SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, OCTOBER 30, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ADDRESS OF THE PRESIDENT OF THE SECTION OF ANTHROPOLOGY OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

IT is now nearly twenty years since anthropology attained to the dignity of being awarded a special and independent section in this association, and I believe it is generally admitted that during this period the valuable nature of many of the contributions, the vigor of the discussions and the large attendance of members have amply justified the establishment and continued existence of this section.

While the multifarious and diverse nature of the subjects which are grouped under the term anthropology gives a variety and a breadth to our proceedings, which are very refreshing in this age of minute specialism, I feel that it adds very considerably to the difficulty of selecting a subject for a presidential address which will prove of general interest.

A survey of the recent advances in our knowledge of the many important questions which come within the scope of this section would cover too wide a field for the time at my disposal, while a critical examination of the various problems that still await solution might expose me to the temptation of pronouncing opinions on subjects regarding which I could not speak with any real knowledge or experience. To

* Southport meeting, 1903.

avoid such a risk I have decided to limit my remarks to a subject which comes within the range of my own special studies, and to invite your attention to a consideration of some problems arising from the variations in the development of the skull and the brain.

Since the institution of this section the development, growth and racial peculiarities of both skull and brain, and the relation of these two organs to each other, have attracted an ever-increasing amount of attention. The introduction of new and improved methods for the study of the structure of the brain and the activity of an able band of experimenters have revolutionized our knowledge of the anatomy and physiology of the higher nerve centers.

The value of the results thus obtained is greatly enhanced by the consciousness that they bear the promise of still greater advances in the near future. If the results obtained by the craniologists have been less marked, this arises mainly from the nature of the subject, and is certainly not due to any lack of energy on their part. Our craniological collections are continually increasing, and the various prehistoric skull-caps from the Neanderthal to the Trinil still form the basis of interesting and valuable memoirs.

While the additions to our general knowledge of cerebral anatomy and physiology have been so striking, those aspects of these subjects which are of special anthropological interest have made comparatively slight progress, and can not compare in extent and importance with the advantages based upon a study of fossil and recent crania. These facts admit of a ready explanation. Brains of anthropological interest are usually difficult to procure and to keep, and require the use of special and complicated methods for their satisfactory examination, while skulls of the leading races of mankind are readily collected, preserved and studied. Hence it follows that the crania in our anthropological collections are as numerous, well preserved and varied as the brains are few in number and defective, in their state of both preservation and representative character. It may reasonably be anticipated that improved methods of preservation and the growing recognition on the part of anthropologists, museum curators and collectors of the importance of a study of the brain itself will to some extent at least remedy these defects; but so far as prehistoric man is concerned, we can never hope to have any direct evidence of the condition of his higher nerve centers, and must depend for an estimate of his cerebral development upon those more or less perfect skulls which fortunately have resisted for so many ages the corroding hand of time.

I presume we will all admit that the main value of a good collection of human skulls depends upon the light which they can be made to throw upon the relative development of the brains of different races. Such collections possess few, if any, brains taken from these or corresponding skulls, and we are thus dependent upon the study of the skulls alone for an estimate of brain development.

Vigorous attacks have not unfrequently been made upon the craniometric systems at present in general use, and the elaborate tables, compiled with so much trouble, giving the circumference, diameters and corresponding indices of various parts of the skull, are held to afford but little information as to the real nature of skull variations, however useful they may be for purposes of classification. While by no means prepared to express entire agreement with these critics, I must admit that craniologists as a whole have concentrated their attention mainly on the external contour

of the skull, and have paid comparatively little attention to the form of the cranial cavity. The outer surface of the cranium presents features which are due to other factors than brain development, and examination of the cranial cavity not only gives us important information as to brain form, but by affording a comparison between the external and internal surfaces of the cranial wall it gives a valuable clue to the real significance of the external configuration. Beyond determining its capacity we can do but little towards an exact investigation of the cranial cavity without making a section of the skull. Forty years ago Professor Huxley, in his work 'On the Evidence of Man's Place in Nature,' showed the importance of a comparison of the basal with the vaulted portion of the skull, and maintained that until it should become 'an opprobrium to an ethnological collection to possess a single skull which is not bisected longitudinally' there would be 'no safe basis for that ethnological craniology which aspires to give the anatomical characters of the crania of the different races of mankind.' Professor Cleland and Sir William Turner have also insisted upon this method of examination, and only two years ago Professor D. J. Cunningham, in his presidential address to this section, quoted, with approval, the forcible language of Huxley. The curators of craniological collections appear, however, to possess an invincible objection to any such treatment of the specimens under their care. Even in the Hunterian Museum in London, where Huxley himself worked at this subject, among several thousands of skulls, scarcely any have been bisected longitudinally, or had the cranial cavity exposed by a section in any other direction. The method advocated so strongly by Huxley is not only essential to a thorough study of the relations of basi-cranial axis to the vault of the cranium and to the facial portion of the skull, but also permits of casts being taken of the cranial cavity; a procedure which, I would venture to suggest, has been too much neglected by craniologists.

Every student of anatomy is familiar with the finger-like depressions on the inner surface of the cranial wall, which are described as the impress of the cerebral convolutions; but their exact distribution and the degree to which they are developed according to age, sex, race, etc., still remain to be definitely determined. Indeed, there appears to be a considerable difference of opinion as to the degree of approximation of the outer surface of the brain to the inner surface of the cranial wall. Thus the brain is frequently described as lying upon a water-bed, or as swimming in the cerebro-spinal fluid, while Hyrtle speaks of this fluid as a 'ligamentum suspensorium' for the brain. Such descriptions are misleading when applied to the relation of the cerebral convolutions to the skull. There are, it is true, certain parts of the brain which are surrounded and separated from the skull by a considerable amount of fluid. These, however, are mainly the lower portions, such as the medulla oblongata and pons Varolii, which may be regarded as prolongations of the spinal cord into the cranial cavity. As they contain the centers controlling the action of the circulatory and respiratory organs, they are the most vital parts of the central nervous system, and hence need special protection. They are not, however, concerned with the regulation of complicated voluntary movements, the reception and storage of sensory impressions from lower centers, and the activity of the various mental processes. These functions we must associate with the higher parts of the brain, and

especially with the convolutions of the cerebral hemispheres.

If a cast be taken of the cranial cavity and compared with the brain which had previously been carefully hardened *in situ* before removal, it will be found that the cast not only corresponds in its general form to that of the brain, but shows a considerable number of the cerebral fissures and convolutions. This molding of the inner surface of the skull to the adjacent portions of the cerebral hemispheres is usually much more marked at the base and sides than over the vault. Since the specific gravity of the brain tissue is higher than that of the cerebro-spinal fluid, the cerebrum tends to sink towards the base and the fluid to accumulate over the vault; hence probably these differences admit of a simple mechanical explanation. Except under abnormal conditions, the amount of cerebro-spinal fluid between the skull and the cerebral convolutions is so small that from a cast of the cranial cavity we can obtain not only a good picture of the general shape and size of the higher parts of the brain, but also various details as to the convolutionary pattern. This method has been applied with marked success to the determination of the characters of the brain in various fossil lemurs by Dr. Forsyth Major and Professor R. Burckhardt, and Professor Gustav Schwalbe has made a large series of such casts from his craniological collection in Strassburg. The interesting observations by Schwalbe* on the arrangement of the 'impressiones digitatæ' and 'juga cerebralia,' and their relation to the cerebral convolutions in man, the apes and various other mammals, have directed special attention to a very interesting field of inquiry. As is well known, the marked prominence at the base of the human skull, separating the anterior from the middle fossa, fits into the deep cleft between the frontal and temporal lobes of the brain, and Schwalbe has shown that this ridge is continued—of course in a much less marked form—along the inner surface of the lateral wall of the skull, so that a cast of the cranial cavity presents a shallow but easily recognized groove corresponding to the portion of the Sylvian fissure of the brain separating the frontal and parietal lobes from the temporal lobe. Further, there is a distinct depression for the lodgment of the inferior frontal convolution, and a cast of the middle cranial fossa shows the three external temporal convolutions.

We must now turn to the consideration of the relations of the outer surface of the cranium to its inner surface and to the brain. This question has engaged the attention of experts as well as the 'man in the street' since the time of Gall and Spurzheim, and one might naturally suppose that the last word had been said on the subject. This, however, is far from being the case. All anatomists are agreed that the essential function of the cranium is to form a box for the support and protection of the brain, and it is generally conceded that during the processes of development and growth the form of the cranium is modified in response to the stimulus transmitted to it by the brain. In fact, it is brain growth that determines the form of the cranium, and not the skull that molds the brain into shape. This belief, however, need not be accepted without some reservations. Even the brain may be conceived as being influenced by its immediate environment. There are probably periods of development when the form of the brain is modified by the resistance offered by its coverings, and there are certainly stages

* 'Ueber die Beziehungen zwischen Innenform und Aussenform des Schädels,' *Deutsches Archiv für klinische Medicin*, 1902.

when the brain does not fully occupy the cranial cavity.

At an early period in the phylogeny of the vertebrate skull the structure of the greater part of the cranial wall changes from membranous tissue into cartilage, the portion persisting as membrane being situated near the median dorsal line. In the higher vertebrates the rapid and early expansion of the dorsal part of the fore-brain is so marked that the cartilaginous growth fails to keep pace with it, and more and more of the dorsal wall of the cranium remains membranous, and subsequently ossifies to form membrane bones. Cartilage, though constituting a firmer support to the brain than membrane, does not possess the same capacity of rapid growth and expansion. The head of a young child is relatively large, and its skull is distinguished from that of an adult by the small size of the cartilaginous base of the cranium as compared with the membranous vault. The appearance of top-heaviness in the young skull is gradually obliterated as age advances, by the cartilage continuing slowly to grow after the vault has practically ceased to enlarge. These changes in the shape of the cranium are associated with corresponding alterations in that of the brain, and it appears to me that we have here an illustration of how the conditions of skull growth may modify the general form of the brain.

Whatever may be the precise influences that determine skull and brain growth, there can be no doubt but that within certain limits the external form of the cranium serves as a trustworthy guide to the shape of the brain. Statements such as those by Dr. J. Deniker ('The Races of Man,' p. 53), 'that the inequalities of the external table of the cranial walls have no relation whatever to the irregularities of the inner table, and still less have anything in common with the configuration of the various parts of the brain,' are of too general and sweeping a character. Indeed, various observers have drawn attention to the fact that in certain regions the outer surface of the skull possesses elevations and depressions which closely correspond to definite fissures and convolutions of the brain. Many years ago Sir William Turner, who was a pioneer in cranio-cerebral topography, found that the prominence on the outer surface of the parietal bone, known to anatomists as the parietal eminence, was situated directly superficial to a convolution of the parietal lobe of the brain, which he consequently very appropriately named 'the convolution of the parietal eminence.' Quite recently Professor G. Schwalbe has shown that the position of the third or inferior frontal convolution is indicated by a prominence on the surface of the cranium in the anterior part of the temple. This area of the brain is of special interest to all students of cerebral anatomy and physiology, since it was the discovery by the illustrious French anthropologist and physician, M. Broca, that the left inferior frontal convolution was the center for speech, that laid the scientific foundation of our present knowledge of localization of function in the cerebral cortex. This convolution is well known to be much more highly developed in man than in the anthropoid apes, and the presence of a human cranial speech-bump is usually easily demonstrated. The faculty of speech, however, is such a complicated cerebral function that I would warn the 'new' phrenologist to be cautious in estimating the loquacity of his friends by the degree of prominence of this part of the skull, more particularly as there are other and more trustworthy methods of observation by which he can estimate this capacity.

In addition to the prominences on the

outer surface of the cranium, corresponding to the convolutions of the parietal eminence and the left inferior frontal convolution, the majority of skulls possess a shallow groove marking the position of the Sylvian point and the course of the horizontal limb of the Sylvian fissure. Below these, two other shallow oblique grooves indicate the line of the cerebral fissures, which divide the outer surface of the temporal lobe into its three convolutions, termed superior, middle and inferior. Most of these cranial surface markings are partially obscured in the living body by the temporal muscle, but they are of interest as showing that in certain places there is a close correspondence in form between the external surface of the brain and that of the skull. There are, however, distinct limitations in the degree to which the various cerebral fissures and convolutions impress the inner surface of the cranial wall, or are represented by inequalities on its outer aspect. Thus over the vault of the cranium the position of the fissure of Rolando and the shape of the cerebral convolutions in the so-called motor area, which lie in relation to this fissure, can not usually be detected from a cast of the cranial cavity, and are not indicated by depressions or elevations on the surface of the skull, so that the surgeons in planning the seats of operations necessary to expose the various motor centers have to rely mainly upon certain linear and angular measurements made from points frequently remote from these centers.

The cranium is not merely a box developed for the support and protection of the brain, and more or less accurately molded in conformity with the growth of this organ. Its antero-lateral portions afford attachments to the muscles of mastication and support the jaws and teeth, while its posterior part is liable to vary according to the degree of development of the muscles of the nape of the neck. Next to the brain the most important factor in determining cranial form is the condition of the organs of mastication—muscles, jaws and teeth. There is strong evidence in favor of the view that the evolution of man from microcephaly to macrocephaly has been associated with the passages from macrodontic to a microdontic condition. The modifications in the form of the cranium due to the influence of the organs of mastication have been exerted almost entirely upon its external table; hence external measurements of the cranium, as guides to the shape of the cranial cavity and indications of brain development, while fairly trustworthy in the higher races, become less and less so as we examine the skulls of the lower races, of prehistoric man and of the anthropoid apes.

One of the most important measurements of the cranium is that which determines the relation between its length and breadth and thus divides skulls into long or short, together with an intermediate group neither distinctly dolichocephalic nor brachycephalic. These measurements are expressed by an index in which the length is taken as 100. If the proportion of breadth to length is eighty or upwards, the skull is brachycephalic; if between seventy-five and eighty, mesaticephalic; and below seventy-five, dolichocephalic. Such a measurement is not so simple a matter as it might appear at first sight, and craniologists may themselves be classified into groups according as they have selected the nasion, or depression at the root of the nose, the glabella, or prominence above this depression, and the ophryon, a spot just above this prominence, as the anterior point from which to measure the length. In a young child this measurement would practically be the same, whichever of these

three points was chosen, and each point would be about the same distance from the brain. With the appearance of the teeth of the second dentition and the enlargement of the jaws the frontal bone in the region of the eyebrows and just above the root of the nose thickens, and its outer table bulges forward so that it is now no longer parallel with the inner table. Between these tables air cavities gradually extend from the nose, forming the frontal sinuses. Although the existence and significance of these spaces and their influence on the prominence of the eyebrows were the subject of a fierce controversy more than half a century ago between the phrenologists and their opponents, it is only recently that their variations have been carefully investigated.

The frontal sinuses are usually supposed to vary according to the degree of prominence of the glabella and the supra-orbital arches. This, however, is not the case. Thus Schwalbe* has figured a skull in which the sinuses do not project as high as the top of the glabella and supra-orbital prominences, and another in which they extend considerably above these projections. Further, Dr. Logan Turner ('The Accessory Sinuses of the Nose,' 1901), who has made an extensive investigation into these cavities, has shown that in the aboriginal Australian, in whom this region of the skull is unusually prominent, the frontal sinuses are frequently either absent or rudimentary. The ophryon has been selected by some craniologists as the anterior point from which to measure the length of the skull, under the impression that the frontal sinuses do not usually reach above the glabella. Dr. Logan Turner, however, found that out of 174 skulls in which the frontal sinuses were present, in 130 the sinuses extended above the ophryon. In 71 skulls the depth of the sinus at the level of the ophryon varied from 2 mm. to 16 mm., the average being 5.2 mm., while in the same series of skulls the depth at the glabella varied from 3 mm. to 18 mm., with an average depth of 8.5 mm. It thus appears that the selection of the ophryon in preference to the glabella, as giving a more accurate clue to the length of the brain, is based upon erroneous assumptions, and that neither point can be relied upon in the determination of the anterior limit of the cranial cavity.

The difficulties of estimating the extent of the cranial cavity by external measurements and the fallacies that may result from a reliance upon this method are especially marked in the case of the study of the prehistoric human calvaria, such as the Neanderthal and the Trinil, and the skulls of the anthropoid apes.

Statistics are popularly supposed to be capable of proving almost anything, and certainly if you allow craniologists to select their own points from which to measure the length and breadth of the cranium, they will furnish you with tables of measurements showing that one and the same skull is dolichocephalic, mesaticephalic and brachycephalic. Let us take as an illustration an extreme case, such as the skull of an adult male gorilla. Its glabella and supra-orbital arches will be found to project forward, its zygomatic arches outwards, and its transverse occipital crests backwards, far beyond the anterior, lateral and posterior limits of the cranial cavity. These outgrowths are obviously correlated with the enormous development of the muscles of mastication and those of the back of the neck. In a specimen in my possession the greatest length of the cranium, *i. e.*, from glabella to external occipital protuberance, is 195 mm., and the greatest

* 'Studien über *Pithecanthropus erectus*,' *Zeitschrift für Morphologie und Anthropologie*, Bd. I., 1899.

breadth, taken between the outer surfaces of the zygomatic processes of the temporal bone, is 172 mm., giving the marked brachycephalic index of 88.21. The zygomatic processes, however, may reasonably be objected to as indicating the true breadth, and the side wall of the cranium just above the line where the root of this process springs from the squamous portion of the temporal bone will certainly be much nearer the cranial cavity. Measured in this situation, the breadth of the cranium is 118 mm., which gives a length-breadth index 60.51, and thus represents the skull as decidedly dolichocephalic. The transverse occipital crests and the point where these meet in the middle line to form the external occipital protuberance are much more prominent in the male than in the female gorilla, and the estimate of the length of the cranium in this male gorilla may be reduced to 160 mm. by selecting the base of the protuberance in place of its posterior extremity as the posterior end measurement. This raises the index to 73.75, and places the skull near the mesaticephalic group. At the anterior part of the skull the prominent glabella is separated from the inner table of the skull by large air sinuses, so that on a median section of the skull the distance from the glabella to the nearest part of the cranial cavity is 36 mm. We have here, therefore, another outgrowth of the cranial wall which in an examination of the external surface of the skull obscures the extent of the cranial cavity. Accordingly the glabella can not be selected as the anterior point from which to measure the length of the cranium, and must, like the zygomatic arches and occipital protuberance, be excluded from our calculations if we desire to determine a true length-breadth index. The difficulty, however, is to select a definite point on the surface of the cranium to represent its anterior end, which will be free from the objections justly urged against the glabella. Schwalbe suggests the hinder end of the supra-glabellar fossa, which he states often corresponds to the beginning of a more or less distinctly marked frontal crest. I have found this point either difficult to determine or too far back. Thus in my male gorilla the posterior end of this fossa formed by the meeting of the two temporal ridges was 56 mm. behind the glabella, and only 24 mm. from the bregma, while in the female gorilla the temporal ridges do not meet, but there is a low median frontal ridge, which may be considered as bounding posteriorly the supra-glabellar fossa. This point is 22 mm. from the glabella, and between 50 mm. and 60 mm. in front of the bregma.

I would suggest a spot in the median line of the supra-glabellar fossa which is crossed by a transverse line uniting the posterior borders of the external angular processes of the frontal bone. I admit this plan is not free from objections, but it possesses the advantages of being available for both male and female skulls. In my male skull the selection of this point diminishes the length of the cranium by 25 mm., thus reducing it to 137 mm. The breadth being calculated at 114 mm., the index is 83.21, and hence distinctly brachycephalic. The length of the cranial cavity is 118 mm. and the breadth 96 mm., and the length-breadth index is thus the brachycephalic one of 81.36.

I have given these somewhat detailed references to the measurements of this gorilla's skull because they show in a very clear and obvious manner that from an external examination of the skull one might easily be misled as to the size and form of the cranial cavity, and that, in order to determine from external measurements the proportions of the cranial cavity, skull

outgrowths due to other factors than brain growth must be rigorously excluded. Further, these details will serve to emphasize the interesting fact that the gorilla's skull is decidedly brachycephalic. This character is by no means restricted to the gorilla, for it has been clearly proved by Virchow, Schwalbe and others that all the anthropoid apes are markedly round-headed. Ever since the introduction by the illustrious Swedish anthropologist Anders Retzius of a classification of skulls according to the proportions between their length and breadth, great attention has been paid to this peculiarity in different races of mankind. It has been generally held that brachycephaly indicates a higher type of skull than dolichocephaly, and that the increase in the size of the brain in the higher races has tended to produce a brachycephalic skull. When the cranial walls are subject to excessive internal pressure, as in hydrocephalus, the skull tends to become distinctly brachycephalic, as a given extent of wall gives a greater internal cavity in a spherical than in an oval form. In estimating the value of this theory as to the evolutionary line upon which the skull has traveled, it is obvious that the brachycephalic character of the skulls of all the anthropoid apes is a fact which requires consideration.

Although an adult male gorilla such as I have selected presents in an extreme degree outgrowths from the cranial wall masking the true form of the cranial cavity, the same condition, though to a less marked extent, is met with in the human subject. Further, it is interesting to note that the length of the skull is more liable to be increased by such growths than the breadth, since they occur especially over the lower part of the forehead and to a less degree at the back of the skull, while the side walls of the cranium in the region of its greatest breadth generally remain thin.

Few, if any, fossils have attracted an equal amount of attention or given rise to such keen controversies as the Neanderthal and the Trinil skull-caps. According to some authorities, both these skull-caps are undoubtedly human, while others hold that the Neanderthal belongs to an extinct species of the genus *Homo*, and the Trinil is the remains of an extinct genus—*Pithecanthropus erectus* of Dubois—intermediate between man and the anthropoids. One of the most obvious and easily recognized peculiarities of these skull-caps is the very marked prominence of the supra-orbital arches. The glabella-occipital length of the Neanderthal is 204 mm., and the greatest transverse diameter, which is over the parietal region, is 152 mm.—an index of 74.51—while the much smaller Trinil calvaria, with a length of 181 mm. and a breadth of 130 mm., has an index of 71.8. Both these skulls are therefore slightly dolichocephalic. Schwalbe has corrected these figures by making reductions in their lengths on account of the frontal 'outworks,' so that he estimates the true length-breadth index of the Neanderthal as 80 and that of the Trinil as 75.5. These indices, thus raised about 5 per cent., are considered to represent approximately the length-breadth index of the cranial cavity. A comparison of the external and internal measurements of many recent skulls with prominent glabellæ would, I suspect, show a greater difference than that calculated by Schwalbe for the Neanderthal and Trinil specimens. In a male skull, probably an aboriginal Australian, with a cranial capacity of 1227 c.cm. I found that the glabella-occipital length was 189 mm., and the transverse diameter at the parieto-squamous suture 127 mm., which gives an index of 67.20 and makes the skull de-

cidedly dolichocephalic. The length of the cranial cavity, however, was 157 mm. and the breadth 121 mm. (an index of 77.07 and a difference of nearly 10 per cent.), so that while from external measurements the skull is distinctly dolichocephalic, the proportions of its cavity are such that it is mesaticephalic. It is probable that many skulls owe their dolichocephalic reputation simply to the prominence of the glabella and supra-orbital ridges. An excessive development of these structures is also liable to give the erroneous impression of a retreating forehead. In the Australian skull just mentioned the thickness of the cranial wall at the glabella was 22 mm.; from this level upwards it gradually thinned until 45 mm. above the glabella it was only 6 mm. thick. When the bisected skull was placed in the horizontal position the anterior surface of the frontal bone sloped from the glabella upwards and distinctly backwards, while the posterior or cerebral surface was inclined upwards and forwards. In fact, the cranial cavity in this region was separated from the lower part of the forehead by a wedge-shaped area having its apex upwards and its base below at the glabella.

The cranial wall opposite the glabella is not appreciably thicker in the Neanderthal calvaria than in the Australian skull to which I have already referred, and the form of the cranial cavity is not more masked by this prominence in the Neanderthal than in many of the existing races.

Although the Neanderthal skull is by no means complete, the base of the cranium and the face bones being absent, still those parts of the cranial wall are preserved that are specially related to the portion of the brain which subserves all the higher mental processes. It includes the frontal, parietal and upper part of the occipital bones, with parts of the roof of the orbits in front, and of the squamous division of the temporal bones at the sides. On its inner or cranial aspect there are markings by which the boundaries between the cerebrum and the cerebellum can be determined. In a profile view of such a specimen an inio-glabellar line can be drawn which will correspond very closely to the lower boundary of the cerebrum, and indicate a horizontal plane above which the vaulted portion of the skull must have contained nearly the whole of the cerebrum.

Schwalbe* has devised a series of measurements to illustrate what he regards as essential differences between the Neanderthal skull-cap and the corresponding portion of the human skull. From the inio-glabellar line another is drawn at right angles to the highest part of the vault, and by comparing the length of these two lines we can determine the length-height index. According to Schwalbe, this is 40.4 in the Neanderthal, while the minimum in the human skull is 52. He further shows that the frontal portion of the vault, as represented by a glabellar-bregmatic line, forms a smaller angle with the base or inio-glabellar line, and that a vertical line from the posterior end of the frontal bone (bregma) cuts the inio-glabellar further back than in the human subject. Professor King, of Galway, attached special importance to the shape and proportions of the parietal bones, and more particularly to the fact that their mesial borders are shorter than the lower or temporal, whereas the reverse is the case in recent man. This feature is obviously related to the defective expansion of the Neanderthal vault, and Professor Schwalbe also attributes considerable significance to this peculiarity.

Another distinctive feature of the Ne-

* 'Ueber die specifischen Merkmale des Neanderthalschädels,' *Verhandl. der anatomischen Gesellschaft in Bonn*, 1901.

anderthal skull is the relation of the orbits to the cranial wall. Schwalbe shows that its brain-case takes a much smaller share in the formation of the roof of the orbit than it does in recent man, and King pointed out that a line from the anterior inferior angle of the external orbital process of the frontal bone, drawn at right angles to the inio-glabellar line, passed in the Neanderthal in front of the cranial cavity, whereas in man such a line would have a considerable portion of the frontal part of the brain-case anterior to it.

From the combined results of these and other measurements Schwalbe arrives at the very important and interesting conclusion that the Neanderthal skull possesses a number of important peculiarities which differentiate it from the skulls of existing man, and show an approximation towards those of the anthropoid apes. He maintains that in recognizing with King* and Cope† the Neanderthal skull as belonging to a distinct species, *Homo neanderthalensis,* he is only following the usual practice of zoologists and paleontologists, by whom specific characters are frequently founded upon much less marked differences. He maintains that as the Neanderthal skull stands in many of its characters nearer to the higher anthropoids than to recent man, if the Neanderthal type is to be included under the term *Homo sapiens,* then this species ought to be still more extended, so as to embrace the anthropoids.

It is interesting to turn from a perusal of these opinions recently advanced by Schwalbe to consider the grounds on which Huxley and Turner, about forty years ago, opposed the view, which was then being advocated, that the characters of the Neanderthal skull were so distinct from those of any of the existing races as to justify the recognition of a new species of the genus *Homo.* Huxley, while admitting that it was 'the most pithecoid of human skulls,' yet holds that it 'is by no means so isolated as it appears to be at first, but forms in reality the extreme term of a series leading gradually from it to the highest and best developed human crania.' He states that 'it is closely approached by certain Australian skulls and even more nearly by the skulls of certain ancient people who inhabited Denmark during the stone period.' Turner's* observations led him to adopt a similar view to that advanced by Huxley. He compared the Neanderthal calvaria with savage and British crania in the Anatomical Museum of the University of Edinburgh, and found amongst them specimens closely corresponding to the Neanderthal type.

While yielding to no one in my admiration for the thoroughness and ability with which Schwalbe has conducted his elaborate and extensive investigations on this question, I must confess that in my opinion he has not sufficiently recognized the significance of the large cranial capacity of the Neanderthal skull in determining the zoological position of its owner, or made sufficient allowance for the great variations in form which skulls undoubtedly human may present.

The length and breadth of the Neanderthal calvaria are distinctly greater than in many living races, and compensate for its defect in height, so that it was capable of lodging a brain fully equal in volume to that of any existing savage races and at least double that of any anthropoid ape.

A number of the characters upon which Schwalbe relies in differentiating the Neanderthal skull-cap are due to an appreci-

* 'The Reputed Fossil Man of the Neanderthal,' *Journal of Science,* 1864.

† 'The Genealogy of Man,' *The American Naturalist,* Vol. XXVII., 1893.

* 'The Fossil Skull Controversy,' *Journal of Science,* 1864.

able extent to the great development of the glabella and supra-orbital arches. Now these processes are well known to present very striking variations in existing human races. They are usually supposed to be developed as buttresses for the purpose of affording support to the large upper jaw and enable it to resist the pressure of the lower jaw due to the contraction of the powerful muscles of mastication. These processes, however, are usually feebly marked in the microcephalic, prognathous and macrodont negro skull, and may be well developed in the macrocephalic and orthognathous skulls of some of the higher races. Indeed, their variations are too great and their significance too obscure for them to form a basis for the creation of a new species of man. Both Huxley and Turner have shown that the low vault of the Neanderthal calvaria can be closely paralleled by specimens of existing races.

If the characters of the Neanderthal calvaria are so distinctive as to justify the recognition of a new species, a new genus ought to be made for the Trinil skull-cap. In nearly every respect it is distinctly lower in type than the Neanderthal, and yet many of the anatomists who have expressed their opinion on the subject maintain that the Trinil specimen is distinctly human.

Important and interesting as are the facts which may be ascertained from a study of a series of skulls regarding the size and form of the brain, it is evident that there are distinct limits to the knowledge to be obtained from this source. Much additional information as to racial characters would undoubtedly be gained had we collections of brains at all corresponding in number and variety with the skulls in our museums. We know that as a rule the brains of the less civilized races are smaller, and the convolutions and fissures simpler, than those of the more cultured nations; beyond this but little more is definitely determined.

As the results of investigations in human and comparative anatomy, physiology and pathology, we know that definite areas of the cerebral cortex are connected with the action of definite groups of muscles, and that the nervous impulses starting from the organs of smell, sight, hearing and common sensibility reach defined cortical fields. All these, however, do not cover more than a third of the convoluted surface of the brain, and the remaining two thirds are still to a large extent a *terra incognita* so far as their precise function is concerned. Is there a definite localization of special mental qualities or moral tendencies, and if so, where are they situated? These are problems of extreme difficulty, but their interest and importance are difficult to exaggerate. In the solution of this problem anthropologists are bound to take an active and important part. When they have collected information as to the relative development of the various parts of the higher brain in all classes of mankind with the same thoroughness with which they have investigated the racial peculiarities of the skull, the question will be within a measurable distance of solution.

Johnson Symington.

SCIENTIFIC BOOKS.

The Alchemist. By Ben Jonson, edited with introduction, notes and glossary by Charles Montgomery Hathaway, Jr. New York, Henry Holt & Co. 1903. Pp. vi + 373. 8vo.

This comedy was first produced in 1610, and proved a most severe satire on alchemy and an effective exposure of many of the swindles associated with it; in this satisfactory edition Dr. Hathaway has given his readers a text based on the folio of 1616, together with variants of several other early and rare editions.

Prefixed to the text are sections on the history and on the theory of alchemy; these