon their art. The 'ka,' the double, or spirit of the body, was supposed to perish miserably if it had not the dead body, in the shape of a mummy, or at least a counterfeit presentment of the same, to attach itself to. Now, as

the mummy might be stolen, there were provided for the 'ka' in that case one or more figures of the deceased person. These were not intended as memorials for the children or friends to gaze upon, since they were shut up in rooms to which no entrance was afforded. In figures constructed for this purpose, extreme accuracy of facial resemblance was the only thing to be sought for, and we find, therefore, that whilst the head and face are most carefully represented, the remaining parts of the body were less accurately rendered—merely sketched in, if we may use such a phrase in connection with sculpture. It is obvious that figures executed under conditions such as these would not require any carefully devised canon of proportion for their construction. With respect to the manner in which the mural sculptures were executed, an interesting account is given by Jones in his handbook to the Egyptian Court of the Crystal Palace. He says, 'A wall was first chiselled as smooth as possible, the imperfections of the stone were filled up with cement or plaster, and the whole was rubbed smooth and covered with a coloured wash. Lines were then ruled perpendicularly and horizontally with red colour, forming squares all over the wall corresponding with the proportions of the figure to be drawn upon it. The subjects of the paintings and of the hieroglyphics were then drawn upon the wall, with a red line, most probably by the priest or chief scribe, or by some inferior artist, from a document divided into similar squares. Then came the chief artist, who went over every figure and hieroglyphic with a black line and a firm and steady hand, giving expression to each curve, deviating here and confirming there, the former red line. The line thus traced was then followed by the sculptor. In this stage there are instances of a foot or head having been completely sculptured, whilst the rest of the figure remains in outline. The next process was to paint the figure in the prescribed colours; and in some cases the painted line deviates from the sculptured line, showing that the painter was the more important workman, and that even in this

process no possible improvement was omitted. There are other instances where a considerable deviation from the position of an arm or leg has been made. After the sculpture was finished and painted, the part was recarved, and the defective portion filled in with plaster, which, having since fallen off, furnishes us with this curious evidence of their practice.'

Turning now to the canon adopted by the Egyptians, Jomard states that they used one of seven and a half heads as proved by measurements of a figure made by Delile. He also states that they made the foot one-sixth of the length of the body and the cubit one-fourth. These proportions are not true to nature as shown by the following table, which he supplies:

	Egyptian.	Natural.
Stature	24	26
Foot	4	4
Cubit	6	7

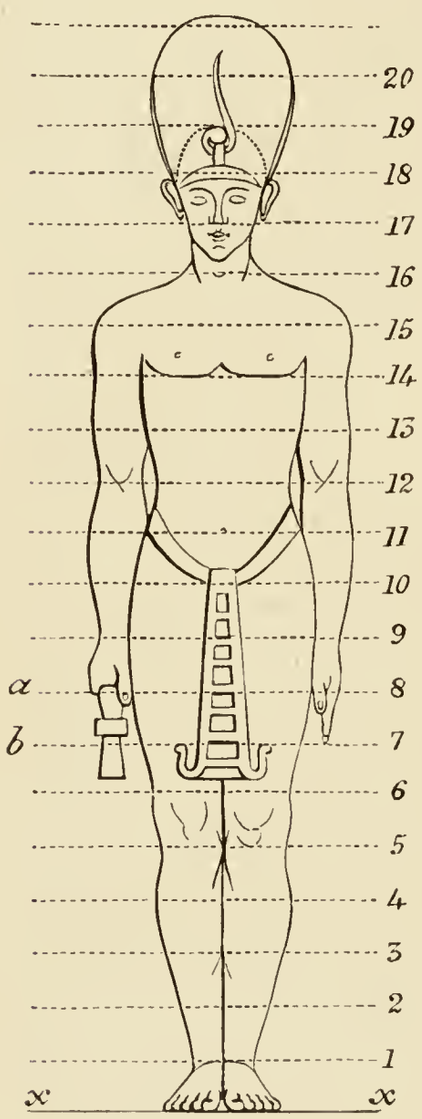


Fig. 2.—The Egyptian Canon, or Canon of Lepsius (Duval).

Blanc considered that the Egyptian canon was founded upon the length of the middle finger, which should be contained nineteen times in the body. Topinard calls this the canon of Lepsius, and states that the head and neck contain this measure three times, the upper extremity eight times, the inferior from the pubes, ten times, thus giving the relation of the upper to the lower extremities as 4 is to 5. The term 'canon of Lepsius' is due to the fact that in the 'Selection of Funeral Monuments' published by that author, there is a figure in which the body is divided by horizontal lines into nineteen parts (Fig. 2). Of this figure Duval says, 'As several passages in different ancient authors seem to indicate

that the Egyptian sculptors have taken the finger as the unit of the system, Charles Blanc very ingeniously remarks this fact, that in the figure in question, one of the horizontal lines, the eighth, beginning at the soles of the feet, passes exactly at the base of the middle finger in the right hand (closed, holding a key), while the seventh touches the extremity of the middle finger of the extended left hand. It seems to him, then, very probable that the distribution of these horizontal lines indicates a system of measuring the figure, and that the space between the seventh and the eighth lines measures the length of the middle finger, which thus becomes the standard of this system of proportion. According to the Egyptian rule, the length of the middle finger will be found nineteen times in that of the height; it may be that this rule was adopted by the Greek artists, and Charles Blanc does not hesitate to think that Polycletus, who has composed a "Treatise on Proportions," with a model in marble known by the name of Doryphorus, used no other system but the Egyptian; there has always been found in a number of antique figures this same proportion of nineteen times the middle finger to the height of the body, and in the Achilles, for example, the total height does not exceed by more than one-twentieth of an inch the length of the middle finger multiplied by nineteen.' MM. Perrot and Chipiez, whose position as authorities on Egyptian art stands very high, are inclined to doubt the existence of any fixed canon of stature in use amongst artists of this nation. They point out that though the figure above alluded to is contained in nineteen squares, others have been found in which the height of the figure occupies sixteen, twenty-two and a quarter, and twenty-three squares respectively. They look upon these squares not as related to a canon, but as being merely the method used to copy accurately from another, and possibly smaller, representation in the manner well known to artists, and alluded to in the description of the procedure of the sculptors as given above. There seems some possibility that the Greeks received their knowledge of a canon of stature from the Egyptians. Such a theory is supported by Blanc's state-

ment, by the stories of Diodorus Siculus, which probably had at least some foundation, and receives some confirmation from an incident related by Broca, the celebrated French anthropologist. M. Fock, in 1866, gave an order to Tramond, the well-known preparer of skeletons, to find him one with certain proportions, which he indicated, and which were those which he had obtained from the examination of the statue of the Apollo Belvedere. Tramond not being able to find a skeleton satisfying these requirements, particularly in so far as they concerned the fore-arm, applied to Broca. After a search, he found a skeleton which fulfilled the requirements. It was that of Abdallah, a superb negro from the Soudan, which is still in existence in the museum of the Society of Anthropology of Paris. Broca drew from this the conclusion, that the statue of the Apollo Belvedere was fashioned without doubt upon the Egyptian canon, which had been drawn up from Nubian negroes, who were used as models. Whether they obtained their canon from Egypt or not, there can be no doubt that rules of proportion were studied and employed by the Greeks. Schadow says that a canon was probably used in the workshops of the oldest Greek sculptors, and calls attention to the fact that in the group of the Æginetans in Munich, the proportions used for the wrestlers are the same. The most celebrated canon of which we have any knowledge was that of Polycletus, after whom Schadow's work is named. This artist was a native of Argos and a contemporary of Phidias, flourishing between the years B.C. 452-412. He was a pupil of Ageladas, and designed the temple and theatre of Epidaurus. He composed a commentary upon the proportions of the human body, and also constructed a figure in illustration of his views, the Doryphorus or Lancebearer, which he called the 'Canon.' This figure is mentioned by various old writers, Galen twice alluding to it as follows: 'Carvers, painters, sculptors and artists in general, strive to paint and represent the most beautiful forms they can find, whether of human beings or animals. Such a form is exemplified by the

canon of Polycletus. This statue owed its name to the fact that its parts are of perfect proportion and in harmony.' And again: 'The beauty of the human body is shown in the symmetry of the various parts, as clearly explained in the canon of Polycletus' (here the commentary is probably alluded to). 'In these writings the master has described his law of all the proportions of the body, and has illustrated this by means of a statue made in exact conformity with his rules. The name of canon was given by him both to his writings and to the statue.' Winckelmanns, in his 'History of Greek Art,' states that amongst the ancients the foot was the standard of all large measurements, and by its length sculptors determined the height of their statues, giving to them, as Vitruvius states, six lengths of the foot; for the foot has a more determinate length than the head or the face, from which modern sculptors and painters generally deduce the proportions of their figures. Hence Pythagoras calculated the height of Hercules from the length of his foot, with which he measured the Olympic stadium at Elis. As regards the number of heads in height, the various artists seem to have at times adopted different scales. Thus the Farnese Hercules and the Gladiator measure eight heads, the Apollo and the Laocoon seven and two-thirds, and the Antinous seven and a half. The Venus of the Medici has a similar measurement. We are ignorant of the exact rule which the Greek artists made use of, but various attempts have been made to arrive at it by measurements of various masterpieces. I here reproduce some of the figures arrived at by Quetelet:

Stature	1,000
Height of the head	130
Neck, from the chin to the clavicles	37
Trunk, from the clavicles to the pubis	306
Lower Limb, from the pubis to the ground	513
Lower Limb, from the perineum to the ground	482
Upper Limb, from the acromion to the extremity of the middle finger	455
Length of the hand	109
Length of the foot	149

A good idea of the variation in proportions may be

obtained from the following table, prepared by Professor Langer, of Vienna, which gives the measurements of certain parts of the body reduced to terms of the stature, which is considered as consisting of 1,000 parts.

Measures reduced to 1,000 parts of Body Stature.	Germanicus (so-called).	Apoxyomenos.	Apollo (Vatican).	Venus (Medicean).
Height of the head - -	127·3	119·0	117·5	127·5
Height of upper part of body (above symphysis pubis) - - - -	480·0	446·2	461·5	470·4
Height of lower part of body (below symphysis) -	520·0	553·8	538·5	529·6
Difference between two last measurements - - -	40·0	107·6	77·0	59·2
Length of Thigh - -	220·4	264·8	233·5	235·0
Length of Leg - - -	221·0	266·1	267·8	260·0

It will be noticed that in the first and last the head is contained 7·8 times in the body, whilst in the second and third it is contained about 8·5 times. The effect produced by this difference of proportion, as well as by the other variations in measurement, is well shown by Fig. 3, from the same author, which gives linear schemes of the proportions of the so-called Germanicus (A) and the Apoxyomenos (B).

Winckelmanns states that the following rule of proportion for the face is, in his opinion, the exact method observed by the ancients. It was devised by Antonio Raphael Mengs. 'Draw a vertical line and divide it into five equal parts, the uppermost fifth is for the hair. Again divide the remainder of the line into three equal parts. Draw a horizontal line through the lower extremity of the first of these three divisions, forming with the perpendicular line a cross. The horizontal line must be as long as two of the three parts into which the length of the face is divided. Let curved lines be drawn from the extreme points of this line to the upper extremity of the fifth part originally set off; these form the smaller end of the oval of the face. Now divide one of the three parts of the length of the face into twelve equal portions. Let three of them, that is to say, one-fourth of one of these thirds, or one-twelfth of the

length of the face, be measured off on both sides of the point of intersection of the horizontal and perpendicular lines; these two portions indicate the space between the eyes. Let three other portions be measured off on both outer extremities of the horizontal line. The space which now remains included between the quarter at the outer end of the horizontal line and the quarter at the point of

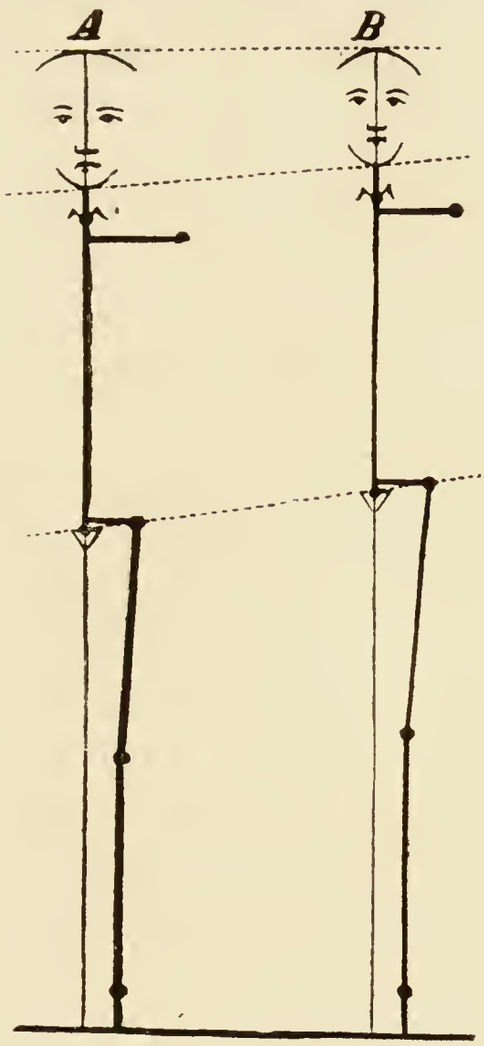


FIG. 3.—Linear scheme of the proportions of the so-called Germanicus and of the Apoxyomenos (Langer).

intersection of the two lines is equal to two quarters, or six of the twelve portions mentioned above, and gives the length of an eye. One quarter is the width of the eye, and also the distance from the tip of the nose to the opening of the lip, and from this point to the curvature of the chin, and thence to the tip of the chin. The breadth of the nose to the wings of the nostrils contains just a quarter. The length of the mouth requires two quarters; it is

therefore equal to the length of the eye, or to the height of the chin from its point to the line of junction of the lips. One-half of the face measured from the roots of the hair gives the length from the chin to the pit at the lower extremity of the neck. The German editor of this work notes that instead of 'and thence to the tip of the chin' we should read 'from the depression to the point of the chin is two portions.' He also points out that the length of the mouth is half as long again as the eye.

The best known Roman canon is that of Vitruvius, who flourished B.C. 46. According to this rule the head forms the eighth part of the body; the face, from the roots of the hair to the chin, is equal to the length of the hand, and forms the tenth part of the body. The foot is the seventh part, and the fore-arm and hand taken together is the fourth. Vitruvius is also the authority for the incorrect statement that the umbilicus is the central point of the body. He says, 'The umbilicus is naturally the centre of the body, so that if a man lies down flat on his back with his arms and legs stretched out, and if a circle be described with the umbilicus as its centre, the line will touch the points of the digits of both hands and feet.' He is also the authority for the statement that the height of the body is equal to the distance between the tips of the fingers when the arms are stretched out as far as possible from the sides.

Having thus described so far as they are known the canons adopted by ancient artists, we must now turn to the consideration of those of more modern times. Amongst the Italians, Giotto (1276-1336), is said to have written on the subject, but I am not aware that any remains of his writings are extant. Alberti (1398-1475) made a much more successful attempt than any other early modern to deal with the subject of proportion. In fact, Topinard says of his work that it is an essay in rational anthropometry, and a very remarkable attempt for the period. Alberti took the foot as his unit, and states that it is included six times in the body, in which he followed

Vitruvius and, according to Winckelmanns, various of the ancient sculptors. The foot he divided into ten parts, and each of these again into ten minutes, each of which thus formed the six-hundredth part of the body. Alberti's figures were based upon a number of measurements of the body relating to its height, transverse and antero-posterior diameters, and reduced to averages. Leonardo da Vinci (1445-1520), in his 'Treatise on Painting,' often mentions a standard of measurement, but never seems to have been satisfied with any. He took the face for his starting-point, and says that in his first infancy man has the width of his shoulders equal to the length of his face, and to that portion of the arm which is between the shoulder and the elbow when the arm is bent. It is also equal to the distance between the middle finger of the hand and the fold of the elbow, and to the interval between the bend of the knee and that of the ankle. But when man has come to his full stature all these measurements double in length, except the face, which, as the whole head, undergoes little change, and so the man who at adult stature is of a well-proportioned figure should have ten faces' height, the size of his shoulders should be two faces, 'and so all the parts of which I have spoken are alike of two faces.' He also says: 'Divide the head into twelve degrees, and each degree into twelve minutes, and each minute into twelve seconds, and so on until you have found a measure equal to the smallest parts of your figure,' a statement upon which possibly is based Rossi's surely sarcastic story that Leonardo had divided the face into 248,832 parts. Michael Angelo (1474-1563) left a sheet of proportions of which a representation is given in Fig. 1. It represents a man standing in three-quarter face, the head being in profile. The right arm is only partly shown, and the right leg and foot are incompletely represented. The skin is not removed, but the muscles are clearly shown, and the position of the left trochanter major is marked by a star. On the right side of the figure is a divided scale for the whole body, together with a special one for the arm. On the left side

is a smaller representation of the proportions of the human body, which shows the bony skull, the cervical vertebræ, the first rib, clavicle and upper part of the scapula. The corresponding proportions of the outstretched arm to those of the middle line of the body are shown by three quadrants. From the vertex to the sole of the foot is described a semicircle whose diameter is formed by the length of the body. Along the perpendicular line in the smaller figure are the words: testa, collo, peto (petto), soto peto (sotto petto), col corpo, natura, coscia, congiunta, gamba, congiata di piedi. On the horizontal line, spala (spalla), congionta, oso (osso) di sopra, congionto, oso di soto (osso di sotto), congionto, oso (osso) de la mano. Under the clavicle, inguiniatura sopra il petto. But Michael Angelo has stated his opinion that the artist must rely upon his own eye as the surest guide to correct proportions. A curious statement made by Lamozzo respecting Michael Angelo seems to have a bearing upon his ideas as to proportion, but it is phrased in as enigmatical a style as the directions of the alchemists, and to me is at least as unintelligible. Lamozzo says: 'And because in this place there falleth out a certain precept of Michael Angelo much for our purpose, I will not conceale it, leaving the farther interpretation and understanding thereof to the judicious reader. It is reported, then, that Michael Angelo upon a time gave this observation to the painter Marcus de Sciena his scholler; that he should alwaies make a figure pyramidall, serpent-like, and multiplied by one, two and three. In which precept (in mine opinion) the whole mysterie of the arte consisteth.' (The quotation is as given by Hogarth.)

Amongst other Italians who wrote about the canon of proportion may be mentioned Paggi (1554-1629), who in a work entitled 'Acus Nautica,' which was published in 1601, gave some tables of proportions from which it is believed those subsequently issued by Testelin were copied. Barbaro, in his 'Practica della Perspectiva,' gave a series of proportions which he proposed as intermediate between those of Dürer, which he considered to be too minute, and

those of Vitruvius, which, on the other hand, he thought too general. Barca of Milan (1620) issued a sheet containing the proportions of Jupiter, Hercules, Minerva and Venus.

The Germans, as might have been expected from a nation always anxious to reduce all possible matters to scientific rules, and filled with a genuine love of art, have supplied various works on our subject. Of these, perhaps the earliest, and certainly one of the most famous, is that of Albrecht Dürer (1470-1528), who had a very high opinion of the science of proportion, bestowed much thought upon the subject, and eventually published a work concerning it. His opinion of the potentialities of the subject was, in fact, almost overstrained, if one may judge from his statement that 'by means of outward proportion one can indicate the natures of men which correspond to fire, air, water, and earth, for the power of art is supreme.' His first book was entitled, 'Instruction in the Measurement, with the Compass and Rule, of Lines, Surfaces and Solid Bodies, drawn up by Albrecht Dürer, and printed for the use of all lovers of art, with appropriate diagrams, in 1525.' This book contains a course of applied geometry in connection with Euclid's elements; in fact, Dürer states from the commencement of it that his book will be useless to anyone who understands the geometry of 'the very acute Euclid, for it has been written only for the very young and for those who have no one to instruct them accurately.' This work was followed by his book on Proportion, which was published with the following title: 'Herein are comprised four books on human proportions, composed and printed by Albrecht Dürer, of Nürnberg, for the use of all those who love this art, MDXXVIII.' In his system of measurement of the human body he adopts two plans, for in the first book he uses as a standard a fraction of the entire height, whilst in the second his scale is composed of six hundred parts, like that of Alberti, a proof, says Thausing, that he had some acquaintance with the, at that time unpublished, writings of the Florentine. In the third

book the varying proportions of the figures given in the first two are changed according to definite rules, the scale being increased and diminished in all kinds of different ways, but always with a certain consistency. The fourth book indicates 'where and how the figures are to bend.' It is, in point of fact, 'an application of the science of geometrical projection to the drawing of the human body expressed by lines and plane surfaces, and represented under different aspects and in different positions.' He declares in his preface that he intends to write nothing about the inward parts of the body, and at the beginning of the fourth book says: 'But how to describe the limbs, and how wonderfully they fit into each other, is known to those who occupy themselves with anatomy, and I leave it to them to speak of these things.' He himself is content with briefly pointing out the limits within which the body can be bent, and how the joints become enlarged when they are stretched and in action. In the first book he gives figures of bodies varying from six to nine, and even ten, heads in stature, though the latter proportions are only treated as supposititious cases, and not as actually occurring conditions. Thus he represents a pair of robust peasants, male and female, in whom he makes the foot one-sixth, the head one-seventh, and the hand one-tenth, of the entire stature. He then gives another pair of figures, also male and female, of a less robust and more slender form, in whom the head is one-eighth, the hand one-tenth, and the foot, in the male, one-sixth, and in the female one-seventh, of the entire stature. 'The vertical and horizontal lines into which he divides the head,' says Topinard, 'merit special attention. He established his first horizontal line to orient the head in profile, and drew it so as to pass by the lower part of the lobule of the ear and the lower part of the nose. Amongst the other lines are two called slanting—the one a tangent to the chin and to the two lips, the other a tangent to the frontal eminences, to the glabella and to the nose. At the point of meeting of this line with the horizontal line above mentioned is an angle which the

authors of the "Crania Ethnica" have described as a sort of facial angle which preceded that of Camper. It is a fact that on a figure of a negro given by Dürer, in which the two lines are represented, the angle is more acute than amongst Europeans, and the forehead therefore rendered more retiring.' Very different opinions seem to have been held respecting the value of Dürer's work; Michael Angelo is said to have thought but little of it, whilst Hogarth, in the book from which I have already quoted, says: 'Albert Dürer, who drew mathematically, never so much as deviated into grace, which he must sometimes have done in copying the life, if he had not been fettered with his own impracticable rules of proportion.' On the other hand, Francisco Pacheco, the master of the great Velasquez, in his book on painting, recommends that the female figure should be studied from Dürer's drawings, instead of from the living model. Passing to other Germans, Bergmuller, who published in 1723 a book entitled 'Anthropometria,' Lichtensteger and Zeising, all devised canons which were more or less fantastic and artificial. The last-named author published his 'Lebre von der Proportionen' in 1854, the details of which rested upon the following proposition: Proportion is a fundamental necessity for beauty of form; if the division of a whole consisting of unequal parts is to appear proportional, the relation of the unequal parts to one another must be the same as the relation of the parts to the whole; that is, the smaller parts must be related to the greater, as the greater to the whole. From this rule he deduced his so-called 'Goldenen Schnitt' as a canon of ideal beauty in the division of all structures. This section consisted in a line so divided that the smaller part bore the same portion to the larger as that did to the whole.

Schadow, who was sculptor at the court of the King of Prussia, published in 1834 his work on proportions, entitled 'Polycletus,' a name which was that of one of the earliest devisers of a canon, the author of the celebrated 'Doryphorus.' Of Schadow so great an authority as

Quetelet had a high opinion within certain limitations. 'We find him,' he says, 'an artist before all things: that which unceasingly occupied him was grace, was the elegance of forms, much more than the law of proportions and of stature, and he is correct up to a certain point.' In his system he describes the face as the portion between the upper part of the orbit and the lower part of the chin, and he states that this distance is in a full-grown man five inches. He divides this space into six parts, the first extending to midway between the orbit and the lower limit of the nose, the second to the last-named point, the third to the angle of the mouth, the fourth midway from this to the chin, and the last to the point of the chin itself. The foot of a man of five foot six inches in stature should be ten inches—this is the same length as the ulna, and both are, therefore, double the length of the face according to his definition of that region. In the female the face is four and a half inches, and the foot nine; whilst in the child the head is six and a half inches, and the foot five and a half. One of the most interesting attempts to solve the question of proportions is that of Carus, the celebrated Dresden physiologist, who published a work called 'Die Proportions-Lehre der Menschlichen Gestalt' in 1854. His views are well expressed in a letter to Quetelet, which the latter quotes. He says: 'I have considered the proportions of man as an object of morphology, and I have tried to find in consequence physical laws to fix that which we may call the canon, or, according to the expression of architects, when they are dealing with the column, the module, of our organization.' Having then given an account of the progress of his ideas, and having stated that the statuary Rictochel had made a figure from his directions, he proceeds: 'It is twenty years and more since I repeated in several places in my writings if anyone wishes to find the true key to our proportion he must set out with the vertebral column, which is, so to speak, the true organic ell divided into twenty-four inches (free vertebræ). When the ovum of a mammal is opened at the commencement of its

formation there is found, as the first model of the future animal, the germinal area grooved in the middle with a line, which becomes the vertebral column at a later period. This line elongates, and in time there may be observed, as a model somewhat more complete of the future animal, a division of this line by the rudiments of vertebræ. To speak correctly, this form is then the first canon of all the other organs of the future skeleton, for after the manner of its production and development should be regulated all the organism. There are extremely interesting relations when the ratios of the length of the free vertebral column are examined in the new-born child and in the adult. In the first (*i.e.* at the end of fœtal life) it is found that the length of all the twenty-four free vertebræ—from the atlas to the last lumbar vertebra—correspond in a normal infant precisely to one-third of the same column of free vertebræ, consisting of twenty-four vertebræ, measured in the adult at the end of the epoch of growth by a line from the spine of the atlas to the spine of the last vertebra.'

The modulus, therefore, which he employed, and which he considered to be both physiologically and philosophically justified, was one-third of the length of the human spine. By applying this rule, then, it ought, in his opinion, to be possible to draw the various parts of the body with mathematical accuracy. 'His investigations,' says Sir George Humphry, 'conducted with all the assiduity and accuracy which characterize the German anatomists, appear to justify the selection, for he found the various parts of the frame to correspond in a remarkable manner with this standard. Thus the length of the skull from the forehead to the occiput equals one module. The height from the vertex to the lower margin of the upper jaw is the same. The circumference of the skull is three modules, or the whole length of the spine. The length of the breast-bone and of the shoulder-blade is in each case one module. The width of the chest from the extremity of one clavicle to that of the other is two modules. In the pelvis each of the measurements from the highest point of the

ilium to the symphysis pubis, from the anterior superior spine to the tuber ischii, and from one anterior inferior spine to the other, corresponds with one module. The arm and fore-arm give three modules and the hand one. The thigh-bone gives two and a half, the tibia two, and the foot, from the ankle to the tip of the toe, one. The height of the body is nine and a half modules. The module measures eighteen centimetres, or rather more than seven inches, making the entire figure five feet six and a half inches, or five feet seven inches. These,' he proceeds, 'are the ideal proportions of the well-developed European, deduced from the measurements of numerous skeletons. They represent the mean between the male and the female, and are stated by Carus to be generally true, though not applicable with mathematical accuracy to any one person, slight deviations from the standard being essential to the endless varieties of individual form. The measurements which I myself have made for the purpose of testing the value of this means of determining the scale of proportions of the figure, though in a general manner confirmative of the results obtained by Carus, have proved that the exceptions to the rules laid down by him are very numerous.' It has been already mentioned that Carus caused to be constructed, according to directions drawn up by himself, a statuette or canonical figure, as he called it. Of this he says: 'No sex has been assigned to this little statue, and it is easy to see that, in order to form a living individuality, the modulus or canon must always be made to vary slightly. For instance, if I wished to depict a woman's body I should give a little less breadth to the shoulders, and I should make some members more voluminous; while I should act exactly the contrary in the case of a man. In the same way the individualities might be varied: if I wished to represent a Cicero or a Leibnitz I should give to the head more than a module in height and length, and less at the extremities; on the other hand, if I wished to represent an athlete or a giant, I should add to the limbs, and should take ten modules or more as the height of the whole body.

By this means one could even succeed in depicting every sort of expression by an algebraical formula, where one would have the same elements, but increased or diminished in their value.' Mr. Roberts' criticism of the foregoing facts and figures is of so much interest that I shall here quote it. 'Thus,' he says, 'it appears that Professor Carus uses his "canon" either as a kind of artist's lay-figure, which he dresses out according to his fancy, or as a skeleton, which he clothes with flesh according to his anatomical and physiological knowledge — knowledge, it must be remembered, which must be first obtained from actual observation and measurement of the living model. The canon may, indeed, be theoretically correct, but it can be of little practical use for scientific purposes. The greater breadth of shoulders required to convert the statue into the figure of a man must first be determined by actual measurement, as must also the greater breadth of pelvis to convert it into the form of a woman, before we can be satisfied that it represents the natural human form. The difficulty would be still greater if it were attempted to represent any decided deviation from the typical form. In the case of a giant, for instance, it is not sufficient to add half a module in equal proportions to the nine and a half modules representing the stature of an ordinary man in order to produce the giant; for actual observation and measurement show that the size of the head and trunk of giants differs little from those of men of ordinary stature, and that the excess of height of the former is chiefly due to an unusual development of the lower extremities relatively to the rest of the body. Professor Carus' canon, moreover, renders no assistance to the study of the progressive development of the body, as we know that the different parts of the body develop at various rates. Thus, in the young child the middle point is near the navel, but in the adult man it is below the pubis.'

Liharzik of Vienna proceeded by the method of averages, his figures being drawn from measurements of three hundred persons, and his researches extending over seven

years. He makes the following statements: The distance above the pubis is to that below as 81 is to 94. The length of the forearm and the hand taken together is to that of the arm as 91 is to 63. The height of the head and neck taken together is to that of the body as 33 is to 175. The length of the foot is equal to that of the forearm. The length of the hand is equal to that of the clavicle, and both are equal to six-sevenths of the forearm or to two-thirds of the humerus. The distance from the centre of the trunk to the extremity of the middle finger is equal to one half the stature.

Amongst the French the older writers on the subject of proportion may be briefly dismissed, though those of a later period will require a longer consideration. Cousin (1502-1590) is the author of a system in which the limbs are enclosed in squares, and the head and neck and the torso in quadrilaterals. Certain of his figures will be referred to hereafter. Poussin (1594-1665) dealt particularly with Leonardo da Vinci's ideas. Testelin (1616) was the author of a work entitled 'Conférences de l'Académie avec les Sentiments des plus habiles Peintures.' His proportions are supposed by Schadow to have been copied from the 'Acus Nautica' of Paggi. Pader (1649), in his 'Traité de la Proportion Naturelle et Artificielle des Choses,' gave exact copies of Dürer's figures, although he only mentioned that artist in his preface. Bardon of Marseilles gave similar tables to those of Testelin, and Horace Vernet, with others, also wrote on the subject of proportion. Gerdy, in his 'Anatomie des Formes Extérieures du Corps Humain,' published in Paris in 1829, set himself the task of finding simple proportions for the human body. He divided the head into four equal parts, and made it the eighth part of the body. The trunk contained three heads, the first from the chin to the nipple, the second from the nipple to the umbilicus, and the third from the umbilicus to the pubis. The lower extremity contained four heads, two from the pubis to the spine of the tibia below the knee, and two more from this point to the

ground. The upper extremity contained three and a quarter heads, one from the shoulder to the front of the elbow, a second from thence to the wrist, and the third from this point to the extremity of the middle finger.

Of this system Quetelet says: 'The relations expressed by the table are extremely simple; but in order to obtain this simplicity it has been necessary to make great sacrifices of truth.' According to Topinard, the canon most in use in French studios is that of Cousin, somewhat modified by Blanc. In this canon the whole body is divided into thirty parts, four of which, equivalent to the seventh and a half part of the body, are allotted to the head, nine to the trunk from the supra-sternal notch to the genitalia, two to the neck, and the remaining fifteen to the lower extremity, of which fifteen, six are allotted to the thigh from the genitalia to above the knee. Topinard gives the following table as the canon of the studios, the total stature equalling 100.

Head	Vertex to roots of hair	1 nose,	3·3	13·2	
	Roots of the hair to root of the nose	1 „	3·3		
	Root of the nose to its base	1 „	3·3		
	Base of the nose to the chin	1 „	3·3		
Neck	Chin to supra-sternal notch	½ head 2 „	6·6	6·6	
Trunk	Supra-sternal notch to edge of pectoral	1 face 3 „	9·9	29·7	
	Pectoral to umbilicus	1 „ 3 „	9·9		
	Umbilicus to root of penis	1 „ 3 „	9·9		
Inferior Extremity	Penis to above the knee	1½ head 6 „	19·9	53·0	
	Knee	½ „ 2 „	6·6		
	Below the knee to the instep	1½ „ 6 „	19·9		
	Instep to the ground	½ „ 2 „	6·6		
			102·5		
Superior Extremity (Cousin).	Shoulder to upper part of wrist	1¼ „ 8 „	25·0	37·5	
	Wrist	¼ „ 1 „	3·1		
	Hand	1 face 3 „	9·3		
	Shoulder to elbow	1¼ head 5 „	15·6	40·6	
	Elbow to upper part of wrist	1 „ 4 „	12·5		
	Hand and wrist	1 „ 4 „	12·5		

Various:
- Span of arms is equal to the stature.
- Maximum breadth of the shoulders is equal to ¼ the stature (Blanc).
- Maximum breadth of the hips is equal to ⅕ the stature (Blanc).
- Clavicle to pubis or trunk; Ilium to patella or thigh; Patella to ground or leg — are equal (Cordier).

In examining this table it should be remembered that, in Blanc's canon, the nose is the 30th part of the body, and is therefore to the stature as 3·33 is to 100. In that of Cousin, the nose is the 32nd part, or 3·124. The head, in that of Gerdy, is 12·5 parts of the 100 comprised in the stature. I shall have occasion further to quote from the great French anthropologist Topinard when dealing with the differences of stature in different races, and with other points at a later period; but this will, perhaps, be the best place to quote his remarks upon the standard European canon, which, on account of their importance, I shall give *in extenso*. He points out, in the first place, that in order to arrive at really accurate results it would be necessary to obtain thoroughly accurate measurements of at least one hundred absolutely typical Europeans, measurements of which, at the time of writing his book, he was not possessed. 'However,' he says, 'as it is urgent that we should possess a standard of comparison to which a traveller can refer his measurements, so that he may be understood when he says that in a certain population the upper or lower extremities are long or short, and since, naturally, the European nations are those on which such a canon should be based, I have set aside my scruples and devised a canon relating to the adult male of our countries of about 1·65 m. in stature. In order to do this I have put together all the partial results on which I believe that I can rely, have taken into account my own measurements, and have adopted the most justifiable compromise amongst them all. The canon of proportion for the anthropologist, I need scarcely say, is the vertical figure of a man divided into one hundred parts, in which are represented the segments of the body, each with the number of parts which enter into its composition in the vertical as well as in the transverse directions—so far, at least, as possible. I have not considered it necessary,' he proceeds, 'to endeavour to obtain an approximation nearer than that of 0·5, although two-tenths added or subtracted from any part of the body have often a great importance in the differentiation of races

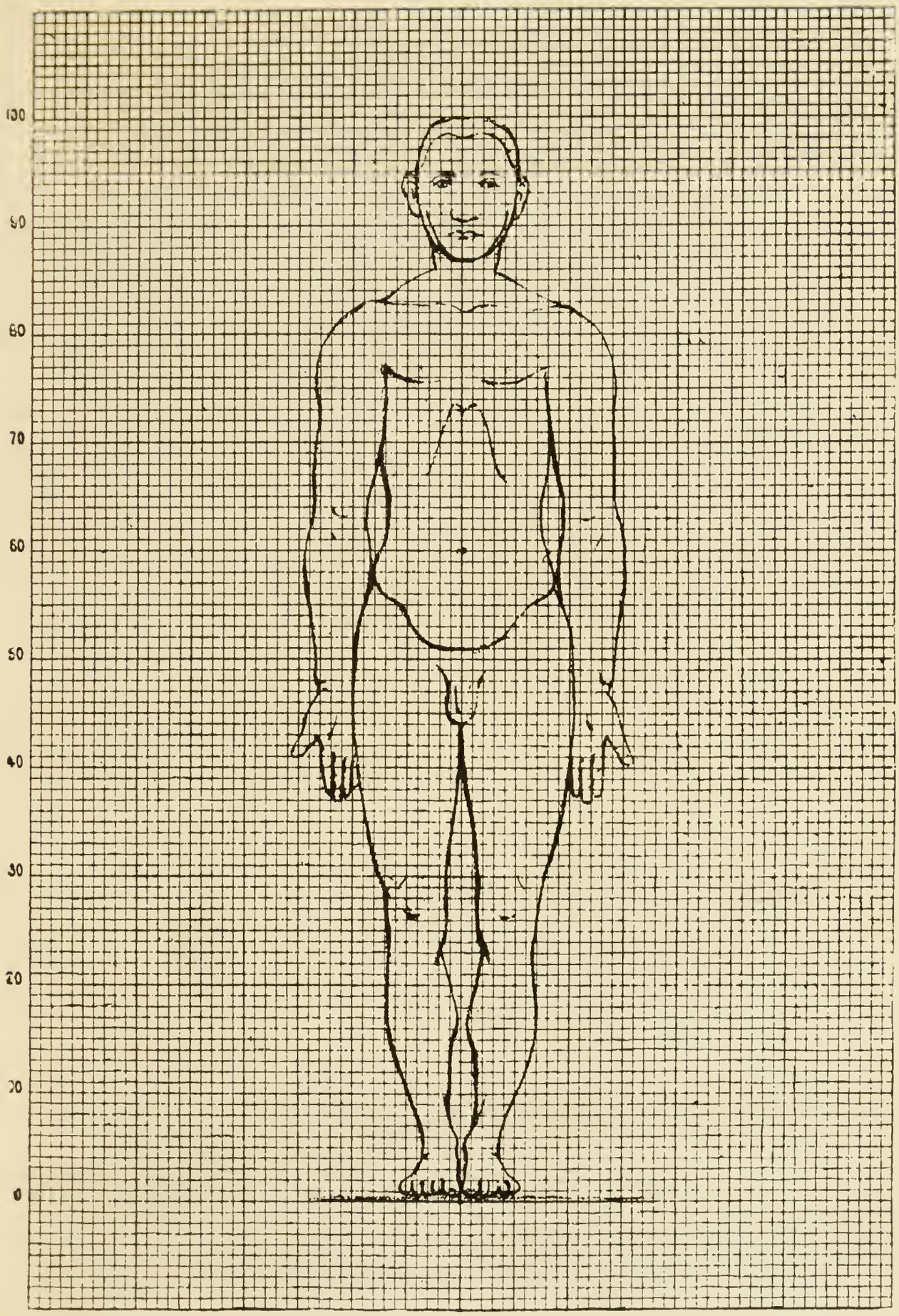


FIG. 4.—Scheme of proportions of Paul Topinard.—The human body divided in the vertical direction into one hundred equal parts.

from this aspect, and in the determination of the influences of environment and of education on the proportions. The following table gives the elements which have served for the construction of the figure:

Mean canon of the European male. Stature = 100.

	Head, vertex to chin	13·3	100
	Neck, chin to supra-sternal notch	4·2	
	Trunk, notch to seat	35·0	
	Inferior extremity, seat to ground	47·5	
Superior Extremity	Arm, acromion to olecranon	19·5	45·0
	Fore-arm, olecranon to styloid process	14·0*	
	Hand†	11·5	
Inferior Extremity	Thigh, seat to centre of knee	20·0	47·5
	Leg, knee to malleolus	23·0	
	Malleolus to ground	4·5	
	Foot	15·0	
	Height of umbilicus	60·0	
	,, ,, pubis	50·5	
	Span of arms	104·4	
	Maximum width of shoulders	23·0	
	,, ,, pelvis	16·9	
	,, ,, hips	18·8	

'It will now be interesting to compare the canon which has just been given with that already stated as the canon of the studios. The chief differences are as follow: The head, higher than that of Cousin and Gerdy, is practically the same as that of Blanc; that is to say, it is contained seven and a half times in the stature. The neck, which all artists find too long in the canon of Blanc, is nearly that of Cousin. The inferior extremity in its entire length, estimated by the height of the pubis to permit of comparison, is notably too long in the system of Blanc. It is, on the contrary, too short in the two canons of Cousin and Gerdy; the divisions are bad in the system of the latter. The span of the arms used by artists is absolutely false, for it is equal to the height only once in every ten cases. The shoulders and the hips are too large, and the umbilicus is too high. The height of the pubis can only

* The line of separation between the arm and fore-arm is here taken at the superior part of the olecranon.

† 'This proportion, being the total of the three segments of the limb, is less when the member is measured in a straight line from the acromion to the extremity of the middle finger. I have considered, however, that this difference might be neglected.'

be measured approximately, but it has an exceptional importance, because it is in its neighbourhood that the centre of the body in the vertical direction is to be found. M. Sappey, whose measurements relate especially to this point, places it 13 mm. below the pubis, at the root of the penis. This agrees very well with my conclusions, but not with the canon of Blanc, which places it lower still.'

Before leaving for the present the observations of Topinard, to which I shall have again to recur, it should be remembered that his conclusions are of the greatest weight, being based upon accurate measurements and comparisons. They will be used as a touchstone by which the various canons may be judged at a later part of this work.

In Spain, Philip Borgogna is the author of a system which estimates the stature of the adult male as being equivalent to nine and one-third times the height of the face. Juan de Arphe y Villafãne, who, like Borgogna, studied at Toledo, published in Seville, in 1585, a work entitled 'Varia Commensuracion para la Escultura y Arquitectura,' in four books, of which the second dealt with human proportions. According to Choulant, this book contains a large number of plates, some of which give figures of the whole body, and others separate portions thereof, with scales of measurement, from which we gather that the author had seen Dürer's figures of proportions. The representations are, however, more true to nature, more living and more spirited. Two male and two female figures are represented, in each of which the stature is made equal to the length of the faces. Chrisostomo Martinez (1650-1691 or 4) was the author of a work in which appeared the plate represented in Fig. 5. According to Quetelet, he made the stature contain eight heads. It may be noted of this last writer, that his figures of skeletons were regarded by the great anatomist Winslow as models of what such drawings should be.

In Holland, S. van Hoogstraeten, born at Dordrecht in 1627, published at Rotterdam in 1678 his 'Polymnia,' in

which he gave three plates illustrative of the proportions of man. In the first plate he represents two men, one being fifteen, the other sixteen, palms in height; and as his head

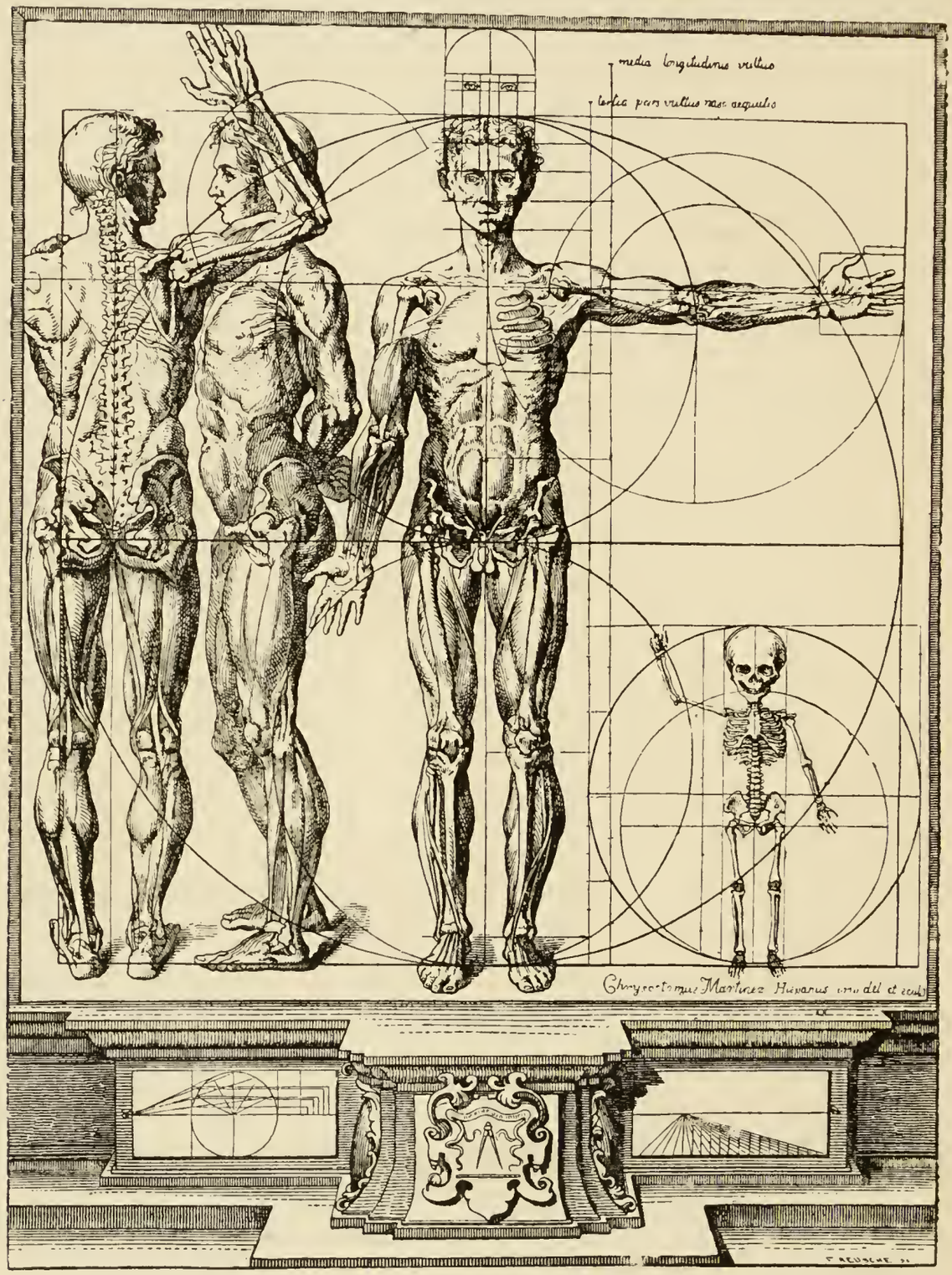


Fig. 5.—Plate by Chrisostomo Martinez (Choulant).

contained two palms, it follows that these two figures were respectively of seven and a half and eight heads in height. In his second plate he represents a female figure divided into fifteen parts: seven of these are from the ground to the

genitalia, and seven from this point to the line of the eyes, by which method of division the legs are made shorter than the upper part of the body. The arms and hands of both his male and female figures are made too short.

In Belgium, Johan de Laet, of Antwerp, published an edition of Vitruvius, in the appendix of which he quotes Pomponius' canon, as given in his work on sculpture, as being nine faces. Geerardt de Lairesse (1640-1711) makes the following statements: 'The eyes are at such a distance apart that a third can be placed between the two. The nose is one-third of the length of the face. The mouth is as large as an eye. The ears are at the level of the eyes above and of the nose below, however long or short it may be.' Van Brée of Antwerp published in 1821 his 'Leçons du Dessin,' in which he uses the head as a modulus, dividing it into four parts. This writer, who was the first professor in the Academy at Antwerp, gives in his books a number of measurements from ancient statues, which are, however, according to Quetelet, of doubtful accuracy. The most useful work which has appeared in Belgium, an epoch-making book, is that of the last-named author—'Anthropométrie ou mesure des différentes Facultés de l'Homme.' In this work Quetelet commenced by giving a sketch of the labours of former writers in the same field, to which I have to express my indebtedness for many of the facts which I have laid before you. Having thus cleared the ground, he proceeds to give the result of his own observations as to the proportions of the adult male and female body, the laws of growth, the influence of locality, food, profession, and other factors of the environment upon the stature and proportions. As I shall have to mention many of his observations at a later stage, I shall not in this chiefly historical portion delay longer over his writings. I have now to pass to the English writers on the subject of proportion, to whom Quetelet pays the high compliment of saying that 'amongst the different schools which have occupied themselves with the proportions and symmetry of man, there is, perhaps, none which has considered this important subject

from a higher and juster standpoint than that of England.' In the first rank he mentions Sir Joshua Reynolds, some of whose observations I have already quoted. Flaxman, in his lectures on Sculpture, has dealt with the same question. John Chamberlain published in 1796 a book in reversed writing, in which he reproduced Leonardo da Vinci's designs. The late John Marshall, who filled the Chair of Anatomy in the Royal Academy, published a work on the Proportions of the Human Body, of which it will be necessary to give a more detailed account. He divided the axial portion of the body into four principal parts, to each of which again he assigned nine units. Thus the head, neck and trunk, are divided into thirty-six portions. The four portions are thus allotted; the first is the head, which he thus takes as his standard, though dividing it into nine, and not, as many earlier writers had done, into four parts. The second is from the chin to near the lower end of the sternum, a little below the nipples. The third extends from this point to the highest part of the crest of the ilium, and the fourth is placed one unit and a half below the tuberosity of the ischium, that is to say, half a unit below the gluteal fold. I cannot give all his figures, which can be easily consulted by those desirous of pursuing the subject further, but some few are of such importance as to require mention now, whilst I shall return later to the consideration of others. The upper extremity, according to his system, contains twenty-nine and a half units, and the lower forty-one. The entire stature contains sixty-seven units. Now, as the mean height of the inhabitants of the British Isles is 67·3 inches, it follows that his unit is, in the case of the average man, very nearly equal to one inch. Again, if the number of units be reduced to heads, it will be found that the entire stature includes seven heads and four units, or very nearly seven and a half heads, which, from all accurate observations, we may regard as the correct estimate, the classical canon of eight heads to the body making the head too small. In another place he mentions that the supra-sternal notch is equal to

one unit. His comparison of the stature of the female with that of the male is also of much interest. The axial portion of the female he also divides into four parts, each containing nine units, but in this case the units are proportionately smaller than those of the male, being in the proportion of ·933 inches to 1 inch. The four divisions in the female are, first the head, second from the chin to the lower part of the sternum just below the nipples, the third to the upper part of the pelvis, and the fourth to half a unit below the tuberosity of the ischium. The gluteal fold being one and a half units below this, it follows that the female axis is one and a half units longer than four heads. Thus the trunk of the female is proportionately longer than that of the male. The stature of the female is sixty-seven and a half units, or exactly seven and a half heads, and thus the head in the female is slightly smaller proportionately than that of the male. The lengthened proportions of the female torso are due to three facts. First there is a proportional or actual elongation of the spine, and especially of its lower portion, the lower limit of the third of Marshall's divisions reaching in the female to the upper part of the fifth lumbar vertebra, and in the male to the lower part of the same vertebra; secondly, there is a greater arching of the lumbar column, making the anterior wall more convex supero-inferiorly; and, thirdly, there is the greater obliquity of the pelvis, which also causes a lowering of the hips. Before leaving the English writers, I should not omit to mention Mr. Roberts' book, 'A Manual of Anthropometry,' published in 1878, which, though not primarily intended for artists, contains many useful figures and observations to which I shall have shortly to recur.

In concluding this historical part, it may be convenient to tabulate the names of the authors who have dealt with the subject of the Proportions of the Human Body. I also add the names of several works in which the student who is desirous of pursuing his studies in the history of the subject further will find more full information.

YEARS.	ITALY.	FRANCE.	GERMANY.	BELGIUM AND HOLLAND.	ENGLAND.	SPAIN.
0	The two Plinys, Vitruvius					
300	Philostratus					
1300	Cimabue, Giotto					
1400	Ghiberti					
1450	L. B. Alberti, Ghirlandajo, A. Verrochio					
1500	Perugino, Bramante, L. da Vinci			Hubert and Jan Van Eyek		
1525	Raphael, Michael Angelo, Mazzuoli		Albrecht Dürer	Van Orley		A. Berruguetto
1550	Firenzuola, Bandinelli, Ruscelli, Cardi		Lucas Cranach, Jan Holbein			
1575	Luca Longhi, Lomazzo, L., Aug., and Annib. Carrachi	J. Cousin				J. y Villafañe
1600	B. Paggi					
1625		N. Poussin		Rubens, Van Dyck		
1650		Hilaire Pader	Von Sandrart	Rembrandt		
1675		H. Testelin, J. B. Corneille		S. van Hoogstraeten		C. Martinez
1700		A. Audran	Daniel Priesler, Bergmuller	G. de Lairesse, J. de Witt		
1725		Gérard Audran, Dugrez, Ch. Ant. Jombert, N. Cochin				
1750	Volpatto	Bouchardon, André Bardou, Cochin fils	Ant. Raph. Mengs, J. Winckelmanns	Bd. G. Camper	Jos. Reynolds, Jno. Chamberlain	
1775		Watelet, Buffon	G. Lichtensteger, Meil	M. van Brée	Flaxman	
1800		David	Pflugfelder, J. Mattersberger			
1825		Gerdy	Schadow, Sömmering	Martinet	D. Granville	
1850	G. B. Sabattini	H. Vernet	Carus, Zeising, F. Liharzik, C. Schmidt, G. Röber	Fock	Hay, Bonomi, Humphry	
1870		Topinard		Quetelet	Roberts, Marshall	

Books dealing with the History of the Subject.

Schadow, J. G., Polyclet oder von den maassen des menschen, nach dem geschlechte und alter mit angabe der wirklichen naturgrösse, u.s.w. Folio and 4to. Berlin, 1834. (German and French.)

Quetelet, L. A. J., Anthropométrie ou mesure des différentes Facultés de l'Homme, 8vo., Bruxelles, 1870.

Topinard, P., Eléments d'Anthropologie Générale, 8vo., Paris, 1885.

Choulant, L., Geschichte und Bibliographie der Anatomischen Abbildungen, u.s.w., Leipzig, 1852.

Roberts, C., A Manual of Anthropometry. London, 1878.

PART II.—CRITICAL.

In the foregoing pages I have endeavoured, though necessarily briefly, to lay before you an account of the labours of the numerous workers in the field of proportion. It remains for me to point out, so far as they are known, what exactly are the proportions of the human body, and how and under what circumstances they undergo modification.

Before doing so, however, it may be well to call attention to two points which strike one forcibly in reviewing the history of the subject. The first is, that the credit of commencing, and for many years carrying on this study, is due to artists, and not to men of science. Long before Anthropometry as a branch of Anthropology had taken its place as an object of scientific study, artists in many countries had devoted their time and attention to endeavouring to ascertain and lay down for their own guidance, and for that of their pupils, a law of proportion for the human body. But when the scientific study of the measurements of the human body was commenced, an important difference between the methods which were then adopted and those of the preceding workers at once became apparent, and this is the second point upon which I wish to dwell. What the artist observers, very naturally, had chiefly striven after, was grace and elegance; what the scientific observer sought was absolute accuracy. The artist had in some cases, as in that of Sir Joshua Reynolds, contented himself with giving a poetic, or perhaps it would be more accurate to say a purely æsthetic explanation of the proportions of the body, or in other cases he was led

away by his artistic feelings into giving rules for the construction of impossible or non-existent forms. And in this they were followed by some of the writers representing the science of their day. I have a curious book by William Salmon, the author of an English edition of 'Diemerbrock's Anatomy,' himself a professor of physic, which is entitled 'Polygraphice, or the Arts of Drawing, Engraving, Etching, Limning, Painting, Washing, Varnishing, Gilding, Colouring, Dyeing, Beautifying and Perfuming.' It also contains incongruously enough 'The one hundred and twelve Chymical Arcanums of Petrus Johannes Faber, a most learned and eminent Physician, translated out of Latin into English, and an Abstract of Choice Chymical Preparations, fitted for Vulgar Use, for curing most Diseases incident to Humane Bodies.' It was evidently a popular book, and one of which the author was proud, for the copy in my possession is stated to be 'The fifth Edition; Enlarged with above a thousand considerable Additions; Adorned with XXV. Copper Sculptures; the like never yet extant.' In his fourteenth chapter, Salmon gives an account of human proportions, to which he adds directions how to make a 'side way head,' and how to describe the 'fore-right face.' He commences by stating that the length of an upright body is equal to eight times the length of the face or head, thus falling into the error of the ancient writers. But he afterwards proceeds to give instructions for the proportion of a man of ten faces, the face being the same as what we now call the head, since the first of his ten equal divisions begins at the top of the head and reaches to the root of the chin. He also gives the proportions of a man of eight faces, of a young man of nine faces, and finally the proportion of a body of seven heads, which last I shall quote, since I think it affords a key to the idea which permeated this custom of drawing figures of different proportions. He says, 'The length from the crown of the head to the sole of the foot is seven times the length of the head; this is a large head, and all the members and limbs are answerable to it—viz., strong,

sturdy, and raised. Yet the ancient Grecians painted only the goddess Vesta with this proportion, it being grave and matron-like. But you may give it to any other goddess which has any kind of grave or solid resemblance, as also to the more staid and ancient sort of women, to Sibylls, Prophetesses and such like, whom to draw with a slender and delicate proportion would be a great oversight—as also to draw a prophet with the proportions of a young man.' Here we see the conventionalism which was, I think, in some measure accountable for these unnatural canons of stature, the same conventionalism which rendered it necessary for certain characters to be played on the stage in certain conventional dresses, regardless of whether such dresses were correct or not. From this spirit of conventionalism, art has been by degrees emancipated, and as this has taken place, there has sprung up a greater desire for accuracy of details anatomical or otherwise.

I shall now proceed to examine in order the proportions of each part of the body, giving in connection with each what appears to me to be the best established opinion. I shall also mention the differences existing between the two sexes, and between various races, leaving the question of the changes due to growth and age to be dealt with in a subsequent section. In this part I shall take the measurements of Topinard as my standard of comparison, since they appear to me to be the most careful and complete.

Head.—The head was by the ancients generally considered to be contained eight times in the body, though this proportion is one which, as we have already had occasion to note, is frequently departed from. I give here a few figures, with the authority for each, and others appear in the more elaborate table of Topinard :

Statue.	*Heads.*	*Authority.*
Pythian Apollo	$8\frac{1}{2}$	Humphry.
Farnese Hercules	8	Quetelet.
Laocoon	$7\frac{2}{3}$	Duval.
Antinous	$7\frac{1}{2}$	*Ibid.*
Gladiator	8	*Ibid.*

Moreover, more modern artists have varied the canon con-

siderably; thus, in some of Michael Angelo's figures the size is equal to nine, or even to twelve heads, in order to communicate more grace to a stooping attitude (Humphry). Roberts errs in making it the seventh part of the whole height, though he also says that the proportion may vary between six and eight, and in the case of giants, nine times; while in dwarfs it may form a fourth part of the height.

Quetelet makes the male head 7·4, or very nearly seven and a half times included in the stature.

Topinard gives the following table showing the proportion of the head to the body, as expressed by various artists. The second column shows what this amounts to in numerical terms of the stature, the latter being taken as 100.

Canon.	*Heads.*	*Stature* = 100
Hindoo - - - - - - -	$6\frac{5}{6}$	14·6
Egyptian (two statues) - - - -	$7\frac{1}{2}$	13·2
Greek (mean of 11 statues varying from 7 to $8\frac{1}{4}$) - - - - - -	$7\frac{2}{3}$	13·0
Roman (Vitruvius) - - - -	8	12·5
Italian (Alberti) - - - - -	$7\frac{1}{2}$	13·2
Prussian (Schadow) - - - -	$7\frac{1}{3}$	13 6
French (Cousin) - - - - -	8	12·5
„ (Gerdy) - - - - -	8	12·5

Having thus laid down the figures employed by various artists, and after tabulating a number of figures ascertained by anthropologists, he makes the following remarks upon the two sets: The canon of Vitruvius adopted by Gerdy and Cousin exists only in the imagination of the authors; the Greek canon is that of Europeans with small heads, and more particularly, perhaps, of those of Mediterranean races; the Hindoo canon, which relates to the yellow Dravidian races, is approximately correct; and, finally, the canon of Schadow, which was formed from fair races of tall stature with long and narrow faces, is also approximately correct. The European races have shorter heads, although amongst these are met with higher types, such as the Belgians. The yellow races have very notably higher heads. The negroes of Africa

are in this respect nearer the first, and the negroes of Oceania are nearer the second. Using the language of artists, and speaking of the large average, it may be said that the stature of Europeans is equal to seven and a half heads, that of negroes to seven, and that of typical yellow races to six and a half. This figure Topinard has expressed in his own canon, which I gave at a former period; he there makes the head 13·3 of the stature, an amount which is contained a trifle more (·25) than seven and a half times in the one hundred parts allotted to the stature. This also coincides with the canon of Marshall, in which the head is nine parts of a stature of sixty-seven, giving seven heads and four units, or very nearly seven and a half heads for the stature.

We may, I think, conclude that in representing the average European male this figure may be accepted as accurate. When the number of heads is decreased an appearance of heaviness and dwarfishness is imparted to the figure. When it is increased slightly it may give an appearance of greater gracefulness to the person, yet still without sacrifice of truth; but when it is carried to eight heads the boundary is passed. A good idea of the effect produced by altering the number of heads in the stature of a figure will be gained by examining the linear scheme of the Germanicus and Apoxyomenos (Fig. 3, p. 27), the former containing rather more than seven and a half heads, and the latter nearly eight and a half. Camper has given an example of the difference produced by adopting these two standards, by comparing the pictures of Watteau with those of Rubens. The figures of the former, having eight heads instead of seven, are more graceful than those of the latter, notwithstanding the wonderful power of execution and colouring exhibited by that great master. It should also be remembered that some of the great artists—and this specially applies to the sculptors—varied the proportions, and even totally falsified them, because of the peculiar circumstances under which their work was to be viewed. Thus, as I have already mentioned, Michael

Angelo made some of his stooping figures as much as twelve heads; and, as Topinard points out, if the head was to be seen from below and in perspective, being placed in an elevated situation, it was increased in size, and the body was made to contain it no more than six times. With regard to differences in proportion between the male and female head, there is some variety of opinion. Quetelet says that the male head is contained 7·4 times in the stature, and the female 7·2, thus the head in woman is somewhat longer proportionately than in man. Topinard also says that in general the head is higher in women than in men, and that this is probably the case in all races. On the contrary, Marshall makes his female figure contain exactly seven and a half heads, and his male seven and four-ninths, the former thus having proportionately a smaller head. The following relations between the different parts of the face are given by Quetelet, who says: 'We may remark an admirable harmony which exists between the principal parts of the human physiognomy. Each of its essential parts has an extremely simple relation with the neighbouring portion, and this harmony is so striking that it cannot escape the most superficial observation, even without the aid of measurements. Thus, artists have well recognised that in a regularly proportioned body the size of the eye is equal to the distance between the two eyes; it is also equal to the length of the nose. This proportion is so simple, and at the same time so constant, that it enters into the first notions of design. It has, perhaps, been less remarked that the ear, an organ apparently of little importance and of irregular form, remains at all ages exactly equal to the size of the two eyes. The measurement must be taken in the direction of the greatest size of the ear. This rule is subject to so few variations that in my tables the greatest differences in the averages do not amount to more than a millimetre; this regularity is still more remarkable since the ear is of all the organs of sense that which attracts usually the least attention. The size of the

ear is also half the distance from its opening to the summit of the head. A relationship not less curious is that which exists between the size of the eye and that of the mouth, the values being in the ratio of two to three. This relation is absolute at the period of puberty; the mouth is smaller in infancy on account of the fatness of the cheeks; it becomes a little larger at a more advanced age. These relationships can be pushed still further, and it will then be found that the eye is contained five times in that diameter of the head which is taken through the temples, and seven times in the antero-posterior diameter.'

Neck.—When we come to consider the measurements of the remaining portions of the axial part of the body, we are met with the difficulty that different observers have not always taken the same points for their observations, which makes any comparison of them exceedingly difficult. This is especially the case in connection with the measurements of the trunk proper, as we shall shortly have occasion to notice; but it is not less true of the neck. According to Quetelet, this is defined as being the area included between two parallel lines drawn, the one below the chin, the other above the point of junction of the clavicles. This is a trifle higher than the measurements which are taken, as in Topinard's work, to the suprasternal fossa, but so little so as to be negligable in the case of artists. Marshall makes the length of the neck in the male three units, or one-third of a head; and in the female three and a half units, or a little longer, the difference in proportional length being explained by him by the fact that in the female the sternum is placed at a lower level, the clavicles being thus also depressed internally, and the upper ribs have a greater obliquity. If we compare these measurements with Topinard's standard, which for the neck is 4·2 parts of one hundred, we find that, calculated in the same manner, Marshall's figure would amount to 4·4 for the male, or a little longer than that of the French author. Blanc, on the contrary, makes it one nose or one-fourth head in length, which is too short. The transverse measurement of the

neck in the male is four and a half units, or exactly one half head; in the female it is four units. The antero-posterior measurements in the two sexes are five units and four and a half units respectively; thus the female neck is proportionately more slender than that of the male.

Trunk.—There are three methods of considering the trunk as an object of measurement. The first of these is to take the measurements of the spinal column from the first dorsal vertebra to the termination. The second, which is strictly anatomical, is to disregard the clavicles and other portions of the shoulder-girdle above as belonging properly to the upper extremity, and to confine the measurements to the thoracic, abdominal, and pelvic cavities. The third, which is certainly the most useful from an artistic point of view, is to include the portion omitted in the second, and to measure the trunk as it appears to exist in the nude figure clothed with its skin and muscles. This is the system adopted by the French Society of Anthropologists, whose directions state that measurements are to be taken from the suprasternal notch to the seat, that is, to that portion of the body which rests upon the ground, or upon a chair, in the sitting posture. Topinard's conclusions drawn from measurements made in various ways are as follows: The relation of the trunk, considered as the vertebral column, varies within narrow limits, as Carus, who on this account took it as his standard of comparison, had already pointed out. At the same time differences do exist; thus, the Esquimaux and the Tasmanians, so far as the measured cases go, have a trunk shorter than the average; the Samoyedes, the Indo-Chinese, the Polynesians, and the South Americans, all yellow races, have one which is longer. The mean of 108 Europeans examined being 33·8, we may say, in order to assist the memory, that the average of humanity is 33·33, or one-third of the stature. The character seems to vary somewhat in different races; but amongst Europeans the female has proportionately a longer trunk. Finally summing up all the evidence which he has been able to obtain

from various sources, he concludes that in whatever manner measurements be taken, provided that similar observations be compared with one another, the trunk will be found to be longer in the yellow races, shorter in those of the negro type, and of intermediate length in white races, though exceptional cases are met with in each which are contrary to the rule. The female has a longer trunk, at least amongst European nations; and in individuals of lofty stature the trunk is longer. Turning now to Marshall's directions, it will be found that he agrees with Topinard in making the female trunk longer, and this for reasons which I have already detailed. His measurements are taken to a point one and a half units below the tuberosity of the ischium, which is the bony point on which the body rests in the sitting posture, and we must, therefore, subtract this figure from the twenty-seven units which he allows for the trunk and neck. We have seen that he allows three of these for the neck, thus four and a half must be deducted in all. If we reduce the figure of twenty-two and a half units thus obtained to the same terms as those employed by Topinard, we find that it comes out as 33·5, which is very nearly the figure given by the French author.

The intrinsic measurements of the trunk have also been dealt with by Marshall, and the following are his principal results. In the transverse direction the measurement from one deltoid prominence to the other—that is, the extreme breadth of the shoulders in the nude subject—is in the male two heads; that is exactly one-half of the length of the axis, that from one acromion process to the other, or the maximum breadth of the skeletal shoulders, being one unit less. In the female the deltoid measurement is seventeen units, or one unit less than two heads, and thus it is proportionately shorter than in the female. The distance between the nipples is one head in the male, one unit less —or eight units—in the female. The normal waist in both sexes is ten units, being thus one sixty-seventh of the stature more than a head. The width of the brim of the

pelvis is eleven units, and the measurement across the trochanters the same in the male, whilst in the female these two figures are twelve and a half and fourteen and a half units respectively. The following table gives three of the more important antero-posterior measurements in the male and female respectively:

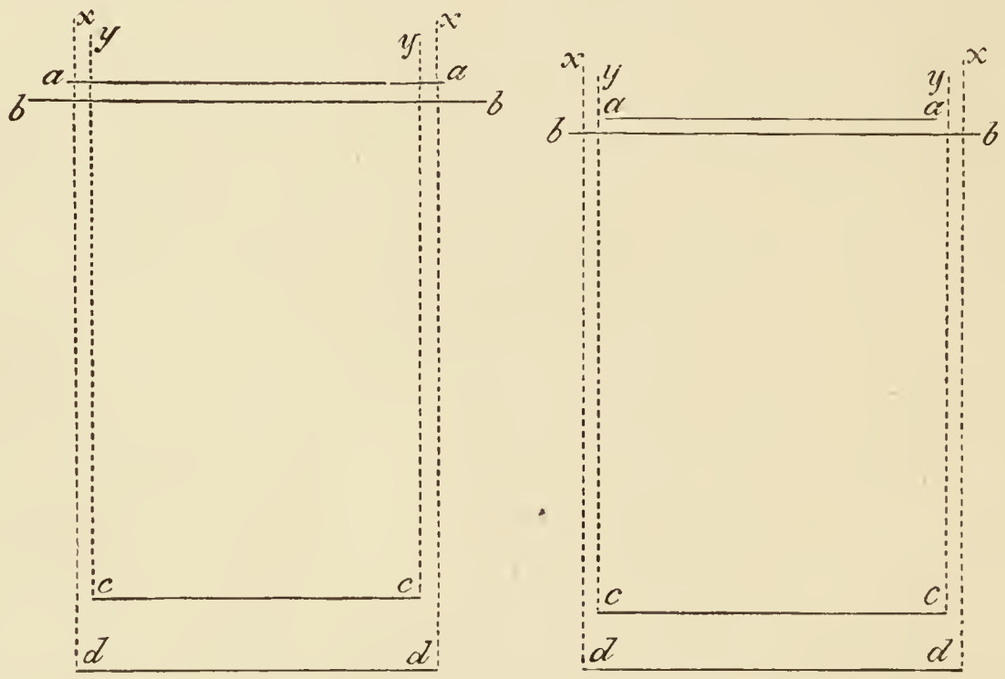
	Male.	*Female.*	
Level of nipples - - -	$10\frac{1}{2}$	$9\frac{1}{2}$	units.
Waist - - - - -	8	8	
Gluteal prominence - -	9	$10\frac{1}{2}$	

From these measurements it will be obvious that in the male the transverse and antero-posterior diameters are greater above—that is, in the region of the shoulders—than below, in the region of the hips; whilst in the female, though the superior are also greater, the difference is not so marked as in the male. On this important point Duval has the following remarks, which I think worthy of quotation. Comparing the diameter of the hips with that of the shoulders, he says: 'What strikes us most in this comparison, at the first glance at a series of skeletons, is the great projection which the hips form in the female. In order to express this, various formulæ have been proposed. They consist in considering the trunk as a figure more or less regularly oval, of which one extremity corresponds to the shoulders, the other to the hips, and in determining, according to the sex, which diameter exceeds the other. The ancients did not hesitate to express this formula in the following manner: In the male and in the female the trunk represents an ovoid—that is to say, an oval similar to that of a figure of an egg, having a greater and a lesser extremity; but in the male this has its greater extremity superior, while in the female the greater is inferior. Therefore in the female the diameter of the hips exceeds that of the shoulders, while in the male it is the diameter of the shoulders which exceeds that of the hips. This formula, as regards the female, is evidently exaggerated, as we see in a moment by comparing the actual figures. It seems, in fact, to Savage and Malgaigne, to be exaggerated, and

in their works on anatomy they propose substituting the following formula: Allowing that the trunk of the male is an ovoid, with the greater extremity superior, the trunk of the female forms an ellipse—that is to say, a figure in which both extremities are of the same dimensions; therefore in the male the diameter of the shoulders exceeds that of the hips, and in the female the diameter of the hips does not exceed that of the shoulders, but is only just equal to it. Now, this last formula also exaggerates the real proportions of the hips in the female. The correct formula is as follows: In the male, as well as in the female, the trunk represents an ovoid with the greater extremity superior; but while in man the difference between the greater extremity and the lesser is very considerable, in the female this difference is very slight. We shall see by figures that in the female the diameter of the hips, though always less, differs very little from that of the shoulders. In the male the distance from the head of one humerus to the corresponding part on the opposite side (inter-humeral diameter) is on the average $15\frac{1}{4}$ inches, and the measure taken from one great trochanter to the other (inter-trochanteric diameter) is $12\frac{1}{4}$ inches; therefore there is between the two diameters a difference of about one-fifth. In the female the inter-humeral diameter is on the average 14 inches, the inter-trochanteric diameter is $12\frac{1}{2}$ inches; therefore there is between the two diameters a difference of only one-twelfth. These figures also serve to demonstrate that the diameter of the shoulders is much greater in the male than in the female (15 to 14), and that inversely the diameter of the hips is much greater in the female than in the male ($12\frac{1}{2}$ to $12\frac{1}{4}$); so that if a man and a woman of average stature are supposed to throw their shadow on the same portion of a screen, the shadow of the shoulders of the male would cover a much larger surface than the shadow of the shoulders of the female; and, on the contrary, the shadow of the hips of the woman would exceed the shadow of the hips of the man, but only to a very small extent.

'By the diameter of the hips we have in the preceding considerations understood the inter-trochanteric diameter. There is, however, a method of considering the subject which justifies to a certain extent the formulæ adopted by the authors previously mentioned. It consists in comparing on the skeleton in both sexes the diameter of the pelvis (the femora being removed) with the diameter of the shoulders (the humeri being removed). Then the shoulders are represented by the *inter-acromial diameter*, and the hips by the *inter-iliac* (from one iliac crest to the other). Under these circumstances the exact measurements show that in the male the inter-acromial diameter is twelve and three-quarter inches and the inter-iliac eleven inches; therefore, as in the preceding, the trunk, deprived of its members, still represents an ovoid, with its greater extremity superior. But we see that in the female, the inter-acromial diameter being eleven and a half inches, the inter-iliac increases to twelve inches, and therefore that here the trunk, deprived of its members, represents an ellipse or an ovoid, with its greater extremity inferior, the superior extremity differing very little in size from the inferior. But this mode of mensuration does not express the subject as it exists; for the artist does not consider the trunk as otherwise than complete—that is to say, provided with its superior and inferior members—and it is necessary to take into account the part which they take in the diameters of the trunk by the presence of their extremities (the head of the humerus and the great trochanter). We have thought fit, however, to show here this mode of mensuration, for it explains clearly the greater diameter of the pelvis in the female compared with that of the male. If we arrange in a table the figures given in the preceding for the inter-humeral, inter-trochanteric, inter-acromial, and inter-iliac diameters in the male and in the female, or if, better still, we represent those figures by proportionate lines intended to express, on the profile of a man and that of a woman, the proportionate value of the diameters of the pelvis and the hips, and if we cause vertical lines to pass

through the extremities of the inter-iliac and inter-trochanteric diameters, we obtain two figures which express in a striking manner all that has been pointed out (Figs. 6 and 7). We see, in fact, that in the male subject (Fig. 6) the vertical lines (y, y) passing through the extremities of the inter-trochanteric (d, d) and the inter-iliac (c, c) diameters, both fall within the extremity of the inter-humeral diameter (68), and also the inter-acromial (a, a). On the contrary, in the female (Fig. 7) we find that these same vertical lines both fall within the extremities of the



Figs. 6 and 7.—Diagrams comparing the diameters of the hips with the diameters of the shoulders in the male (Fig. 6) and in the female (Fig. 7).

inter-humeral diameter, but on the outer side of the inter-acromial.'

The following table will supply accurate information on this point, and show the exact relations of the parts in the two sexes:

Relation of the maximum size of the hips to that of the shoulders = 100

100 male Parisians	83·0
30 female Parisians	91·8
30 male Belgians	82·5
30 female Belgians	94·5

Before leaving the subject of the trunk, there are certain points of some interest to artists which may well be disposed of in this connection, and the first of these is the

position of the umbilicus. According to Vitruvius, as we have already seen, this was placed at the central point of the body, so that if a man were laid on his back with the arms and legs extended a circle might be described around them, having the umbilicus as its centre. This statement is incorrect, save for one period, and that an early one of life—that is, at two years of age. The central point of the body is, according to Roberts, at the time of birth, when the child is about the sixth of the height it will ultimately attain to, a little above the umbilicus; at two years it is at the umbilicus; at three years, when the child has attained half its total height, the central point is on a line with the upper borders of the iliac bones; at ten years of age, when the child has attained three-quarters of its total height, the central point is on a line with the trochanters; at thirteen years it is at the pubes, and in the adult man it is nearly half an inch lower. In the adult woman the central point is a little above the pubes. Topinard gives the following table, which shows the position of the umbilicus according to various artists and anthropologists. The stature is considered as 100, and the figures show the proportion of that amount between the ground and the umbilicus:

Greek sculptors	60·7
Alberti	60·0
Schadow	60·9
Gerdy	62·5
10 Belgians, 25 years old (Quetelet)	60·4
100 Parisians (A. Bertillon)	58 9

The position of the centre of gravity also differs slightly in the two sexes. The line of gravity passes through the occipital condyles, the middle of the sacrum, the head of the femur, the patella, and the arch of the foot; it is thus a little in front of the knee, and a great deal in front of the ankle. The centre of gravity in the male is three and a half units above the upper border of the acetabulum—that is to say, thirty-nine and a half units above the ground. In the female the centre of gravity is four units above the upper border of the acetabulum.

Upper Extremity.—There are several methods of arriving at the measurements of the upper extremity, which may be divided into direct and indirect. The former are three in number. The first is to measure from the acromion to the extremity of the middle finger, the arm being extended,

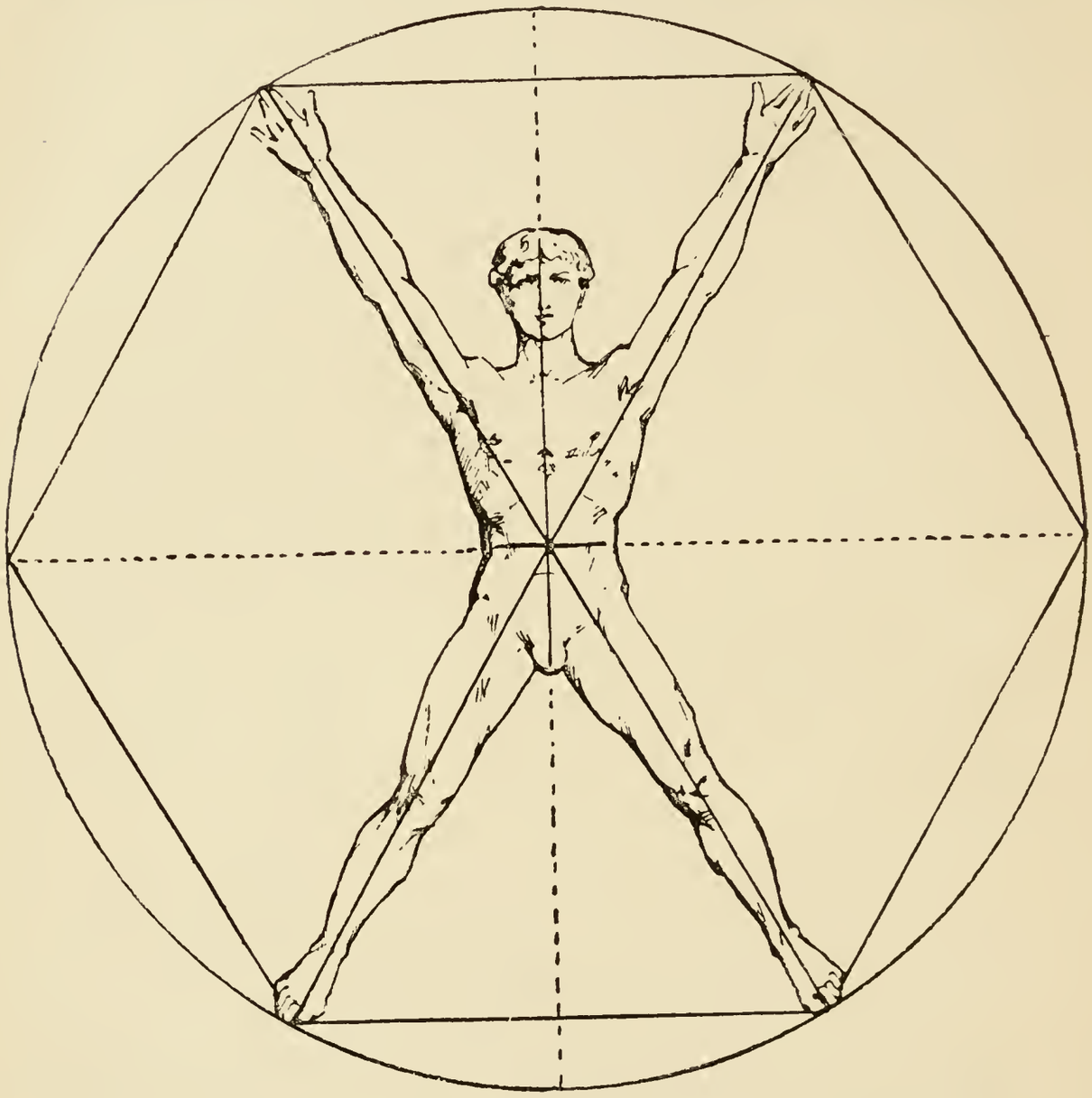


Fig. 8.—The human figure described within a circle.

by which means, however, the length arrived at is somewhat too short, since the head of the humerus, which lies in the axilla, is not fully taken into account. The second is to add together the measurements of the various segments of which the extremity is composed. This also gives a somewhat false figure, since the limb in a natural condition is not extended in a perfectly straight line, the arm and forearm meeting at an obtuse angle at the elbow.

The third is to measure from the acromion to the extremity of the middle finger when the arm is lying by the side of the body. The two indirect methods are, firstly, to ascertain the distance between the extremity of the middle finger and the superior border of the patella when the arms are lying straight by the side, as in the military position known as 'attention.' The second method is to measure the full span of the two arms when fully extended from the shoulders—a method to which I shall have shortly to return.

The length of the whole upper extremity in the male is, according to Marshall, twenty-nine and a half units, and in the female twenty-nine. The following table will show the division of these figures between the different segments of the limb :

	Male.	*Female.*
Humerus - - - -	13 units	12½ units
Radius - - - -	9 „	9 „
Hand - - - - -	7½ „	7½ „
	29½	29

Reducing the figure in the male to terms of the stature, the latter being considered as 100, so as to compare the result with that given by Topinard, we find that the proportion is forty-four, whilst that of the French author is forty-five. The differences in the points of measurement adopted by the two authors may account for this discrepancy, which is in any case not very large. With regard to the relation of the limb to other parts of the body, it may first be mentioned that, according to Marshall, the top of the shoulder-joint is thirteen units below the vertex. It must not, however, be forgotten that this is a figure which may vary within certain limits in persons of the same stature and possessing limbs of the same length, according to whether they are square-shouldered or round-shouldered, to use the common phrases. The position of the middle finger, with regard to the trunk, in the position of 'attention' is also one of importance. In the European of average height it corresponds usually to the middle of

the thigh; in subjects of short stature the extremity of the hand descends a little lower than the middle, and in very tall men it is a little higher. In the yellow and black races the extremity of the middle finger descends considerably lower than the middle of the thigh. It is interesting to note that in the highest apes the position of the same point gradually descends still farther. Thus in the chimpanzee it is placed below the knee; in the gorilla it corresponds to the middle of the leg; whilst, finally, in the orang-utang and in the gibbon it nearly reaches to the ankle. The facts respecting the position of the middle finger in different races are also brought out by the following table, which give the distance between its point and the centre of the patella in figures relative to the stature (=100):

1,061 sailors (white) - - -	8·73
10,875 American soldiers - - -	7·49
517 Iroquois Indians - - -	5·36
2,020 negroes - - - - -	4·37

Turning now to the intrinsic measurements of the upper limb, we may first consider the relation between the arm and the forearm, a subject which has received considerable attention, what is known as the antibrachial index being founded on the measurements of the two parts when compared with one another. In the first place, in the adult condition, the forearm of the negro is much longer in comparison with the arm than that of the European. The measurements, for example, of five Congo negroes gave an average of 93·4, the arm being considered as 100, whilst the measurements of thirty Germans gave 83·5 to 100 as the proportion between the same two parts. Amongst white and yellow races, however, there is no special rule to differentiate one from another by the comparison of the segments of the limb. The relation of the hand to the body stature is a matter of considerable interest to artists, since it has been taken as the canon by several writers. Respecting the racial variations of this part, Topinard says that, speaking generally, Europeans have the smallest hands, with the exceptions of the true gipsies (Tziganes),

who have still smaller. The largest hands are met with amongst the yellow races, whilst the negroes hold a middle place in this respect. The following table will give an idea of the manner in which the hand has been used as a canon, the figures being the number of times which it was included in the stature:

Greek artists (Topinard) - -	10·9
Vitruvius - - - - - -	10·0
Dürer - - - - - -	10·0
Cousin - - - - - -	9·3
Duval - - - - - -	10·0
Roberts - - - - - -	9·0
Quetelet - - - - - -	9·0
Marshall - - - - - -	8·93
Topinard - - - - - -	8·69

From this table it will be noticed that artists in general, and those of antiquity in particular, have made the hand too small in proportion to the stature. It should, however, be mentioned that Duval says that his figure is subject to great variations. Taking all the figures into consideration, we may say that the hand is contained nine times in the stature of the average European.

The full span of the arms when extended at right angles from the trunk is another measurement which has attracted the attention of artists; it is the *grande envergure* of the French. We have already noticed Vitruvius's statement that the span was equal to the stature, and that this is accepted as accurate in the canon of the French studios as given by Topinard. Duval says respecting this matter: 'The relation of the span of the upper limbs to the height has been expressed long since by the formula known as the square figure of the ancients. If we cause two horizontal lines to pass, one at a tangent to the soles of the feet, the other at a tangent to the summit of the head, and two vertical lines at right angles to the extremities of the two arms extended horizontally, these four lines form by their junction a perfect square; in other words, the man having the arms horizontal is enclosed within a square. This shows that the span of the arms is equal to the height. This statement is correct for a man of the Caucasian race

of the middle height; but it is not so for the yellow and black races, in whom the span of the arm is greater than the height. If from man we pass on to the superior monkeys called anthropoid (chimpanzee, gorilla, etc.), we find that the span of the arms in these becomes more and more extended as compared with the height until it becomes almost double. Thus, in the gorilla, the height being 5 feet $7\frac{1}{4}$ inches, the span becomes 8 feet $9\frac{1}{4}$ inches; and in the chimpanzee, to a height of 5 feet $5\frac{1}{4}$ inches, the

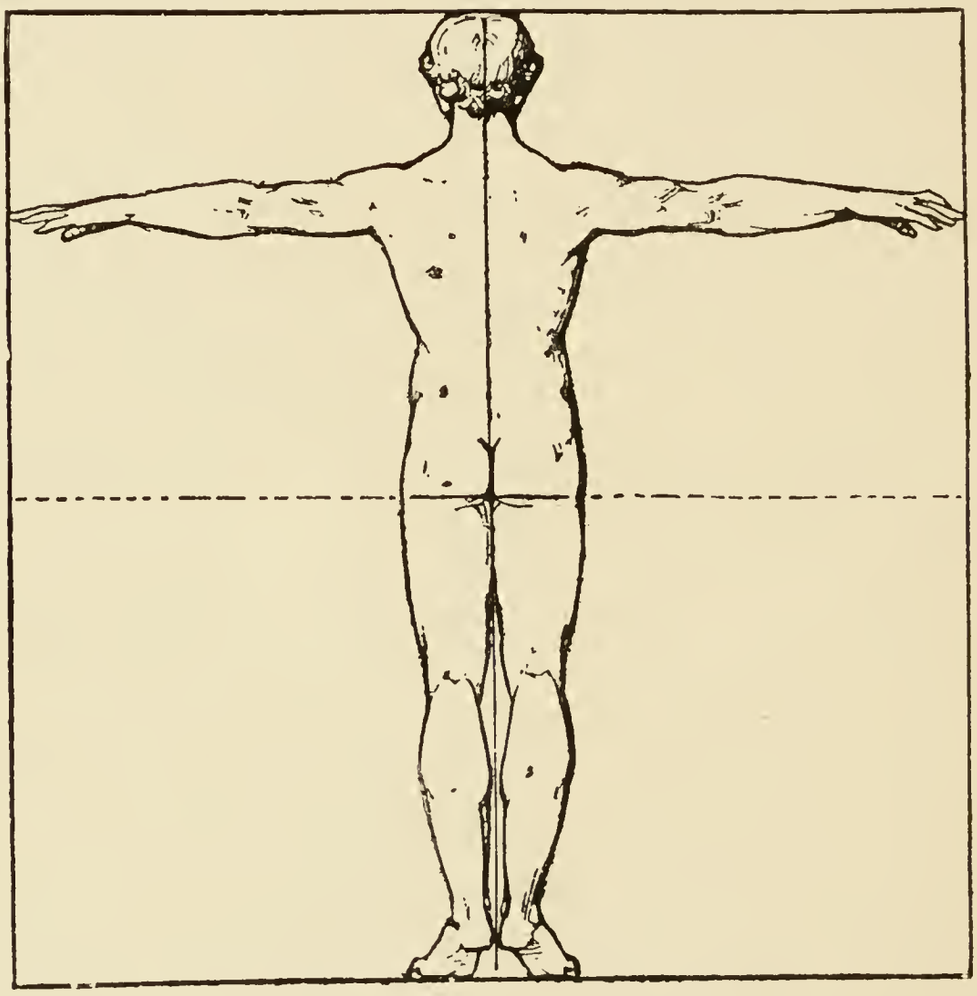


Fig. 9.—The human figure inscribed within a square.

corresponding span is 6 feet 6 inches.' The statement, however, that the span equals the stature is not absolutely correct, for the relation between the two, though very variable, is in favour of the span as compared with the height.

Roberts states that the theory which holds that the span is equal to the height is true only within certain limits, namely, from the time of birth to that of puberty, a state-

ment which is true of both sexes. After puberty more decided changes in the proportions take place, the horizontal being greater than the perpendicular measurement, especially in men, whose chest and shoulders have a greater development in breadth than women. The ratio of height to the measurement of the extended arms is in the adult man as 1 to 1·045, and in women as 1 to 1·015. Duval notes certain relationships between parts of the upper extremity, which may conveniently be given here in the form of a table:

The length of the hand, less the third phalanx of the middle finger, is equal to:

the clavicle,
the vertebral border of the scapula,
the manubrium and gladiolus sterni, taken together,
the distance between the scapulæ when the hands are hanging by the sides,
half the length of the humerus,
two-thirds of the length of the forearm.

But, as he remarks, these proportions are so variable that they cannot be insisted upon.

Lower Extremity.—The difficulties of measuring this limb are even greater than those attaching to the upper, since the head of the femur is buried in the acetabulum and covered over by a mass of muscles, which render its identification extremely difficult. The following table shows the proportions of the various parts according to Marshall:

	Male.	*Female.*
Femur - - - - - - -	18 units	18 units
Tibia - - - - - - -	14 „	14 „
Foot, from lower border of tibia to end of second toe - - -	9 „	8 „
	41	40

From this it appears that the lower extremity in the female is proportionately one unit smaller than in the male, and that this difference is found altogether in the foot.

Another useful series of figures, readily to be remem-

bered also, are those relating to the position of different joints from the vertex, which are:

	Male.	*Female.*
Shoulder - - -	1 head 4 units	1 head $4\frac{1}{2}$ units
Hip - - - -	3 „ 4 „	3 „ 5 „
Knee- - - -	5 „ 4 „	3 „ 5 „
Sole of foot - -	7 „ 4 „	7 „ $4\frac{1}{2}$ „

The following antero-posterior measurements are also worthy of notice:

	Male.	*Female.*
Knee - - - - - -	$4\frac{1}{2}$ units	5 units
Calf - - - - - -	5 „	$4\frac{1}{2}$ „
Foot - - - - - -	$10\frac{1}{2}$ „	$9\frac{1}{2}$ „

From the difference in the points from which measurements are taken it is difficult to compare Topinard's measurements with these, save in the case of the foot. According to the latter author, this forms 15 parts, the stature being represented as 100. Marshall's proportion, reduced to the same terms for the male, comes to 15·6, for the female to 14·17, and the average between the two to almost 15. The difference between the figures may, of course, be racial.

The measurement of the foot, like that of the hand, is of peculiar interest to artists, since it has also been used as a canon of stature. The following table shows the number of times which the foot is included in the stature according to various authorities:

Greeks - - - - -	6·44
Vitruvius - - - - -	5·9
Alberti - - - - -	6·5
Dürer - - - - -	6·0
Schadow - - - - -	6·6
Quetelet (male) - - - -	6·75
„ (female) - - -	6·25
Duval - - - - -	6·33
Marshall - - - - -	6·38
Topinard - - - - -	6·6

The remarks of some of the authors on this point are of interest. Roberts says that at all ages of life and in both sexes it forms from the 0·15 to 0·16 of the total height of the individual; it is, however, comparatively a little longer

at the period of adolescence, but rather shorter in children and adults. Taking the length of the foot for unity, the total height of man would be six and three-fourths, and of women six and one-fourth. It is generally believed that the length of the foot is equal to the height of the head; but this is only true of the age of ten years; before that period the head is longer, and after it shorter, than the foot. Duval notes the interesting point that the length of the foot being considered as six and one-third times contained in the stature, as he believes to be correct, if one-third of the foot be taken as a canon, it will be found to be contained nineteen times in the stature. But the number nineteen is the same as that which, according to Blanc, in the Egyptian canon expresses the proportion which the middle finger bears to the height.

Quetelet, from whom the remarks quoted above by Roberts are taken, also says: 'It is in drawing the foot that mistakes are most frequently made; in fact, it is so customary to make it too small that the proportion is falsified in all designs where the artist has preferred to please the public rather than to express the truth. Often, in fact, in fashion plates the foot is not represented one-half its correct size. We may say that there is scarcely any human measurement which is more frequently altered; there is a species of foolishness which prevents nature from producing the exact size of this member, and substitutes for it another, which at the same time destroys the harmony of the body and the firmness of its support. The Chinese have even carried these exaggerated tastes to such a pitch that their most distinguished women blush if they know how to walk. It appears that this faculty should only belong to servants.' The same author mentions that, speaking generally and starting from the age of puberty, the height of the head forms a proportional arithmetical mean between the length of the hand and that of the foot. Examining this by Topinard's figures, which give for the foot 15·0, for the head 13·3, and for the hand 11·5 respectively, we find that the statement is approximately correct.

Quetelet also notes that, according to a well-established belief, the length of the foot is equal to the circumference of the fist, so that we often see drapers wrap the foot of a stocking round the fist in order to avoid the trouble of direct measurement of the hand. This belief, he thinks, is fairly established by his tables, although Roberts does not consider that there is much foundation for it.

Duval endeavours to establish some easy relations between the parts of the lower limb, and says that here, as in the case of the hand, we cannot make the foot a common measure for the interior extremity. It is easy, he says, to perceive upon the skeleton that the distance from the superior extremity of the head of the femur to the inferior border of the internal condyle is equal to two feet; but this has no practical value; it cannot be used on the living body, as it is difficult to recognise the level of the superior part of the femur. If, instead of the head of this bone, we take the superior border of the great trochanter (a part easily felt beneath the skin), we find that the length from that point to the inferior border of the external condyle scarcely ever measures two lengths of the foot; in fact, the great trochanter is upon a considerably lower level than the head of the femur. The leg, including the thickness of the foot, does not contain the length of the foot an even number of times; in fact, the distance from the inferior border of the internal condyle of the femur to the ground (or the sole of the foot) is not equal to twice the length of the foot; but it is interesting to observe in general that the length of the leg, plus the thickness of the foot, is equal to the distance from the great trochanter to the inferior border of the external condyle; therefore, the middle of the lower limb (starting from the great trochanter) corresponds exactly to the line of the knee. When we compare the length of the foot with the leg, beginning from below upwards, we find a regular proportion and one of practical interest, viz., that from the ground to the middle of the patella usually measures twice the length of the foot.

I have now concluded that portion of my lectures which deals with the proportions of the adult human body, and before passing to the final section, in which I shall give some notes as to the growth of the body and its constituent parts, I think it well to make one remark. I have throughout that portion of my remarks which I am now concluding contrasted Marshall's canon of proportion with the careful figures given by Topinard, and the reader can scarcely have failed to notice that the two correspond in a very remarkable and uniform manner. Now, Marshall's rule was devised for artists; it was intended to meet their requirements, and, so far as I am aware, though here I speak under correction, it is well fitted to do so. It is satisfactory to find that his conclusions are so well grounded and so corroborated by the scientific figures, so that in using his rule, use is made of one which is scientifically accurate, as well as artistically useful. I have now to turn to the consideration of the method of increase of the human body and of its various parts, a portion of my subject which I trust will not be without usefulness and interest.

It will be noticed that the proportions of the infant when first it makes its appearance in the world are very different from those which it has when it arrives at the period of adult existence, and that between these two epochs the proportions are constantly altering, one part of the body chiefly increasing at one time and a second at another. It will also be noticed that the proportion in two sexes, which, as we have seen, are in many instances different in the adult, for some time remain the same during childhood, and that on arriving at a certain age they commence to take on their adult characters and to differentiate from one another.

The facts stated in this section are chiefly from the works of Roberts and Quetelet; having made which acknowledgment, I need not refer more particularly to the author of any individual statement.

As regards height, at the time of birth there is but little

difference between the stature of the male and female infant, the average for the former being 19·34 inches, and for the latter 18·98 inches. Thus, the actual longitudinal proportions almost coincide, whilst the relative ones absolutely do so. Between the fourth and the ninth years the relations remain much the same, but towards the thirteenth year the female gets in front of the male, and is larger and heavier. After this period the growth of the male becomes more rapid; he soon passes the female, and eventually the adult differences between the sexes are established. The difference between the sexes in respect to height are due to several causes. In the first place, as noticed above, the female is a little smaller at birth. In the second place, after the thirteenth or fourteenth year the growth of the female is considerably feebler than that of the male, and finally the growth of the former is concluded about two years before that of the latter. The last of these causes is the most potent in determining the difference in stature, for the initial difference is abolished, or indeed reversed, at the thirteenth year; but at the period when growth is terminated there is an average advantage in stature of males over females of four inches.

Taking the head, this portion of the body is contained three times in the axis at the time of birth, a proportion which is maintained until the fourth year; at the ninth year the axis is three and a quarter times as long as the head, at the fifteenth three and three-quarters, and at the twenty-fifth four times. In relation to the stature, the head is at birth contained four times in the body-length. But we have already seen that in the adult it is contained seven and a half times, from which facts it follows that the head grows only half as rapidly (nearly) as the remainder of the body. As a matter of fact, it doubles its height between the time of birth and that of adult life. This increase is, however, not evenly distributed over the whole head, since the lower part grows more than the upper. This is shown by the fact that the lower part of the nose,

which in the adult divides the face into two equal parts, is in the infant placed much nearer to the chin.

The neck, which is short at birth, apparently becomes shorter during the first few years of life; this apparent decrease in size is due to the accumulation of fat at the chin of the infant.

The torso triples in length and in width. The relations of its antero-posterior diameters in the infant and in the

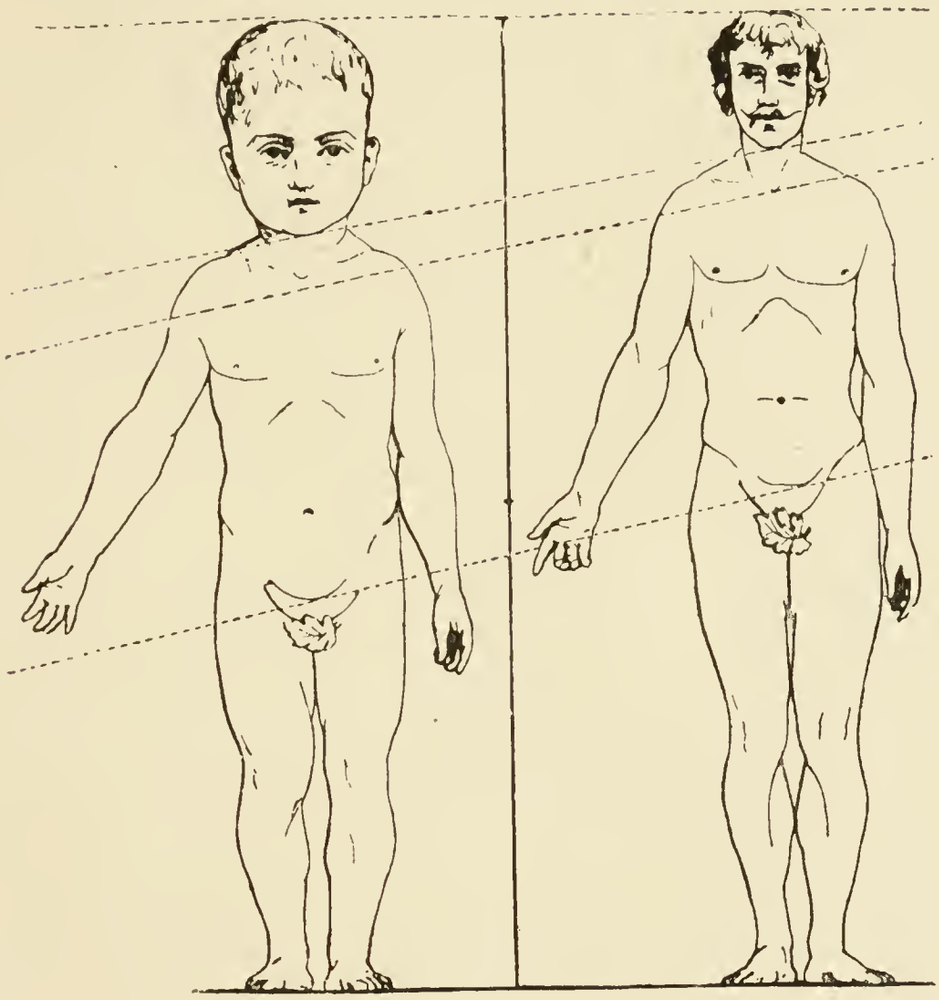


FIG. 10.—A comparative representation of the infantile and adult figures, both being shown as of the same height. The relation between the various parts of the body and of the limbs is shown by the dotted lines. Convergence of the line towards the side of the adult shows proportional diminution of size, and divergence increase, or, in other words, less or greater increase of size during the time of growth (Langer).

adult are as 1 to 2·36; thus, increase in this direction is not as great as in the other two. Quetelet has shown by the employment of two triangles that the increase in size of the torso, like that of the head, is not the same in all its

parts. If we construct a triangle having its base situated at a line drawn between the two nipples and its apex at the suprasternal notch, it will be found that the two sides are less in their respective measurements than the base. After the first year this difference is twenty-one millimetres, and this difference is maintained almost exactly throughout the period of development; thus, the growth of this portion is proportionately even. The proportions between the base in the infant and the adult are as 1 is to 2·81, and those of the sides at the same epochs as 1 to 3·41. The height of the

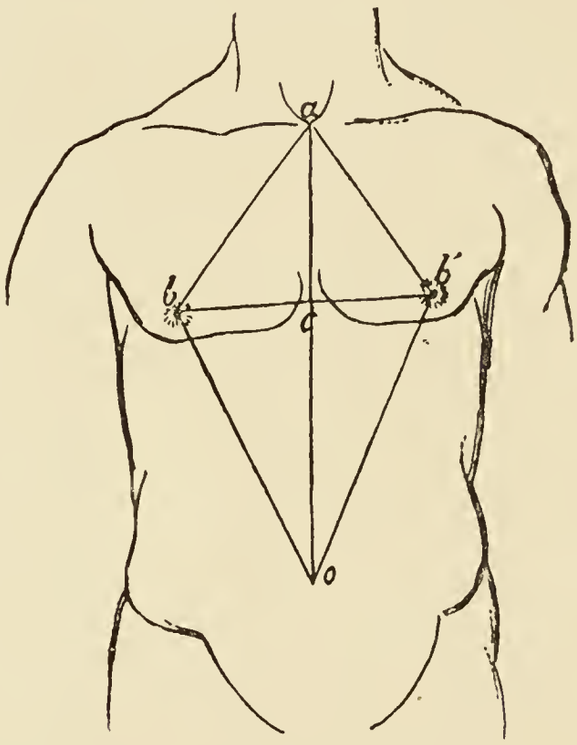


FIG. 11.—Triangles showing growth of thorax and upper part of abdomen (Quetelet).

triangle in the infant is to that of the adult as 1 to 3·78, so that, as we have seen that the whole torso triples during growth, the increase of this part is more rapid than that of the whole. If now the length from the base of this triangle to the umbilicus be taken, and the differences between the child and the adult represented proportionately, it will be found that they are as 1 to 2·42, or less than the general growth of the torso. From these figures we may conclude that the portion between the nipples and the upper part of the thorax grows more rapidly than that between the first-

named points and the umbilicus. I am now assuming that Quetelet's figures are correct on this point, and should mention that he expressly states that they apply only to the male sex, since this part of the body is subjected to so much artificial treatment in the female that it is not possible to come to accurate conclusions respecting it.

The upper extremity, with the hand included, is three and a half times longer in the adult than in the infant. The hand, however, grows more slowly than the remaining parts, doubling between the fifth and seventh years, and tripling between this date and the termination of development. If the arm be considered without the hand, it doubles between four and five, triples between thirteen and fourteen, and is four times the infant size at the termination of growth. The forearm grows more than the arm proportionately, the proportion between the former in the child and adult being as 1 to 4·26, and of the latter as 1 to 3·78. The circumferences at the biceps and elbow increase two and three-quarter times nearly.

The lower extremities, measured from the fork to the sole of the foot, double their length before the third year; at twelve years they are four times, and at twenty years five times, their original length. These are Quetelet's figures. According to Marshall, the whole lower extremity increases four and a half times during the process of development. The various segments do not increase at the same rate, for the thigh grows more rapidly than the leg, and the leg than the foot. Thus there is this difference between the growth of the upper and the lower extremities: that the greatest amount of growth in the former takes place in the middle segment, whilst in the latter it is in the segment which is nearest to the trunk. It will also be remarked that the lower extremity increases proportionately to a greater extent than either the stature, the torso, or the upper extremity. Turning now more particularly to the growth of the various segments of the lower limb, the thigh in the adult is 7·31 times the length of the same part in the child. Thus the increase in this part is far in excess of

that of any other part of the body. The leg, measured from the lower edge of the patella, increases four and a half times, the height of the foot three and a quarter times, and its length three and a half times.

As I have had occasion at an earlier part of this lecture to call your attention to the differences between the proportions of the arm and the forearm in the European and the negro, I think that the following remarks on that subject in connection with the rate of increase with which I have just been dealing may not be without interest to you. 'With regard to the proportions of the different segments of the extremities,' says Humphry, 'in the earliest periods the arm and thigh are respectively shorter than the forearm and leg, and the latter are respectively shorter than the hand and foot. During development and growth these proportions gradually become reversed; but the final relations between the several segments are not established until after puberty. At birth the arm, leg, and foot are of about equal length, and the hand is a little longer than the forearm. These facts are interesting as showing clearly that in its earlier conditions the most perfect human form presents more numerous approximations to the type of the negro, and likewise to that of the quadrumanous animal, than at subsequent periods. They show, also, that it is during the work of development and growth that the lower extremities attain their greater relative dimensions, and that the proximal segments of both upper and lower extremities come to bear that large proportion to their distal parts whereby the European type is characterized. Thus the difference in type between the negro and the European is reduced to a mere matter of growth, and it is shown that, so far as the extremities are concerned, a transient condition of the one corresponds with a permanent condition of the other. The same remark applies also to the dimensions of the trunk. Till the period of puberty the European and the negro more nearly correspond. It is not till after that period that the greater proportionate breadth of chest and pelvis is attained in the former.'

I must in conclusion say a very few words as to the influence of occupation upon the proportions of man. This, however, is a matter upon which much further work will be necessary before it is possible to draw any conclusions of real value. Everyone is aware that occupation, or at least certain occupations, produce a very marked effect upon the person and the physiognomy, but exactly in what this difference anatomically consists is not always so easy to say. The same remarks may be made respecting the influence of the general environment upon the stature—a subject on which Quetelet, from observations made upon dwellers in the cities and country parts of Belgium, remarks that the average stature in the towns is very much the same as that of the country people, though the former have a slight advantage in point of height. Speaking on this point, Topinard says: 'Have mountaineers longer or shorter legs? Both opinions have been maintained, but theoretically. Do some professions lengthen the parts employed and atrophy those disused? Everybody says so, but there are no direct proofs.' The most important document which was at Topinard's disposal in this matter is a comparison between soldiers, sailors, and students in America, which I give in a tabular form:

	10,876 soldiers.	1,061 sailors.	291 students.
Vertex to seventh cervical vertebra	14·81	15·28	14·82
Seventh cerv. vert. to perineum -	38·93	37·22	38·34
Perineum to knee - - - -	18·55	19·48	18·59
Perineum to ground - - -	27·71	28·02	28·25
Acromion to elbow - - -	20·25	19·95	20·14
Elbow to end of middle finger -	23·16	23·28	22·47

Each of these figures is referable to the stature, which is considered as 100. From the table it follows that the sailors have, in relation to the soldiers, a shorter trunk, longer portions of the lower extremity, a shorter arm, and a slightly larger forearm. Amongst the students, in comparison with the soldiers, the trunk, the leg, and the

forearm are a little shorter. What can be deduced from these facts? Is it the influence of occupation which ought to be invoked? In the case of the sailors, undoubtedly so. But amongst the students there is another factor to be considered, that of age, for their average age was only about twenty years, that of the soldiers being thirty-five.

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