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A REVIEW OF THE VARIOUS PUBLICATIONS ON THE SUBJECT BY PROFESSOR OWEN, F.R.S.

AND

AN ESSAY ON THE TEETH IN THE VARIETIES OF MAN.

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Reprinted from the 'Dental Review.'

ON THE TEETH AND MAXILLARY BONES IN THE HIGHEST FORMS OF QUADRUMANA,

CONSIDERED IN RELATION TO THE SAME STRUCTURES IN THE HUMAN SUB-CLASS.

THE result of greatest interest obtained by the labours of comparative anatomists is the exact limitation of the structural relation subsisting between Man, the crowning creation in the Mammalian series, and its highest inferior developments. All ethnological science must have for its foundation the due appreciation of such limitation; all advances in the physical history of our race must be made from its boundary-line. If, as we hold, Man be a separate creation, not merely the educated and developed progeny of some anthropoid Simia, it behoves us to demonstrate with profoundest care where and how, in his physical organization, the brutal terminates and the human begins; to show with utmost nicety its correlation and distinction, to measure and gauge with exactitude the barriers by which the Creator has surrounded from all inferior approach the material organism of that being who, made a little lower than the angels, has dominion over the beasts of the field, the fowls of the air, and whatsoever passeth through the paths of the sea.

We may premise that it is to the labours of our countryman, the distinguished Superintendent of the Natural History Departments in the British Museum, we must turn, would we sound with scientific precision the depths of the chasm which isolates the mammalian form, when fitted for the reception and furnished for obeying the volition of the reasoning soul.* The vast and complex brain, indexed by the expansion of the neural spines of the cranial vertebræ, is without doubt the great distinguishing mark of man. In him the organ of

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* 'On the Classification and Geographical Distribution of the Mammalia.' By Richard Owen, F.R.S. London, 1859.

'Catalogue of the Osteological Series in the Museum of the Royal College of Surgeons.' 4to, 1853.

'On the Zoology of the Chimpanzee and Orang-utan.' By R. Owen, F.R.S. Zool. Trans., vol. i. London, 1835.

'Osteological Contributions to the Natural History of the Orang-utans.' By Richard Owen, F.R.S. Zool. Trans., vol. ii.

'Osteological Contributions to the Natural History of the Chimpanzees.' By Professor Owen. Zool. Trans., vol. iii., 1849.

'Osteological Contributions to the Natural History of the Chimpanzees and Orangs.' By Professor Owen, F.R.S. Zool. Trans., vol. iv., 1858.

the mind is separated from the brain of the anthropoid Apes, not only by its greater size—though that distinction is so extraordinary that the average volume of the lowest Australian or negro brain is more than double that of the huge and formidable Gorilla—not merely by a greater complexity in the structure of convolutions common both to himself and the higher catarrhine Quadrumana, but by the absolute superaddition of new parts. The human *cerebrum* not only covers and overlaps the olfactory lobes and *cerebellum*, but it extends forwards beyond the one, and backwards beyond the other. To the posterior development of the cerebral hemisphere in Man, anatomists have given the name of the third or posterior lobe ; a cerebral region for which we look in vain in all inferior forms, and that is differentiated by its internal structure, by the posterior *cornu* of the lateral ventricle, and the *hippocampus minor*, which form its true anatomical characteristics. It is on cerebral development that Professor Owen rests his most original and philosophical classification of the Mammalian class; and reasoning from the structure of the human brain, he claims for Man to be the sole representative in that series of a distinct sub-class, to which he assigns the designation 'Archencephala.'

But before we apply ourselves to the immediate object of this article, it may not be uninteresting to our readers to inquire, what are the chief differences which must strike an ordinarily scientific observer, in contemplating the skull of Man side by side with the *cranium* of the Great Ape (*Troglodytes Gorilla*), which has been within the last few years rediscovered on the Western Coast of Africa, and which is held by Owen to be the most anthropoid of Quadrumana. Supposing such a comparison to be commenced by an examination of the skull of the lower animal, the attention of the observer would be arrested by the great size of the whole facial portion as compared with the cranial; the forward or prognathic development of the jaws, furnished with unequal and formidable teeth; the great depth of the lower jaw, and the extent of its ascending *rami;* the long and narrow palate ; the enormous strength and depth of the zygomatic arches, and the comparatively shallow orbits. In studying the cranial portion, he would notice the proportionately small brain-case, its want of upward expansion, and its relatively forward position on the vertebral column, as evidenced by the place which the occipital condyles occupy far back on its under surface. The enormously strong osseous *cristæ* which traverse the external

superficies of the skull, imparting to it an eminently carnivorous character, would likewise claim observation. Of these, the lofty sagittal crest, formed by the junction of the temporal ridges, indicates the powerful muscles by which the animal is enabled to wield its weapons of defence—the huge laniary teeth; whilst the great development of the posterior muscular ridges (the occipital), taken in connection with the rudimentary condition of the mastoid processes, and the position of the occipital condyles and *foramen magnum*, contrasting strongly with the mechanism by which the human cranium is evenly balanced on the vertebral column, furnishes conclusive evidence of the unfitness of the Gorilla for the free, continued, and unaided assumption of the erect posture. Another distinguishing characteristic would be found in the prominent bar of bone which forms the overhanging supra-orbital process, and gives to the head its peculiarly forbidding, scowling expression. The scientific naturalist would recognise in this a distinctive feature of far more importance than the developed sagittal crest; for, independent of muscular attachment, it is essentially a non-modifiable character, and furnishes one of the points by which the African genus (*Troglodytes*) is distinguished from the Orangs of the Indian Archipelago (*Pithecus*).

On turning, on the other hand, to the human skull, his attention would be directed to the extraordinarily expanded brain-case, which in every race of Man towers high above the bony face, and behind, projecting far beyond the vertebral axis, rises in the form of an hemispherical vault, completing in lofty proportions "the dome of thought." In examining the face, he would again be struck by the restricted development of the facial bones, especially of the jaws, the arch of the palate, the evenness and small size of the teeth—organs evidently solely intended for the comminution and separation of the food, and unfitted for purposes of warfare, either offensive or defensive. The depth and capacity of the orbits, the smooth surface of the *cranium* uninterrupted by muscular *cristæ*, the minor development of the temporal ridges, and the tenuity of the zygomatic arches, would claim observation; and he would especially notice the plane and central position of the occipital condyles, supporting the voluminous *cranium* and transmitting its weight to the spine. And in associating with this characteristic the development and position of the mastoid processes, only a rudiment of which exists in the great Troglodyte, he would indubitably be led to the con-

clusion that the erect position is to Man a necessary circumstance of his existence.

The comparison we have thus sketched extends only to the salient characters presented by the two structures,—it has no pretension to be considered a careful osteological investigation. Such a process would disclose many particulars of difference which, although not at first sight so remarkable, are in many cases of equal, and of even greater, scientific value than some of the more conspicuous points of variation. Certain of these will be noticed in the comparative examination we are about to institute of the jaws and teeth in the Anthropoid Apes, as contrasted with the same structures in the Bimanous order.

Our investigation will be restricted to the genera *Pithecus* and *Troglodytes*. It would be foreign to our purpose to enter on the reasons which induce us to follow Professor Owen in ranking the Orangs and Chimpanzees higher than the Gibbons (*Hylobates*). We must refer our readers to a paper on the Gorilla, appended to the Lecture on the Classification of Mammalia, for the details of the masterly argument by which their right of precedence is proved. The genus *Pithecus* (Orangs) includes the large red tailless Apes without ischiatic callosities, of Borneo and Sumatra. Some of the points which distinguish it from the African genus (*Troglodytes*), are the greater length of the upper extremities, and the disproportionate smallness of the lower limbs, as compared with the trunk; the absence of the *ligamentum teres* in the hip-joint; the division of the scaphoid bone of the wrist—the *carpus* consisting of nine bones, as in lower Quadrumana; the inferior development of the innermost of the five digits of the foot; the possession of twelve pairs of ribs (the Gorilla and Chimpanzee have thirteen); and the absence of the super-orbital ridge. It includes two well-defined species. Of these, the Great Orang, or Pongo (*P. Satyrus, P. Wurmbii*), is characterised by a superiority of size and strength, by a greater development of the cranial *cristæ*, by the large size of the canine teeth, and by the presence of cheek callosities. The smaller species (*Pithecus Morio*) is somewhat more anthropoid. Besides other points of difference, it is marked by the absence of cheek callosities; and the superficies of the skull exhibits a want of those osseous *cristæ* which indicate the superior muscular development of the larger species.

The habitat of the genus *Troglodytes* (Chimpanzee) is an intertropical region on the western coast of Africa. It also

is represented by two species differing in size. Of these the smaller (*Troglodytes niger*) is the Chimpanzee with which naturalists have been long acquainted. Like the smaller Orang, it is distinguished from its more formidable congener by the minor development of the muscular *cristæ* of the *cranium;* but, in addition, there are other and more important specific differences, to some of which we shall advert as we proceed. The large species is the *Troglodytes Gorilla*, whose structure affords the nearest approach to the human organisation exhibited in the Quadrumanous series. A few only of the characteristics on which his superiority rests can be noticed here. The Gorilla possesses a brain of absolutely greater size than any other Ape. In him the pre-maxillary bones and four incisor teeth are of relatively less breadth than in the Chimpanzee. The median coalesced margin of the upper half of the nasal bones is slightly produced forwards in his *cranium*, indicating an approach to a nasal prominence. Mastoid processes also are present—rudimentary, indeed, but unmistakeable. The comparative length of the upper and lower limbs presents a closer assimilation to human proportions, whilst the opposable thumb of the hand is of relatively greater size than in the Chimpanzee. The iliac bones are broader and bent forwards, forming a pelvic concavity. In his huge hind hand the *calcaneum* has a more decided backward projection, the innermost digit is of greater thickness, and in the whole organ a nearer approach is made to a plantigrade foot than is to be found in any other Simia.

Such are the genera and species presented for investigation. Although we confine ourselves to an examination of the teeth and the bones in which they are implanted, yet the inquiry is not to be considered of trivial importance; for, if the universal testimony of naturalists is to be received, it may be laid down as an axiom, that with the exception of the brain and the concomitant development of the cranial vertebræ, no organs present surer and more significant grounds for specific and generic differentiation than those which constitute the dental apparatus of the Mammalian.

In Diphyodont Mammalia, the upper jaw is fixed, and is formed of three bones on each side—the inter or pre-maxillary, the superior maxillary, and palatine. The teeth are confined to two of these, the pre-maxillary and superior maxillary bones. In scientific nomenclature, those which are implanted in the former are termed, irrespective of their shape, development, or uses, incisors. The canines or

laniaries are those which are situated at or near to the suture which unites the pre-maxillary with the superior maxillary. The next in order are the *premolares*, which replace the milk molars of the first set; and behind those are the true molars, which are preceded by no deciduous teeth, but which are in fact a continuation of the first series, for they are developed in the same groove in the fœtal gum; they are always most posterior in position, and are usually of larger size and more complex form than the premolars.

Each of the three bones we have mentioned enters into the formation of the bony palate: it is with its examination we would commence our comparison. In Man the palate forms an arch, the breadth of which, after slightly increasing as far the space between the first true molar and the second premolar, begins to diminish at or about the posterior border of the second premolar tooth. Its base is divided into two lateral concave emarginations by a median point of bone, which projects backwards, and gives attachment to the thin muscular fasciculi forming the *azygos uvulæ*. The surface is divided by a longitudinal and transverse suture; the former marking the separation of the palate and the maxillary bones of the two sides; the latter, that of the palate from the maxillary bone of the same side. The longitudinal suture is interrupted near its anterior termination by a *foramen*, the prepalatine or anterior palatine, which is situated almost immediately behind the alveolar border of the middle incisors, the intervening space being scarcely more than a line in breadth. Near the posterior margin of the palatal surface, at the base of the alveolar border, are also situated two *foramina*, one on each side, the posterior palatine. The anterior palatine *foramen* communicates with the nasal fossa by four *foramina*, or short canals, which open into it: two are placed side by side transversely, and two in the median line. The two former are termed incisor *foramina*. The great importance of the position of the prepalatal *foramen*, as a human characteristic, will be at once evident when we remember that it is a guide by which may be invariably estimated the original depth from before backwards of the palatal processes of the premaxillary bones. The existence of these bones as separate structures in the human skull has been denied by many writers, and even in the earlier periods of fœtal existence they have never been observed to be entirely separable. In the human infant, at birth, they are completely anchylosed with the maxillary; yet, in the early conditions of intra-uterine life, traces of the palatal and nasal portions of the maxillo-intermaxillary fissure

are observable, although investigation has never, we believe, succeeded in tracing the line of separation through the external alveolar plate: in this situation, therefore, the two bones in Man may be held to be connate. The significance, however, of the early traces of a maxillo-intermaxillary suture in the human fœtus acquires considerable force from an aberrant condition which has been observed in some cases of hare-lip. In certain instances of this deformity, a detached piece has been found corresponding to the line of fissure existing in the early fœtus, the separation extending, however, completely through the *alveolus*. The true nature of the portion thus isolated is proved by the fact of its always including the incisor teeth, and never the canines. It may be added, that no other portion of the superior maxillary bone has ever been found permanently separable. Science is indebted to the illustrious author of 'Faust' for first demonstrating the value and import of the incisive fissure in the human embryo.

We have seen, then, that the chief characteristics of the palate in Man are, its shape, that of a regular arch; the early and complete obliteration of the suture between the maxillary and intermaxillary bones, and the consequent sole division by median and palato-maxillary sutures; the form of the posterior margin or base of the arch; and the position of the *foramina*, especially of the prepalatine. It remains to compare, in these respects, the bony palate in the Orangs, Chimpanzee, and Gorilla. In all the Anthropoid Apes the palate is of an oblong shape. In length it far exceeds the longitudinal diameter of the human palate, and its breadth continues undiminished forwards as far as the interval between the first premolar and canine teeth. The lines formed by the *alveoli* of the true molars and premolars on each side are nearly parallel; they do not converge in the region of the bicuspids —on the contrary, in *P. Satyrus*, *Tr. Gorilla*, and to a less extent in *Tr. niger* and *P. Morio*, the width of the palate increases opposite the premolar teeth. In the Gorilla, the entire length of the palatal superficies is greater than in *Tr. niger* or *P. Satyrus;* but it is narrower, and, as we shall notice, the increase in length is not due to a relatively longer palatal portion of the premaxillary bone. The posterior margin of the palate in *P. Morio* presents an almost straight line, interrupted only by a small median point of bone, and entirely wanting the lateral concavities observed in the human subject. In *P. Satyrus* the margin is somewhat irregular; on each side of the median line is a bony prominence,

separated by a notch-like depression. *Troglodytes niger* offers in this particular the nearest approach to the human configuration; for in the Gorilla there is an entire absence of the median osseous spine, the border "presents either a shallow median emargination between two slighter ones, or the whole posterior boundary (in the younger male) is slightly undulated with a general curve concave backwards." The situation of the posterior palatine *foramina* is another point of differentiation. In Man they are situated near the posterior border of the palate; in the Gorilla they are more anterior, close to the palato-maxillary suture; in the smaller Troglodytes they are again found nearer the margin; whilst in the Orangs they are situated closer to each other, separated, however, by two tuberosities, which do not exist in the palate of the Gorilla. In addition, in the human palate a larger proportion of the superficies is formed by the palatine processes of the palate bones.

The position and characters of the anterior palatine *foramina* require especial notice. In all the species of Anthropoid Apes their distance from the incisor teeth is far greater than in Man. In an adult male *Tr. Gorilla* the distance from the anterior margin of the intermaxillary bones to the anterior palatal *foramen* was 1 inch 1 line; in an adult male *Tr. niger*, 10 lines; in an adult male *P. Wurmbii*, 1 inch 3 lines: in one specimen of *P. Morio*, 9 lines; in another, 11 lines. The premaxillary portion of the palate is relatively longer in *Tr. niger* than in *Tr. Gorilla;* whilst in the Orangs a farther retrogression is made in this respect from human structure. The prepalatine *foramina* are in Man blended into a single opening; in the Gorilla they are somewhat more distinct, and external to each of them another *foramen* is usually present. In the Orangs, the prepalatal *foramen* is much smaller than in the Chimpanzee; and in the adult skull of *P. Wurmbii*, the course of the obliterated premaxillary palatine suture may be found marked by several smaller *foramina*. Lastly, the period of disappearance of the suture is to be noticed. In Man we have seen it becoming entirely obliterated in the fœtal stage; in *Tr. niger* it disappears at or soon after the period of the first dentition. In the genus *Pithecus*, anchylosis takes place later during the second dentition. In the skull of an adult Morio, however, figured in the fourth volume of the 'Zoological Transactions,' the suture is still visible. In *Tr. Gorilla* it is partially present in adult life, obliteration only taking place in immediate proximity to the alveolar openings.

In the former part of this article we compared the superficies of the bony palate in Man with the same structure in the Chimpanzees and Orangs. Such variations as are met with in the skulls of different varieties of the human race we propose to consider in a future paper. We may, however, remark here, that although the premaxillary palatine suture is usually entirely obliterated at a very early period in the human *cranium*, traces of its existence are occasionally found both in adult European skulls and in those of the dark races. A careful examination of the collection of *crania* in the Museum of the Royal College of Surgeons will satisfy the inquirer on this point. In the skull of the human idiot figured in the first volume of the 'Zoological Transactions,' the same condition is represented, and its occasional occurrence has not only been noticed by Lawrence and other modern writers, but it was especially remarked by some of the older anatomists. In Vesalius's great work, 'De Humani Corporis Fabricâ,' edit. 1555, is an engraving of a skull exemplifying this peculiarity. Let it be, however, distinctly understood that in such exceptional cases the suture has never been found to extend through the *alveolus*. Galen, as Vesalius infers, debarred the practical study of human anatomy, and, restricted to the dissection of the lower animals, was led into the error of reckoning an intermaxillary amongst the separable bones in Man.

In pursuing our comparative examination, we would now direct the reader's attention to the facial portion of the bones constituting the upper jaw. As is the case with the bony palate, the figure and proportions of the parts of the premaxillary and superior maxillary bones which enter into the formation of the face are, to a considerable extent, influenced by the configuration and relative magnitudes of the teeth which are implanted in them. We propose to reserve the study of the teeth themselves to the last portion of this article; but if, in the examination of the bones which form their *alveoli*, we should at times be guilty of forestalling our description, and thus of incurring hereafter the charge of repetition, we must crave indulgence for a fault it is difficult to avoid in a verbal delineation of contiguous and mutually-dependant structures.

In the Human sub-class, from and before the period of birth, we search in vain for any mark of separation between the facial portions of the premaxillary and superior maxillary. Consolidated together, no remnant of suture remains to mark an original distinction; and in the bony face there is no landmark like the anterior palatine *foramen* to remain a lasting memorial

of their limits. At or about the period of the second dentition, consolidation is effected in the genus *Pithecus*. In the Great Orang (*P. Satyrus*) the obliteration of the suture does not take place until the full development of the great canines. Its traces are, however, occasionally to be found in adult *crania*. Thus, in the skull of a large male Bornean Orang, numbered 5051, in the Museum of the College of Surgeons, the line of demarcation is distinctly discernible. In the Gorilla more or less of the suture is permanent, and evidences, even in the mature skull, that remarkable upward expansion of the premaxillaries which is characteristic of the species. The Chimpanzee loses the line of separation sooner than any other Ape. In the *cranium* of an immature *Tr. niger* in the same collection (No. 5171), having the twenty deciduous teeth in place, it is so far obliterated as to be traceable only at the sides of the nasal aperture. The remnant of articulation is so small, that Mr Lawrence, in referring to this specimen, states, "not a vestige of the sutures separating this bone is to be seen." They still, however, exist on the palate, and, as we have said, at the sides of the nasal opening.

The breadth of the anterior surface of the premaxillary in Man is limited by the incisor teeth; the inner margin articulates by a permanent suture with the corresponding bone of the opposite side. This median articulation is not depressed below the level of the neighbouring surface; on the contrary, it is slightly raised, constituting a prominent ridge, and terminating above in a process which projects forwards,—the anterior nasal spine. This process forms the commencement of the nasal ridge, supporting the *septum narium*. In every race of Man, the median cartilage of the nose receives an osseous support which projects in a greater or less degree beyond the margin of the bony nasal cavity. The anterior alveolar surface is slightly undulated by the fangs of the incisor teeth, but the amount of unevenness is insignificant when compared with the prominences and depressions arising from the same cause in *P. Satyrus* and *Tr. niger*. In depth, from the lower margin of the nasal opening to the alveolar border, the human premaxillary is short, and in the direction of its plane it offers a strong contrast to the Quadrumanous configuration. In the white races of Man the premaxillary is usually vertical, although exceptions are not of unfrequent occurrence; in the melanous varieties there is a somewhat greater projection forwards, but the degree to which this occurs differs much in individuals. It is the fashion to choose the most debased specimens of *crania*

as typical of the dark races to which they belong. The fairness of this proceeding would be equalled by selecting the types of European form from amongst a half-starved Irish peasantry; or, on the other hand, by estimating the cranial capacity of the population of Europe from an examination of the head of a Humboldt or a Cuvier. When the investigation is fairly made, and is farther extended by comparing the contour of the human jaw with the prognathic muzzle in the Orang or Gorilla, the variation in the projection of the anterior *alveoli* in Man must be acknowledged to be slight and insignificant.

In the genus *Pithecus* (Orangs) the premaxillary extends in width beyond the incisor alveoli, furnishing a considerable portion of the *diastema*, or space which separates the second incisor tooth from the great laniary. In the young skull its upward extent can be traced above the lower margin of the nasal bone. This is well shown in a skeleton of a young female Orang (No. 5058) in the Hunterian Museum. The mesian articulation between the premaxillaries is situated in a depression which below becomes a deep *sulcus* between the prominent *alveoli* of the central incisors. In many adult skulls this suture is found obliterated, its course being only indicated by small vascular *foramina* and grooves. The anterior nasal spine is absent. In width the premaxillary of *P. Satyrus* exceeds the measurement of the same bone in the Chimpanzee and Gorilla; and whilst the *alveoli* of the incisors are full and prominent, the intervals between them are proportionately depressed. The depth from the nasal aperture to the incisor margin is greater than in either Troglodyte, and the prognathic development of the jaw is, in the present comparison, at its maximum. In these latter respects the Great Orang recedes farther from human configuration than either species of the genus *Troglodytes*.

The breadth of the premaxillaries is the same in *Tr. niger* and *Tr. Gorilla*: therefore, the relative breadth is less in the larger species. The depth below the nasal apertures, the prognathic development, and the prominence of the incisor *alveoli*, are less in the Gorilla. The nasal portion of the premaxillary extends to a variable height on the side of the nostril in the Chimpanzee. In the young specimen before alluded to (No. 5171) it stops short of the nasal bone; in another specimen it articulates with that bone by its pointed extremity, which separates a small portion of the nasal from the superior maxillary. In *Tr. Gorilla* we have, however, a distinguishing feature, not only in the height to which the nasal portion of the premaxillary extends, but in the remarkable expansion of the

ascending process. It spreads into a triangular plate of bone, which articulates by its inner and superior margin with the nasal, by its outer margin with the superior maxillary, completely shutting out the latter bone from a share in the formation of the nasal aperture. In one skull of *Tr. Gorilla*, described by Professor Owen in the fourth volume of the 'Zoological Transactions,' this upper expanded portion of the premaxillary is a separate piece, insulated by a continuation of the premaxillary suture on the inner side of the nostril into the outer one, about nine lines below the nasal bone. These sutures are persistent in adult life; they may be found more or less obliterated in the *crania* of aged individuals of the species, but in the adult skeleton at the College of Surgeons they will be seen to be perfectly distinct. The mode of articulation between the nasals and the premaxillaries and maxillaries is worthy of attention. In the Gorilla they articulate by true sutures, not by harmoniæ, as in *Troglodytes niger* and Man.

As in *Pithecus*, the median suture between the premaxillaries is situated in a smooth depression. There is no approach to the prominent ridge which sustains it in Man. In some of the adult skulls of *Tr. niger* we have examined, it is obliterated. It is probably more persistent in the Gorilla, but in the aged *cranium* in the British Museum it appears to be nearly erased. In both species the anterior nasal spine is entirely wanting; the ridges for the articulation of the *septum narium* commence within the nasal cavity, behind an arched transverse eminence or bar which forms the anterior boundary of the opening. This transverse ridge is well marked in the skull of the Gorilla. Lastly, as in *Pithecus Satyrus*, the premaxillary bone in *Tr. Gorilla* extends beyond the outer incisor, and constitutes a large portion of the *diastema* interposed between that tooth and the canine.

These points of differentiation are most of them specific. Their production is to be referred to the influence of no accidental circumstance, such as the habits of a species, or an increased osseous growth depending on a greater development of attached muscles. Neither are they to be explained on any theory of gradational development. We know no more of the reasons for the peculiar conformation of the premaxillary bones in *Tr. Gorilla*, or the continuation of the premaxillary sutures in *P. Satyrus*, and their early obliteration in *T. niger*, than we do of the ultimate causes on which depend the unalterable properties of the metals and gases of the inorganic world.

In extending our comparison to an examination of the superior

maxillary bones, the following are some of the points to which we would call attention as especially characteristic of human structure. In the *cranium* of Man this bone is distinguished by its short antero-posterior measurement, its sub-quadrate form, the near parallelism of its posterior border with the anterior margin of the premaxillaries; by the minor development of the *alveoli* for the canine and molar teeth; by the backward concavity of the portion it forms of the external nostril leading from the nasal to the anchylosed premaxillary; by the concavity of the surface which descends from the margin of the orbit to the *alveoli* of the premolars; by the single infra-orbital *foramen*, and the proximity of that *foramen* to the orbital margin; by the restricted dimensions of the *antrum*, which neither encroaches on the malar bone in one direction, nor on the inner side of the orbit in the other. In all the Anthropoid Apes the superior *maxilla* is of much greater comparative size than in Man. The tumid socket of the great laniary tooth carries the anterior portion of the bone forwards, and expands it laterally. The size of the canine *alveolus* is so great as completely to exclude the external nostril from the lateral view of the *cranium*. In *Tr. Gorilla* the laniary is of somewhat larger proportional size than in *Tr. niger*, and a corresponding difference is impressed on the anterior contour of the maxillary bone; but in both species the deviation from human configuration is enormous. In *P. Morio* and *P. Satyrus* this anterior expansion of the *maxilla* is as remarkable, the corresponding part of the jaw being even broader in the Great Orang than in the Gorilla. In a front view of the skull, the great canine shuts out the molar series from sight, with the exception in the Gorilla of a small portion of the upper external surface of the first premolar. In Man a corresponding view reveals the whole molar series with the exception of the last true molar, and this in the white races is not always excluded.

Although the posterior border of the superior *maxilla* in the Gorilla is at right angles with the alveolar, yet, owing to the obliquity of the premaxillaries and the prominence of the canine *alveoli*, there is no approach to parallelism between it and the anterior. In *P. Satyrus* the posterior contour of the maxillary bone has a direction more obliquely forwards than in the Great Chimpanzee. The *alveoli* of the molar series are well developed on the external surface of the jaw in both genera. In *Tr. Gorilla* this character is at its maximum. The premolars differ from those of Man, in being implanted by three roots, two of which are external. The complexity of the alveolar border depending on the prominent double *alveoli* of these teeth is a marked feature

in the cranium of the Gorilla. The nasal process of the superior maxillary in the Chimpanzee does not mount vertically, as in Man, but slopes backwards, as in the Baboon. The surface which extends from the premolars upwards towards the orbit in *Tr. Gorilla* is convex and tumid, and contrasts strongly with the concavity which is observed in the human *cranium*. The infra orbital outlet is usually single in *Tr. niger*—sometimes single, but more frequently double, in *Tr. Gorilla;* and there are three *foramina* present in the skull of the Orang. The position of these openings is another point of difference. They are situated at a greater distance from the orbital margin in the Gorilla and in *Pithecus Satyrus*, somewhat higher in *Tr. niger*, the latter in this particular more closely corresponding with human structure. Lastly, the extent of the *antrum* in the Gorilla far surpasses its dimensions in the human cranium; it extends externally into the malar bone, and on the inner side encroaches on the orbit. In one skull of an old male, Professor Owen found it divided by what appeared to be a second wall, having a cribriform or reticulate structure. The orifice of the antrum is of a rounded form, and is covered by the overhanging inferior turbinal bone. At the upper part of this orifice the lacrymal canal terminates: in Man the termination of this canal is in advance of the antrum.

In a side view, the relative position of the alveolar border to the cranial cavity will be seen to differ greatly in Man and the higher Quadrumana. In the Ape, the upper jaw projects downwards far below the base of the shallow *cranium:* in Man, on the contrary, the great depth of the brain-case brings the mastoid process almost to a level with the alveoli of the superior maxillary bone.

The investigation we have hitherto pursued, dry and unproductive as at first sight it may appear, yields on review an irrefragable basis on which an argument for the unalterable distinctive peculiarities of human structure may be founded. Although confessedly inferior in importance to the points of difference which are to be demonstrated in other parts of the organism—for instance, in the sensorium and extremities—the peculiar form and relations of the bones constituting the upper jaw in Man, supposing that it alone could be obtained for comparison, would amply suffice to proclaim the distinction of the possessor from every other known form of living being. But, as we advance to an examination of the mandible, and afterwards extend our comparison to the temporary and permanent teeth, to the order in which they are developed and

come into place, and to the uses to which they are ordained, we shall find that new distinctions between human structure and that of the highest Quadrumana arrest attention at every step of the process; and moreover, that the separation of which these distinctions are indicative cannot, by any fair process of philosophic reasoning, be reduced to mere alteration ascribable to the effect of adventitious influences.

The lower jaw (mandibula) in Man and the Quadrumana consists of two lateral symmetrical parts, joined anteriorly in the mesian line. Separate at first, anchylosis takes place between the two lateral portions at an early period. In the human subject, their union is perfected during the second year after birth. Each half consists of two rami, known from their direction as "horizontal" and "vertical." By their union, the two horizontal rami form the "body" of the bone; the line of junction is termed the "symphysis." The alveoli of the lower dental series occupy the upper border of the horizontal ramus. The vertical ramus projects upwards from the hinder extremity of the horizontal; the junction of its posterior border with the inferior boundary of the horizontal constituting the angle of the jaw. The anterior border of the vertical or ascending ramus terminates above in a process, the coronoid, into which the crotaphite or temporal muscle is inserted. The upper border of the ramus is hollowed into a concavity between the coronoid and the articulating process or condyle, the latter surmounting the posterior border, and terminating the superior concave margin of the ascending portion of the bone. Such are the general features; we will now proceed to note and compare the peculiarities of the mandible in each of the subjects selected for review.

In Man, the lower jaw is distinguished by the shape of the body, or that portion formed by the two horizontal rami; it is convex in its general outline, which resembles that of a horse-shoe. The horizontal rami are short, and the antero-posterior measurement of the entire jaw is small when considered in relation to the space which separates the two condyles, and the corresponding proportions in the Quadrumana. The alveolar border describes a regular parabolic or elliptic curve; the dental sockets are separated by thin osseous plates, and progressively increase in size from the incisor teeth to the molars; there is no diastema or vacant space to interrupt the series. The union of the lateral halves is marked externally by a projecting ridge, which terminates below in a jutting horizontal process or promontory, the chin.

This is a distinctive feature in Man : it is as unmistakeably present in the dark varieties as it is in the higher civilised races ; to it the structure of no inferior animal indicates an approach. Below the second premolar tooth, about midway between the border of its alveolus and the lower border of the jaw, is situated a foramen (the mental), for the transmission of the terminal branches of the dental nerve and artery.

The external surface of the jaw, below the commencement of the anterior border of the vertical ramus, is protuberant in Man. In some human skulls, a line or ridge, the external oblique, extends obliquely upwards from near the symphysis towards the anterior border of the mounting ramus; but this is not of constant occurrence. In approaching the ascending portion of the bone, a slight and gradual diminution is observed in the vertical extent of the horizontal ramus. The anterior border of the vertical ramus is formed by the convergence of two ridges ; the external commences usually below the outer surface of the second molar alveolus, the internal from behind the socket of the last molar. These ridges converge regularly and directly as they ascend ; there is no angular deflection of the internal one. The terminal point of the coronoid process is in a vertical line with the lower portion of the anterior border of the ascending ramus. The concavity between the coronoid process and condyle is comparatively wide and shallow. The convex and oblong condyle is compressed from before backwards ; its greatest thickness is near the middle of the joint, and its articulating surface is well defined. The angle is a well-marked feature in the human jaw ; it is usually somewhat more rounded off in the Australian, but the difference is slight as compared with the posterior contour of the mandible in the Gorilla. In some human jaws, the external surface of the angle presents a protuberance and a vascular groove.

On turning to the internal surface of the bone, and commencing anteriorly, we find no projection backwards of its inferior border below the symphysis. The posterior surface of the symphysis is usually marked by two or more tubercles, which give attachment to muscles, the "spinæ mentales." A ridge, the internal oblique, extends obliquely downwards and forwards, from the posterior border of the last molar alveolus to below the socket of the first tooth of that series ; the inner margin of the molar alveoli overhangs the portion of the jaw below them. The entrance of the dental canal (foramen dentale) is situated on the inner surface of the ascending

ramus, about midway between the anterior and posterior border, and somewhat higher than the line of the alveoli. It is of considerable size, especially in the white races, and in many jaws its inner boundary is continued backwards in the form of a projecting process. The internal attachment of the temporal muscle on the inner side of the coronoid process (crotaphite fossa) is but slightly marked in the human jaw. One or two slight ridges, and a roughness of surface, indicate the attachment of the internal pterygoid muscle to the inner side and posterior border of the ascending ramus.

In contrasting with the human inferior maxilla the mandible in the highly-organized Apes selected for comparison, we shall commence with the genus *Troglodytes*, and would first direct the reader's attention to the lower jaw in the larger species, *Tr. Gorilla*. The first thing that demands observation is the much greater size of the bone in proportion to the size of the animal. The height of the adult Gorilla is five feet six inches; but the jaw is at least twice as massive as that of Man, and its length is considerably greater, not only absolutely, but in proportion to the space which separates the condyles. In a specimen of the adult male examined by Professor Owen, "the length of the jaw, in a straight line from the back part of the condyle to the fore part of the symphysis, was seven inches five lines; from the outer side of one condyle to that of the other, five inches five lines." In Man, the inter-condyloid measurement is quite equal to that of the same space in the Gorilla, in many skulls it is greater; but the length of the adult male human jaw, measuring in the same way from the back part of the condyle to the front of the symphysis, is only from four and a half to five inches. The next point of difference is, that in the bone under consideration there is no approach to the regularly convex horse-shoe shape which characterises the human mandible. If lines drawn on each side, from the outer side of the condyle to the outer side of the canine alveolus, be produced, it will be found that the rami diverge from each other at an angle of 35°. The alveoli, from the canine to the last molar, are almost in a straight line, with a very slight bend inwards; they are parallel on the two sides, and are joined at right angles by the line of the incisor alveoli, which unites them in front. In Man, the size of the aveolar sockets increases in regular gradation from the central incisor backwards: in the Gorilla the incisor alveoli are the smallest; next in size is the socket of the second premolar; those of the true molars and first premolar are about

equal; whilst the largest and deepest depression is that for the great canine. The anterior surface of the jaw exhibits as strikingly the entire absence of chin, as does the same region in animals much lower in the scale of organization. The external surface of the symphysis, curving downwards and backwards from the alveolar border with a gentle convexity, is destitute of any median verticle ridge, and of all transverse rising or tuberosity. The mental foramen is situated below the first premolar tooth—not the second, as in Man, the Chimpanzee, and the Orangs. In one of the specimens described by Professor Owen, it was double on the right side, a smaller opening existing in front of the principal, and two or three much smaller foramina were observed behind. In Man, the "foramen mentale" is always single. In the Gorilla, the opening is placed a little nearer the lower than the upper border of the mandible. The outer walls of the incisor and canine alveoli are slightly protuberant, as is also that occupied by the anterior root of the first premolar; corresponding depressions mark the interspaces. The external surface of the horizontal ramus is flat, but becomes slightly convex near the lower border; along the outer margin of the molar sockets is a thin ridge of bone, and beneath it a shallow longitudinal depression; but the external oblique ridge is absent in the Gorilla, and although there is a slight protuberance below the outer anterior commencement of the vertical ramus, the degree of elevation is less than in the human subject. The vertical extent of the horizontal ramus, instead of diminishing as it approaches the ascending portion of the bone, increases in the Gorilla. The vertical ramus commences anteriorly, as in Man, by two ridges; the outer one forms a platform of bone, which extends outwards beyond the last molar alveolus: the strong inner ridge commences from behind that socket, but in its upward course it presents an angular deflection, which is not present in Man; this ridge joins the outer one after it has formed the anterior boundary of the well-marked crotaphite fossa. The anterior border of the ascending ramus is vertical for two-thirds of its extent; it then gently curves backwards, so that the point of the coronoid process is considerably posterior to the fore part of the base of the ramus—not on the same vertical line with it, as in Man. The concavity dividing the coracoid from the condyloid process is proportionately deeper than in Man. The inner end of the articulating condyle is the larger; it also differs from human structure in the want of definition in

the posterior portion of the articulating surface, which is insensibly lost on the neck of the process. The angle of the jaw may be said to be absent in the Gorilla; for the lower border of the horizontal ramus passes, by a regular convex curve, into the posterior border of the ascending. On the inner surface of the latter are four or five tuberosities, with intermediate depressions for the attachment of the pterygoid. The internal surface of the symphysis is marked in its lower fourth by a rough, oval, shallow depression, divided by a median vertical ridge, which terminates below in a broad transverse ridge extending backwards, and limiting the extent of the bone in this direction. In one jaw of an aged Gorilla we have had an opportunity of examining, this ridge was produced backwards, in the form of a large triangular process. The spinæ mentales on the inner surface of the symphysis are absent in the Gorilla. The inner surface of the horizontal ramus is smooth; it is not abruptly overhung by the inner margin of the molar alveoli, as in Man; neither does it exhibit the internal oblique ridge which is so characteristic of human structure—a slightly roughened longitudinal tract beneath the last two molar sockets takes its place in the jaw under consideration. The inner surface of the ascending ramus commences by a sudden but slight sinking of the surface. It is divided into two portions by a ridge which leads from the anterior internal ridge before described to the condyle; the upper and smaller surface is deeply depressed for the insertion of the great crotaphite muscle (crotaphite fossa); the lower presents about the middle of the ramus the opening of the dental canal. This is smaller than in Man, and its internal margin is not produced backwards. We have already alluded to the more numerous projections for the insertion of the pterygoid muscle on the inner surface of the posterior boundary of the ascending ramus in the mandible of the Gorilla.

It will be unnecessary to enter into so detailed a description of the inferior maxilla in the smaller species of the genus, the Chimpanzee (*Tr. niger*), as in many respects its characteristic points of structure correspond with those we have described in the Gorilla. We shall content ourselves with noticing those particulars in which the jaw of the less formidable Ape departs farther from, and those in which it makes a nearer approach to, the characters which distinguish the human mandible. Some of the latter appear merely to depend on the inferior strength and muscular development of

the Chimpanzee, as compared with its more redoubtable congener. We may premise, however, that in comparison with the height of the animal, and with the intercondyloid measurement, the length of the lower jaw greatly exceeds that of Man. The adult male of *Troglodytes niger* measures four feet in height; the adult female, three feet ten inches: some of the earlier accounts, representing the attainment by the Chimpanzee of a higher stature, undoubtedly had reference to the larger species. The length of the lower jaw, from the back part of the condyle to the anterior margin of the central incisor alveolus, in an adult female skull preserved in the Museum of the Great Northern Hospital, is five inches two lines; whilst the measurement from the outer extremity of one condyle to that of the other is only four inches three lines. In this respect, therefore, the jaw offers almost as great a contrast to that of Man, as does the same bone in the Gorilla. The following are the points of greater departure from human structure:—The height of the ascending ramus is less in relation to the length of the jaw. The proportion which a line drawn vertically from the top of the coronoid process bears to the horizontal extent of the alveolar border is the same in *Tr. Gorilla* as in Man. In both it is about seven-tenths, in the Chimpanzee it is six-tenths. The breadth of the anterior surface supporting the incisor alveoli is almost as great as in the Gorilla; it is therefore much greater in proportion to the size of the animal; and in this very important particular it presents a further deviation from human type. The mental foramen, although below the second premolar alveolus, as in Man, is situated much nearer the inferior border of the bone than in *Tr. Gorilla.* The entry of the dental canal is lower and nearer the anterior internal ridge of the ascending ramus; it therefore departs farther from the central position of that foramen in the human jaw. The ridge which bounds inferiorly the fossa at the back of the symphysis is of crescentic form, and is relatively broader than in some specimens of the larger species.

On the other hand, the jaw of the Chimpanzee offers a nearer approach to that of Man in the smaller breadth of the ascending portion, in the better development of the angle, in the decreasing vertical measurement of the horizontal ramus as it approaches the ascending, and in the consequent greater relative depth of the symphysis. The symphysis slopes backwards, as in the Gorilla, and is equally devoid of vertical or transverse protuberance; but it is slightly more convex

in the lower part. The anterior internal ridge of the ascending ramus does not present the same amount of deflection which marks it in *Tr. Gorilla;* it is situated more behind and farther from the external ridge than in Man. The fossa for the insertion of the temporal muscle is smaller and less marked than in the more muscular Ape. Two or three projections on the inner surface of the posterior border of the ascending ramus indicate the insertion of the pterygoideus internus; of these the upper is the largest. The hinder portion of the articulating condyloid surface is better defined in the Chimpanzee. These differences, it will be seen, are principally dependant on the minor development of bone and muscle in the smaller species, and must not be permitted to outweigh the far more important characteristics in virtue of which the Gorilla takes its place in relation to Man at the head of the order Quadrumana.

In directing attention to the lower jaw in the genus *Pithecus*, it will suffice to point out the chief differences which distinguish it from the same bone in the genus we have already had under consideration. In so doing, we shall at first confine our observations to the mandible in the large and more typical species, the Great Orang of the Indian Archipelago, *Pithecus Satyrus*. In its greater relative size, in its general configuration, in the straightness and parallelism of the line of alveoli from the canine to the last molar, in the absence of regular gradation in the increase of size of the dental sockets from before backwards, in the absence of chin, the jaw under consideration offers as great a contrast to human type as does that of the giant Troglodyte. The following are the principal points in which it differs from the mandible of the Gorilla:—The anterior surface of the symphysis is of greater breadth, and flatter; it is more vertical above, but inferiorly it slopes backwards, as in *Tr. Gorilla*. Below it is a slight prominence, from which a rough surface extends outwards on either side. The mental foramen is situated nearer the inferior border of the bone, and below the second premolar. In the skull, however, figured in the first volume of the 'Zoological Transactions,' there are three foramina present,—a large one below, a smaller above, and a still smaller one posteriorly. The two anterior foramina are placed below the first premolar alveolus. The antero-external ridge of the ascending ramus commences lower than in the Gorilla, and is of greater development; a wider channel separates it from the internal; the latter suffers no deflection in its

upward course to meet the outer ridge on the fore part of the coronoid process. The coronoid process is more obtuse, and does not rise to so great a height; the crotaphite depression is narrower, but of greater depth. The condyle is of greater antero-posterior breadth, and consequently it is of a more full oval form. The angle of the bone is better developed than in *Tr. Gorilla*. A faint indication of an internal oblique ridge is found in a narrow linear ridge which extends downwards and forwards from behind the last molar alveolus on the inner surface of the horizontal ramus. The opening of the dental canal is situated higher than in *Troglodytes niger*, and therefore approximates more nearly to its position in the human subject. The antero-posterior extent of the alveolar portion of the jaw is less in comparison with the rami in *Pithecus Satyrus* than in the Gorilla.

The mandible in the dwarfed species of Orang, *Pithecus Morio*, described by Professor Owen, agrees in its general conformation with the jaw last described. It is of smaller relative size. On comparing the figures published in the 'Zoological Transactions,' it will be seen that in *Pith. Morio* the symphysis slopes more directly backwards from its upper border, and that the commencement of the antero-external ridge of the ascending ramus is higher than in *Pith. Satyrus*. The mental foramen is single, situated below the second premolar alveolus, and near the inferior border of the bone. The alveoli of the premolars and first molar are represented as more prominent in the jaw of the smaller species.

We thus terminate our review of the bones which form the maxillary apparatus in Man and the Anthropoid Apes; and we now ask attention to the form and peculiarities of the teeth. It is almost needless to say that in the Catarhine or Old World Quadrumana the dental formulæ both of the permanent and the milk series are the same as in Man. But in the Anthropoid Apes, in common with inferior members of the group, the purposes for which the teeth are designed differ from those which they fulfil in Man. In him, their primary use is the division and mastication of his varying aliment; and, secondly, they subserve the faculty of speech. The unbroken series and equal length of the teeth, the thin crowns of the moderately-developed incisors, the smooth equality of their posterior surfaces, their vertical or nearly vertical implantation,—are all provisions in which may be recognised a design in unison with the capacious and complicate brain, the exquisitely-organized larynx, and the flexible and highly-

endowed tongue. In human organization, all is rendered subservient to the expression and embodiment of thought. In the Great Ape, the dental apparatus is constituted on a different plan, and answers a widely-differing purpose. Endowed with no power to conceive or perfect instruments by which he may repel attack, or assert superiority over the denizens of his native forest, Nature has furnished his jaws with organs of other mould than those which add enchantment to human smiles, and give distinctness to the accents of human eloquence. His teeth are destined not only for the comminution of his coarse vegetable food, not only for overcoming the resistance of the tough rind or harder shell which encloses the sapid fruit, but as deadly weapons they may claim equality with the fangs of the highest Carnivores. The great cuspidate canines of the Gorilla, implanted deep in the ponderous shafts of the jaw, and worked by the enormous masses of muscle which spring from the crested cranium and huge zygomatic bars, constitute an armature corresponding with the untameable ferocity and brute courage, before which even the boldest elephant-hunter quails. Professor Owen was informed by the commander of a British trader, "that he had seen a Negro at the Gaboon frightfully mutilated by the bite of the Gorilla, from which he had recovered. Another Negro exhibited to the same voyager a gun-barrel, bent, and partly flattened, by the bite of a wounded Gorilla in its death-struggle."

Another, and, if possible, more important point of differentiation, is the sexual inequality in the development of the canines which is observed in all the Anthropoid Simiæ. The size of these teeth in the males, both of *Troglodytes* and *Pithecus*, far exceeds their dimensions in the weaker sex. The huge laniaries of the Gorilla or Orang are to be ranked as sexual developments in the same category with the antlers of the Stag and the tusks of the Boar, and, like them, they indicate a provision by which the function of continuing the species devolves on the males of greatest bodily strength and prowess. It appears to us that the absence of all sexual distinction in the teeth of Man, points as decidedly to an impassable barrier between his organization and that of the brute Ape, as does the symmetry of his limbs, his plantigrade foot, or his perfect hand. Moreover, let it be remembered (as is remarked by the great anatomist on whose researches these papers are founded), that to no external circumstance can the superiority in development of the canines in the male be

ascribed. Whilst the young of the two sexes are still nourished by their mother's milk, long ere the development of the sexual system is perfected, the crown of the great male cuspidatus is being calcified and made ready to displace its small deciduous predecessor. It is, therefore, a preordained structure, a weapon forged whilst yet the forces which are to wield it are undeveloped, and long before the instincts to which it is to be subservient have asserted their sway.

The upholders of the doctrine of the distinct creation of species have been charged by some of their opponents with allowing their judgments to be shackled by the fetters of a traditionary faith ; by others, with giving an undue scope to the exercise of the imaginative faculty—with permitting it to assume an unwarrantable influence in a discussion which should be conducted in exact accordance with the laws, and be scrupulously restricted within the limits, of rigorous induction. We submit that no small demand is made both on faith and imagination, when the naturalist is required to believe that an assemblage of organs analogous to the armoury of the Gorilla, with its formidable garniture and the massive apparatus by which its weapons are wielded, has been transformed into the human mouth—has become endowed with its extraordinary adaptability to the expression of mental conditions ; insomuch, that even the configuration and mode of implantation of the teeth have been rendered subservient to the faculty of speech ; that these *acquired* peculiarities have become so established in Man, that anatomical science can trace the design long before the power of articulation has been developed in the individual : moreover, that this marvellous transmutation has taken place either under the influence of external and accidental circumstances, or from the operation of a law of natural selection of which no evidence can be obtained during the historic period, and to which the records of the rocks afford no confirmation.

We confess that, to our minds, the time-honoured belief, that each beast of the field was created *after his kind*, and that Man has a right to boast a higher and nobler descent, involves no such drafts on credulity, and demands no such flight of imagination.

ON THE TEETH IN MAN AND THE ANTHROPOID APES.*

In the present paper, we propose to institute that detailed comparison between the teeth of Man and the Anthropoid Apes, for which we have been prepared by an examination of the bones which constitute the upper and lower jaws. We would preface our review with a few remarks on the value in systematic zoology which attaches to indications based on the form and structure of the teeth. In the first place, we would observe that no organs are more indicative of the pre-ordained habits and food of the possessor. The complex ridged or tuberculate grinder of the vegetable feeder—the trenchant *carnassières*, and the tearing, holding laniaries of the beast of prey, are indissolubly connected with their aliment and propensities. The strong conical premolar of the Hyæna, belted by a basal ridge for the protection of the gum, constitutes a perfect instrument for breaking and crushing the bones of the forsaken carcase which forms his moonlit banquet. Dr Livingstone, in describing the habits of the Spotted Hyæna, asserts that "leg-bones of Oxen, from which the natives have extracted the marrow and everything eatable, are by this animal crunched up with the greatest ease, which he apparently effects by turning them round in his teeth till they are in a suitable position for being split;" and it was remarked to Professor Owen by an eminent engineer, to whom he showed the jaw of an Hyæna, that the tooth in question was a perfect model of a hammer for breaking stones for roads. In like manner, the thick incisors of the Orang are means expressly designed to overcome the fibrous shells and hard capsules of the fruits on which he subsists; and whilst his formidable

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* Odontography; or, A Treatise on the Comparative Anatomy of the Teeth. By R. Owen, F.R.S. 2 vols. London, 1840-45.

The Cyclopædia of Anatomy and Physiology. Vol. iv. Edited by Robert B. Todd, M.D., F.R.S. Article "Teeth," by Professor Owen. London, 1849-52.

On the Classification and Geographical Distribution of the Mammalia. By Richard Owen, F.R.S. London, 1859.

Osteological Contributions to the Natural History of the Chimpanzees and Orangs. By Professor Owen, F.R.S. Zool. Trans., vol. i.—iv. London, 1835-58.

canines might at first sight inspire the idea of a living prey, his broad and slightly tuberculate molars correct the misapprehension, and indicate another purpose to be fulfilled by the cuspidati than that of alimentation.

Again, the teeth are fixed organs. They form no part of the mechanism of motion, and for this reason they are not subject to that variety of configuration which we see constantly arising in true bones, from the less or greater development of the muscles to which osseous surfaces give attachment. Neither is their conformation modified by any other extraneous influence. Modelled in the dark alveolar recesses of the jaw at a period when the permanent mode and conditions of the animal's existence have neither been developed nor brought into play, their peculiar shape and structure must be admitted amongst those ultimate facts in science of which we can trace the purpose and design, but of the causalities of which we are absolutely ignorant. Hence it is that those species which have shown the greatest amount of adaptiveness to new conditions, which have been in the highest degree altered by domestication, or changed by the influence of climate, aliment, or other accident—under every mask of external modification —exhibit the peculiar and specific dentition of the parent stock. Of this, the Dog, the Swine, and, in fact, all those animals which under human intervention have displayed the widest divergence in form, size, covering, and even instinct, afford undeniable evidence. Man himself, than whom no creature exists under greater dissimilitude of external circumstance, wherever and however he be found—whether it be as the graminivorous Hindoo or the seal-fed Esquimo, the fur-clad Russian or the naked Bechuana, the refined Parisian or the debased Alfourou—whatever the colour of his skin, the capacity of his cranium, the loftiness of his elevation, or the depth of his degradation, still exhibits, constant and unchanged, the specific, the unmistakeable characteristics of human dentition.

The permanent and enduring quality of the tissues which compose the teeth is another circumstance which enhances their value, especially to the palæontologist. Such is the durability characterizing the dental structure, that it is not unfrequently found that the teeth alone have resisted the action of those chemical and physical forces which reduce organized to inorganic matter. Imbedded in ancient deposits on the earth's surface, they remain the solitary memorials of the being of which they once formed part—the sole indicators of its position in an extinct, and its relations to a living,

fauna. On the other hand, their anatomical position renders them of easy examination in living and recent specimens.

Having premised thus much as to the general value of the information which an examination of the dental organs is capable of yielding, we turn to the special object of this paper, and, again availing ourselves of the rich fund of information for which science is indebted to Professor Owen, shall pursue the same plan we followed in our former review, first noticing the peculiarities of human structure, and then comparing it with the dentition of the Gorilla, the Chimpanzee, and the Orang. The permanent teeth will first claim attention.

It was at one time believed that the continuous series of the human teeth, the absence of all break in their implantation, was a character peculiar to Man. But the researches of palæontologists have somewhat detracted from its value as a human characteristic, by demonstrating a like contiguous setting of the teeth in the jaws of a few extinct quadrupeds; *e. g.*, *Anoplotherium*, *Nesodon*, and *Dichodon*. Still, amongst existing Mammals, Man alone uniformly presents an uninterrupted dental series. In *Troglodytes Gorilla* and *Troglodytes niger*, concomitant with the large development of the laniary, an interspace separates that tooth in the upper jaw from the lateral incisor, in the lower jaw from the first premolar. In the male Gorilla, the diastema in the upper jaw measures two lines in breadth; in the female, one line and a half. In the lower jaw, the canine is separated from the first premolar by an interval measuring one line and a half. In *Troglodytes niger*, the diastema in the upper jaw is greater, both in the male and female, than in the Gorilla; in the male skull it measures three lines, in the female two. In the lower jaw, the unoccupied space between the laniary and the premolar does not exceed a line in breadth: in one female skull we have examined, it is absent on the left side; but a small interval separates the canine alveolus from that of the lateral incisor.

In the Great Orang, *Pithecus Satyrus*, the diastema is well marked in the upper jaw; it sometimes measures four lines in breadth, and is rarely less than three. In the lower jaw, in many instances, the teeth present a continuous series; but occasionally an interval exists between the canine and premolar, and sometimes between the former tooth and the lateral incisor. In one male skull of the smaller species of Orang, *Pithecus Morio*, the interspace in the upper jaw between the canine and outer incisor exceeded two lines in

breadth; in the lower jaw the teeth presented no break in their implantation. In another specimen, in both jaws the dental series was as continuous as in the human subject. The absence or minor development of interspaces between the teeth in *Pith. Morio* is dependent on the large size of the canines and incisors, which equal the same teeth in *Pith. Satyrus*, and on the smaller relative size of the jaws. It is this equality in the size of the teeth in the two species which induces Professor Owen to suspect that *Pith. Morio* may have originated in a dwarfed variety of the larger Orang. The specific differentiation between the Chimpanzee and Gorilla is sustained by the smaller size of the dental organs in the former. On the contrary, there is no diminution in the dimensions of the teeth concurrent with inferiority of stature in the dwarfed varieties of the human race.

Incisores.—The characteristics of the human incisors are, their smallness of size in proportion to the other teeth and to the entire skull; their near equality of size with each other; their thin wedge-like form; and their vertical or nearly vertical implantation. In the upper jaw, the two middle incisors slightly exceed the lateral in breadth; the posterior surfaces of both are smooth and slightly concave. The middle incisor presents a slightly-developed basal ridge on its posterior surface; but such elevation is entirely absent on the posterior surface of the lateral one. The external angle of the crown of the lateral incisor is not rounded off, and is in contact with the canine. In the lower jaw, the incisors are somewhat smaller than in the upper, and the breadth of the central is slightly inferior to that of the lateral; the outer angle of the crown of the latter is entire.

Genus *Troglodytes.*—In *Tr. Gorilla* and *Tr. niger* the incisor teeth are not only absolutely much larger (thicker and broader) than in Man, but they are of far greater size in proportion to the molar series and to the entire skull. In the Gorilla, the transverse measurement of the four incisor teeth is not greater than in the Chimpanzee: they are, therefore, proportionately smaller; and in this respect, although still very far removed, the Great Ape makes a nearer approach to human dimensions. A further deviation from human type is seen in the greater inequality of the incisors of the upper jaw, the central incisors being considerably broader than the lateral. This inequality is greatest in the Gorilla, but in both species it is a marked point of differentiation. Each incisor has a well-developed prominent basal ridge on its posterior surface; and the outer angle of the crown of the

lateral, instead of being entire, as in Man, is rounded off. In the lower jaw, these teeth are equally characterized by their great size. As in Man, the lower lateral are broader than the central ones; but the former have the external angles of the crowns rounded off. In both jaws the direction of the incisive teeth departs greatly from their vertical or nearly vertical position in Man.

Genus *Pithecus*.—In the incisors of the Orangs we notice a still greater divergence from human type in the superior breadth of the entire series, in the greater size of the upper central teeth, and the greater amount of inequality between them and the lateral. The central incisor of the upper jaw in *Pith. Satyrus* and *Pith. Morio* is of unusual size and strength, being double the width of the outer one, whilst its thickness is nearly equal to its transverse measurement. From their constant use in overcoming the resistance of hard and tough vegetable substances they become worn down; and in the old Orang they present a broad abraded surface, which extends obliquely backwards from the cutting edge to the posterior margin of the base of the crown. The lateral incisors have their external angles obliquely truncated; in the lower jaw they exceed in transverse measurement the dimensions of the central. In the obliquity of their implantation in both jaws, they exhibit the ordinary Quadrumanous character.

Cuspidati.—In its conical shape, the human cuspidatus does not present an exception to the configuration of canine teeth generally; but its peculiar characteristics are its small absolute and relative size, and the absence of any difference in its development in the two sizes. It is more deeply implanted and possesses a stronger fang than the incisors; its external surface is convex, its internal is flat or sub-concave, and presents a slight prominence at its base.

Genus *Troglodytes*.—The canine tooth in both sexes is of greater relative size than in the human subject, but in the male sex it attains vastly superior dimensions. In the adult male of both species, the apex of the upper cuspidatus extends a little below the alveolar border of the lower jaw when the mouth is shut; in the female the apex is lodged in the interval between the lower canine and first premolar. The crown of the upper laniary in the male is pointed and of a conical figure; its external surface is convex, presenting a longitudinal depression anteriorly; posteriorly it is somewhat flatter, and is bounded by a sharp cutting edge: the internal surface is divided into an anterior and posterior facet

by a longitudinal rising; the posterior is concave, and both it and the anterior are grooved longitudinally. In the male Gorilla the cuspidatus has a more outward direction than in *Tr. niger;* the anterior internal groove is deeper, and the internal ridge is more developed; the posterior internal groove is continued lower on the fang, and the posterior trenchant edge is more produced towards the base. The size of the canine in the male Gorilla is greater as compared with the incisors than in the Chimpanzee; in the male of both species it attains twice the size of the same tooth in the female. In length the enamelled crown of the superior canine in the adult male *Tr. Gorilla* measures one inch and four lines.

An equal sexual distinction is maintained in the dimensions of the canines in the lower jaw. The crown of the lower canine is conical and trihedral, its external surface is convex, and the two internal are flat or slightly concave, and converge to an almost trenchant edge. Anteriorly a ridge separates the external from the antero-internal surface. The entire length of the lower canine in the male Gorilla is two inches and a half, in the Chimpanzee two inches. The crown in the larger species is one inch and a quarter in length, and nearly an inch in breadth at its base; in *Tr. niger* it is three-quarters of an inch in length, and two-thirds of an inch across the base.

Genus *Pithecus.*—In the Orangs we find a like high degree of development attained by the canines, the same sexual difference, and the same general configuration. The laniary of the Great Orang does not, however, quite equal that of the Gorilla, either in length or breadth. The posterior trenchant margin of the upper tooth is moderately developed, but the anterior longitudinal depression which is present in the species of *Troglodytes* is absent. These two latter characters receive their highest expression in some of the Baboons; *e. g.*, the Mandrill (*Cynocephalus Maimon*).

Premolares.—In Man the crowns of the premolar teeth (bicuspides), in both upper and lower jaws, are, as their name implies, surmounted by two cusps or pointed tubercles. These teeth are of less relative size as compared with the true molars than in the Anthropoid Apes. The outer cusps of both premolar teeth are larger than the inner ones, and accordingly the outer curve formed by the premolar part of the dental arch is greater than the inner. In the upper bicuspid the outer and larger cusp is divided from the inner by a deep straight fissure or groove; in the lower bicuspid

this fissure describes a curve concave towards the outer cusp. In some cases the curved groove in the lower premolar is crossed by a ridge which extends from the outer to the inner cusp. The inner cusp in the lower tooth is less developed than the same tubercle in the upper. The fang of the lower premolar is single, long, sub-compressed, and conical. In the upper jaw, although at first sight the fang of the premolar might be supposed to be single, an examination of the pulp cavity, which is bifurcated, shows that it really consists of two connate fangs, which frequently, by the groove on their surface, and by a bifid extremity, evince a tendency to separation.

Genus *Troglodytes*.—In the upper jaw, the premolars of the Gorilla and Chimpanzee are bicuspid, as in Man; but, besides their superiority of size, they differ in several other important particulars. The external cusp of the first premolar in both species of *Troglodytes* is larger than the inner, in the second premolar the inner is larger than the outer; in Man the external is the larger in both. This alternation in the size of the cusps of the premolars of the Chimpanzees corresponds with and contributes to the straight line formed by the whole grinding series; whilst the great size of the external cusp gives to the first premolar, when viewed from without, the appearance of being greatly superior in size to the second. Each premolar is implanted, like the true molars, by three divergent fangs, two external and one internal, which at their ends curve towards each other. Professor Owen states that in one female skull of *Tr. niger* which he examined, the two external fangs of the second premolar are connate, and in the specimen before alluded to (p. 438) a similar peculiarity was noticed; in these cases the first premolar presented the usual implantation by three fangs. In no variety of Man is the upper premolar normally implanted by three roots; the greatest approach to complexity observed in him is a partial division of the fang into two. In the lower jaw, the first premolar, when viewed externally, appears much larger than the second; in the Chimpanzee it is twice the size, in the Gorilla three times the size, of the same tooth in Man. Its crown is somewhat of a three-sided figure, the anterior and outer angle being produced forwards, and making an approach in this respect to the peculiar characteristic of the first premolar in the Baboons. It is surmounted by two trihedral cusps: of these the outer is the larger and higher, whilst the inner is feebly developed on a ridge extending transversely from the external cusp. A thick basal ridge

belts the inner and posterior part of the crown. The second lower premolar is of a four-sided figure; its two cusps are placed on the anterior half of the upper surface of the crown; they are united by a transverse ridge, and a third smaller cusp is developed on the inner and posterior angle. Each lower premolar is implanted by an anterior and posterior fang: of these the former is the larger. They are divergent, and compressed antero-posteriorly.

Genus *Pithecus*.—In the Orangs we recognise the same complex implantation of the premolars by three fangs in the upper and by two in the lower jaw. The first premolar in the upper jaw differs from the same tooth in the Gorilla and Chimpanzee in having the anterior external angle of the base of the crown produced, an approximation to the configuration observed in the lower Quadrumana. The outer lobe of this tooth is a little larger than the inner one; in the second upper premolar both lobes are equal. The two cusps of the first are also more developed than the two cusps of the second. In the lower jaw, the outer cusp of the first premolar attains by far the greater dimensions; from it three ridges proceed, one to the front part of the grinding surface, one to the back part, and a third transversely inwards, where it developes a small tubercle. In the second lower premolar, the inner tubercle attains almost an equal size with the outer.

Molares.—Amongst the distinguishing features of the true molar teeth in Man, are their greater size in proportion to the jaw and in proportion to the other teeth, and the rounded contour of their grinding surfaces. In the upper jaw, the two first teeth of the molar series are quadricuspid. Of the four cusps, the antero-internal one is the largest; and it is connected with the postero-external by a low ridge, on either side of which is a deep groove, extending on the outer side to the middle of the outer surface, on the inner side to the inner surface. The connection of the inner anterior and the outer posterior cusps by the oblique ridge just mentioned gives a sigmoid character to the eminences on the grinding surfaces of these teeth. In the last true molar, which is the smallest of the series, the two inner tubercles are blended together; and in many instances a groove extends at right angles from the one separating the two outer cusps to the middle of the posterior border of the grinding surface. The upper molars in Man are implanted by three diverging fangs, two external and one internal; but not unfrequently in the second molar the two external are found parallel, and occasionally connate. In the third upper molar, the two

external fangs are more commonly connate; and sometimes also the inner fang is blended with them. Owing to the slow accession of maturity in Man, and the long interval which elapses between the acquirement of the first and last true molars, the former tooth is found more worn in proportion to the other teeth of the same series than in the Chimpanzees and Orangs. In the lower jaw, the human molar is quinque-cuspid, the fifth tubercle being developed posteriorly, and connected with the postero-external cusp. The fifth cusp is, however, frequently absent in the second tooth of the series, and is most developed in the *dens sapientiæ*. A crucial depression separates and defines the four principal cusps, and by a bifurcation of its posterior branch includes the fifth. This bifurcation is most apparent in the third molar. As in the upper jaw, the last-named tooth is the smallest of the true grinders. Each molar is implanted by an anterior and a posterior subcompressed fang, which are grooved along their opposed sides. It is not uncommon to find these fangs more or less connate in the second and third teeth of the series.

Genus *Troglodytes*.—The straight line which the grinding series forms in the Chimpanzee and Gorilla is the difference which first attracts notice in comparing these teeth with those of Man. In the upper jaw, there is a slight inclination in the opposite direction to the well-marked curve which the molar teeth describe in the human subject. Another difference is the smaller relative size of the grinders as compared with the incisors. In this last particular the Gorilla makes a nearer approach to Man than the Chimpanzee; for in the former the molars are larger relatively, when compared with the incisors, than in *Tr. niger*. In the upper jaw, the first two molars, both in *Tr. Gorilla* and *Tr. niger*, correspond with the same teeth in the human subject, in being quadricuspid, and in having the inner internal and outer external tubercles connected by a low ridge. The sigmoid character thus given to the eminences on the unworn surfaces of these teeth is highly indicative of the superior position in relation to Man occupied by the Chimpanzees over the Orangs and lower Quadrumana, in whom the grinding cusps rise from the surface of the tooth distinct and unconnected. The third upper molar in *Tr. niger* is the smallest of the series, in consequence of the minor development of the two posterior cusps; also the oblique connecting ridge between the antero-internal and postero-external cusp is either absent or feebly developed. In the Gorilla, the last upper molar

differs from the same tooth, both in the Chimpanzee and in Man, in its greater size, being equal to the second except at the posterior part, which is slightly narrower, and in having both the posterior cusps, but especially the inner one, much more distinctly marked. The connecting ridge between the anterior internal and outer hind cusp is also present, but it is more transverse than the same ridge in the other molars. Each upper molar in both species of Troglodytes is implanted, as in Man, by one internal and two external fangs. These, we believe, have never been observed connate in any of the Anthropoid Apes. In the lower jaw, the three molar teeth of the Gorilla are equal in size; in the Chimpanzee they are nearly equal, the first being only slightly larger than the last. In both species, the four principal cusps, and especially the two inner ones, are more pointed and prolonged than in Man; but the fifth posterior cusp is proportionably smaller. The fifth cusp is present in the second tooth; it is usually absent in the second molar of Man. The crucial depression which separates the cusps is much less distinctly marked, and does not divide the ridge connecting the anterior pair, as in the human lower molar. Owing to the great development of the fifth posterior cusp, the crown of the last molar is of longer antero-posterior measurement. The implantation of these teeth resembles that in the human subject, except in the fact that the two roots of the second and third are never found connate in the Gorilla and Chimpanzee.

Genus *Pithecus*.—The true molars of the Orangs differ from the true molars of the Chimpanzees in their smaller relative size as compared with the premolars. Like the molar series in Troglodytes, they form a straight line in both jaws; and they have a similar implantation, by three roots in the upper and two in the lower jaw. In the superior series, the first and second teeth are furnished with four cusps; but they are less developed, and the depressions between them are shallower; the connecting ridge between the antero-internal and the postero-external tubercles is either absent or but very feebly developed, so that, as before stated, the sigmoid character of the elevated surface is not marked, as in Troglodytes; the whole grinding surface is flatter, and minutely wrinkled. The third molar is smaller than the first and second.

In the lower jaw, the first and second molars have three cusps along the outer side, and two on the inner. The last tooth of the series has two external cusps distinctly marked, but the postero-internal tubercle is but feebly developed.

The unworn surfaces of the lower molars are, like those of the upper, minutely wrinkled. Lastly, it would appear that, in the Orangs, it is not very unusual to find a fourth supernumerary molar, sometimes in the upper, sometimes in the lower jaw, on one or both sides. It is worthy of remark, that supernumerary teeth occurring in the human subject are almost always, if not always, incisors or canines.

We have thus seen that the permanent dentition of the brute Ape indicates in itself, were there no other anatomical differences between them, an impassable boundary between his organization and that of rational Man. The great incisors and canines, the peculiar conformation of the premolars and their complex implantation, the straight line formed by the whole molar series, and the relative inferiority in size of the true molars as compared with the incisors—above all, the sexual differences in the development of the canines—constitute an assemblage of distinctions which no process of transitional transmutation of which we have any cognizance, no law of selection whose operations we are able to trace, are competent to obliterate. In briefly reviewing the differences which exist in the deciduous teeth of Man, *Troglodytes niger*, and the Orangs, we shall place other and even more significant facts in array against the hypothesis of transmutation; for the milk teeth are even farther removed than the permanent ones from extraneous influences, and they are formed at a period far too early in the life of the animal for the occurrence of deviation from the common primordial type.

The human milk incisors differ from those of *Troglodytes niger* and *Pithecus Satyrus* in their small size and the entierty of the outer angles of the lateral pairs. The canines differ in the less pointed configuration and inferior length of the crown, and in the absence of the sharp posterior edge in the inferior one. The crowns of the milk canines are also less obliquely opposed in the human subject, the direction of the inferior one being more advanced in the Chimpanzee and Orang. The first deciduous molars of man differ in the greater complexity of the grinding surface. In the upper jaw it is bicuspid, with a small posterior division notched off from the outer and larger cusp; and the inner cusp is more developed than in the Chimpanzee. In the Orang and Chimpanzee it presents two simple cusps. In the lower jaw, the first human milk molar is quadricuspid, with a small anterior ridge; in the Great Ape it supports one large pointed cusp and a posterior ridge. The second deciduous grinder in the

upper jaw of these animals agrees in general configuration with the same tooth in Man; but the second lower molar is quinque-cuspid in the human subject; in the Chimpanzee the fifth posterior and external cusp is absent, and only a slight indication of it exists in the Orang.

Lastly, the order of succession of the permanent teeth presents this striking difference: In Man the canines and bicuspids come into place before the second molar, and the anterior part of the dental arch is completed long before the acquisition of the full grinding apparatus. In the great Quadrumanes the second molar is cut before the lateral incisors and premolars; and the large canine comes into place the last of the dental series after the third molar. The small size of the canines and bicuspids in Man is doubtless the immediate circumstance on which depends the precedence of their evolution; but it is most interesting to trace in the rapid completion of the fore part of his dental series an adaptation to the early perfection of those powers of speech and expression which are supereminently his endowments; whilst, on the other hand, the priority in succession of the true grinders in the frugivorous Ape is a provision in accordance with the necessities imposed by his coarser vegetable diet.

We have thus endeavoured to present to our readers the salient points which distinguish the teeth and maxillæ of Man from the corresponding structures in those amongst the inferior Mammalia which in organization approach him nearest. Our obligations throughout these papers to the labours of Professor Owen have been before acknowledged; but we cannot lay aside the pen without expressing our sense of the importance of the results elicited by his researches in the anatomy of the higher Quadrumana. The discovery of the identity of the immature Orang with the Great Pongo of Borneo, and of the *Homo Troglodytes* of Linnæus with the mature Chimpanzee; the investigation and comparison of their osteology and dentition; together with the later researches into the still higher development of Quadrumanous organization exemplified in *Troglodytes Gorilla*—have established the existence of a chasm between the physical part of Man and the irrational Ape which existing science is powerless to fill, and hypothetical reasoning can never bridge.

ON THE TEETH IN THE VARIETIES OF MAN.

OUR design in the present paper is to present our readers with such facts as our observation and research have supplied in reference to the natural or acquired conditions of the teeth in the different varieties of mankind. We do not claim for our contribution the dignity of a systematic treatise, neither do we offer it as an original investigation. Much we ourselves have noticed has been already recorded by anatomists, and commented on by ethnologists. Still, we believe that by bringing together the stray facts that are to be found scattered through their writings, and by verifying them as far as our limited field for observation will admit, we shall be drawing attention to a little-cultivated department of professional knowledge, and at the same time be contributing something to the anatomical argument for the specific unity of the human race. We are quite ready to allow that, in reference to the latter subject, we must not demand of anatomy alone a decision. Man, of all the creation, is the being whose origin and relations can never be satisfactorily elucidated by mere physical science. History, philology, and above all psychology, must be heard ere we can hope to arrive at a just conclusion. But, of all the arguments founded on a similarity of structure, that derived from dentition is perhaps the strongest. In a recent article in this Journal, we have referred to the persisting characteristics of the teeth under diversities of outward circumstance; to the inherent property the dental organs possess of resisting those influences which in the course of generations are capable of modifying the osseous, the muscular, and the tegumentary systems; and to the insight into the physiology and affinities of the animal which a study of dental structure and configuration unerringly affords. Whatever opinion may be held as to the origin of mankind; whether, with Prichard and British ethnologists in general, we hold the doctrine of universal descent from a single pair of protoplasts; or whether we incline to the hypothesis of Professor Agassiz and some Transatlantic writers, which demands a multiplication of centres of origination,—we maintain that whilst psychical nature, and the cerebral development subservient to it, isolate Man entirely from the inferior creation, his dentition not only warrants, but requires the reference of every known variety of the human race to one and the same species. The characteristics of the human permanent teeth have been lately dis-

cussed at some length in this Journal: we cannot, however, omit mention of them here, as by so doing we should neglect the definition of the premises on which we found our argument.

They may be summed up as follows:—

1st. The numerical formula (common to Man and the Catarhine Quadrumana).

$$i, \frac{2-2}{2-2}\ c, \frac{1-1}{1-1}\ p, \frac{2-2}{2-2}\ m, \frac{3-3}{3-3} = 32.$$

2nd. The equable development of the teeth.

3rd. The absence of all sexual distinction in particular teeth.

4th. The moderate size of the incisors, canines, and premolars; the configuration of the grinding surfaces of the latter, together with their implantation by one fang in the lower jaw, and by two fangs, which are in most cases connate, in the upper.

5th. The large size of the true molars in comparison with the incisors, canines, and premolars, and the character of their grinding surfaces.

6th. The absence of break or *diastema* in the series.

7th. The curve formed by the molar series, including the premolars, and the parabolic arch which the entire dental series describes.

These distinguishing peculiarities of the human dentition are demonstrable in every nation and tribe; and we may add, that were a race of beings in other respects resembling Man to be discovered in whom the dental organs differed widely from the standard we have indicated, their right of affiliation to the human stock might be considered scientifically disproved.

But it is a matter of everyday experience, that the teeth of individuals differ in many minor points. In some the incisors are larger than in others: in this case the canines may be found to be more acuminated, in that more obtuse, and the relative size of the true molar teeth will be found to differ in individuals. In persons moving in the same class of society, the greatest difference is observed in the tendency to caries; and the teeth of some wear down by attrition comparatively early in life, whilst others retain them to a late period little injured. Again, it is frequently found that these characteristics are repeated in the different members of the same family; that peculiarities in size, strength, and proclivity to disease of the teeth are as much transmitted and inherited as feature and complexion, or gout and insanity. Now, what is true of individuals and families will be found to obtain on a larger scale when we comprehend nations and varieties in our survey. The differences which are observed as individual peculiarities in one tribe become in another the

more general characteristics, and this will be found most frequently the case when such tribe has been long isolated and barbarous. But, be it understood that these national differences do not involve departure from the typical standard of human dentition; and we shall show, as we proceed, that no peculiarity has been found in the teeth of any human variety which may not occasionally arise in individuals of other stocks, and therefore that no such peculiarity can be admitted as a ground of specific differentiation.

For the sake of convenience, in the present article the varieties of mankind will be taken rather according to their geographical distribution than according to their anatomical characters or the affinities of language. We may commence with the nations of Africa, as in the present day affording us tribes sunk in the lowest depths of barbarism, whilst within the historic period the valley and delta of its great northern river have formed the nursery and repository of the art, the science, and the literature of the world.

The Quaiquœ race, including the various tribes of Hottentots, together with the Bushmen or Saabs, has long been known as occupying a very low, if not the lowest position in the scale of humanity. The physical deterioration and mental degradation of the Bushman is only found equalled amongst the Kelœnonesian tribes of Australia and the savages of Tierra del Fuego. What, then, is the condition of the dental organs in this, one of the lowest phases of humanity?—does it in any way approach the dentition of the higher Quadrumana, or does it differ from the standard observed in higher races? To this question we can answer decidedly. We have examined the teeth in both Hottentot and Bosjesman skulls, and have compared them with the teeth of individuals of other nations, and have been unable to detect any difference of a specific character. Professor Owen has observed that in the melanous varieties generally the true molars are of large size, and that the fangs of the wisdom and penultimate molars are not as a rule connate or conjoined. This he finds generally to obtain, although it is most remarkable and constant in the Australian variety. The truth of this observation is not for a moment to be disputed, albeit we meet with exceptions which prove it not to be a ground of specific distinction, and as such it is not advanced by Professor Owen himself. But in these, the lowest races of Africa, we do not find the molar series attaining a remarkable size. In the skull of one female Bosjesman we have examined, the true molars present (the dentes sapientiæ, upper jaw, were not in place) were of moderate size; neither they nor the premolars differed

from the usual standard. The canines did not exceed in length the premolars or the lateral incisors; they were not more acuminated than in the European. In the lower jaw, the third molars were, as usual, smaller than the penultimate; and in the latter there was no indication of the fifth or posterior tubercle, in this respect agreeing with the typical configuration. In the skull we are referring to, the central incisors, upper jaw, were absent; but the examination of another specimen has enabled us to say that these teeth in the Bushman are not remarkable in size or position. In fact, both Bushmen and Hottentots appear to exhibit the prognathic character in a less degree than do the true Negro tribes, and, consequently, the incisor teeth have a less slanting implantation. Cuvier was led by the examination of a female of this race to a different conclusion. In commenting on the head, he remarks: "the jaws are more projecting than in the Negro." A comparison of several Bosjesman and Hottentot skulls with those of other African races will afford evidence that Cuvier's case must have been exceptional. In the head of the male Bushman figured by Blumenbach, as is remarked by Prichard, there is no projection of the jaws; on the contrary, the incisor alveoli and teeth, together with the chin, are on the same perpendicular line. It it usual in the melanous races to find the third molar, in both jaws, relatively larger than in Europeans; and, as we have already noticed, the fangs are most commonly distinct. We shall have to refer frequently to this special point of structure as we proceed. In the skull of a Hottentot we found that the molars present, and especially the wisdom teeth in the upper jaw, were as small, and even smaller, than in many European crania. The grinding surfaces of the third upper molars accorded with the typical condition in the blending of the two internal tubercles; and although the extremities of the fangs were distinct, the two external roots were conjoined for a considerable distance. In like manner, the two external fangs of the upper penultimate molar were partially confluent, but to a less extent. We are thus led to the conclusion that the dentition of this, one of the lowest developments of Man, presents no special aberration from the typical dentition of the human stock.

In the Caffre we have noticed that the incisors, although projecting in accordance with the prognathic character of the maxillæ, have not been of larger than the average size in well-developed Europeans; neither have the canines been longer or more pointed. In one specimen the upper molars were of moderate size, the antero-posterior measurement of the upper

true molar series being one inch one and a-half lines. We have found a greater antero-posterior measurement not unfrequently attained by the upper true molars in the European. The dens sapientiæ, upper jaw, has usually the three fangs distinct. In one cranium we observed an indication of the fifth or posterior tubercle in the second molar of the lower jaw. This, which is not the typical configuration in Man, is nevertheless occasionally to be met with, and it does not appear to be limited to any particular race. We have seen it well marked in modern European skulls, in Negroes, in a cranium of a Greenlander, in a Chinese, and also in an ancient Egyptian and in a Romano-Briton. It is sometimes to be found in the penultimate lower molar of one side only. It has been asserted that the teeth in the Caffre tribes are rarely, if ever, affected by caries. We have, however, seen a specimen in which the lower molars were much decayed.

An examination of the teeth in a considerable number of African Negro crania has enabled us to draw the following conclusions:—In the African Negro the teeth are usually of large, but not excessive, size; they are regular, commonly sound, although caries is occasionally observed, and they seldom present that extreme amount of wearing down of the cutting and grinding surfaces which may be found so commonly in the Australian and Polynesian. The incisors are large, broad, and thick, but not of greater absolute dimensions than in numerous individuals amongst the white varieties. The teeth do not depart from the human type in their relative proportions; for wherever the incisors and canines are of considerable size, the true molars are likewise large, and maintain that superiority which is a distinguishing feature of the teeth of Man. The lateral incisors are well formed, and in the perfect entierty of their outer angles they adhere more invariably to the human type than do the same teeth in some more civilized races. The canines are not proportionally longer or more pointed than in the white man. The premolars agree in configuration and relative size with the typical standard. The true molars are usually of large size, generally larger than in the European; the dentes sapientiæ, although smaller than the other molars, are in the majority of instances of greater relative and actual dimensions, and the fangs of the last-named teeth are usually distinct in both jaws. But in the character of their grinding surfaces and their general contour, the molars of the African Negro present no departure from the typical configuration, and, as in other races, there are many instances in which a general description will not entirely apply. For instance, we have

found the true molar teeth varying considerably in size in individual crania. In several cases we have observed the molars of no larger size than in many European skulls. We have ascertained by measurement that the antero-posterior dimensions of the true molar series in the upper jaw, in eighteen Negro skulls, varied from one inch one and a-half lines to one inch four lines, the former measurement being less than is frequently attained by the same series in the civilized races. A similar result has been elicited by the admeasurement of the true molar series in the lower jaw. To show how the dimensions of the grinding teeth vary even in individuals of the same stock, we may state that we have before us, at the time of writing, three lower jaws of Anglo-Saxons, for the possession of which we are indebted to an eminent archæologist, the late Secretary to the Society of Antiquaries. In one of these the fore and aft measurement of the true molar series is one inch one and a-half lines, in another one inch three and a-half lines, in the third one inch four lines. We have seen the last-named measurement exceeded in only one African jaw; in it the lower true molar teeth measured, from before backwards, one inch five lines. Again, with regard to the size of the dentes sapientiæ, in many Negroes they may be found no larger than in some Europeans, and both varieties present considerable individual differences. The Anglo-Saxon jaws just referred to furnish an instance of this: in one of these the third molar is considerably smaller than the penultimate; in another it is nearly of the same size; in the third it is absolutely larger, longer, and broader than the second. In both African and European jaws the fifth or posterior tubercle in the third lower molar may be found occasionally but slightly indicated or obsolete. Then the implantation of the ultimate and penultimate grinders presents individual differences in Negroes. We have seen the three fangs of the upper third molar tooth in a Negro skull blended into one, and the two outer fangs of the second molar connate; whilst, on the contrary, the distinction of the fangs of these teeth, although not the general rule in the Germanic and Celtic races, is not of very unfrequent occurrence. In an early British cranium, we have noticed the fangs of the posterior molars as separate and distinct, as is common in the Negro and Kelœnonesian. Lastly, we would observe that, according to our limited experience, the general characteristics of the African Negro dentition are best exemplified (albeit liable to exception) in the Negroes of the Western Coast. The teeth in the crania we have seen from Eastern Central Africa, and from the Mozambique, appeared to us to present less markedly the minor differences above noted.

The prognathic development of the jaws also, and the consequent obliquity of implantation of the incisor teeth, though common in a varying degree to all African nations, not excluding the Egyptians, attains its greatest development in crania from the Western Coast. That a projection of the muzzle is not entirely confined to the black varieties of mankind, may be learned by the examination of any large collection of the skulls of different races. In most nations a degree of elongation of the maxillæ is to be noticed in individual instances, and we have seen crania, both of modern and ancient inhabitants of Europe, as decidedly prognathic as some of the better-formed skulls amongst the melanous races.

Before leaving the dentition of the African Negroes, it may not be out of place to notice some of the practices by which they render the teeth subservient to the realization of their conception of personal beauty. The deformities which barbarous races produce in the attempt to arrive at an ideal perfection are matters of some curiosity. As such endeavours are coextensive with humanity, their origin must be sought in a common psychical nature. Civilization has hitherto checked, but has never eradicated, the natural tendency. Constriction of the waist and transfixion of the ear-cartilages are not practices entirely unknown in the politer portions of Christendom; the English of the present day are only beginning to tolerate their beards, in the last century they shaved their heads and wore horse-hair.

According to Livingstone, the Bashinje, a tribe inhabiting Western Central Africa, file their teeth to a sharp point. A similar practice obtains amongst the Makúa or Makúana, a tribe near the coast of Mozambique. We have seen a skull from Eastern Central Africa in which this operation had been performed; and the Quaquas, inhabiting the Ivory Coast, are said to have the same usage. Knocking out one or both of the upper incisors at the age of puberty seems to be the vogue amongst many tribes. The Batoka, inhabiting the central country through which the Zambesi flows, knock out the two upper incisors of both sexes. Dr Livingstone tells us that a person who has the teeth is considered ugly, and that no young woman thinks herself accomplished until she has got rid of them. The reason they assign for the practice is, "that their object is to be like oxen, and those who retain their teeth they consider to resemble zebras." Again, the Shilúkh, a tribe of warlike Negroes inhabiting the plain of Sennaar, extract a single upper incisor. We have seen crania, one of which was certified from the Western Coast of Africa, in which this disfigurement had been effected. It is curious that the same custom appears to have prevailed amongst

some of the savages of Australia. One of the most remarkable arts of the toilet is practised by the ladies of the Fúlah or Felatah race, a tribe of Western Guinea. By means of the acid of the gorra-nut, and the juice of some other shrub, together with indigo, they dye the incisor teeth of different colours, one blue, one yellow, another purple, whilst the fourth is allowed to retain its pristine whiteness. Some tribes hold certain superstitions with regard to the succession of the teeth. Amongst the Bakaa, we are informed by Livingstone, a child who cut the upper front teeth before the under is said to "tlola," or transgress, and is put to death. He adds that he believes the same practice obtains amongst the Bakwains.

In the Abyssinian races, including the Abyssinians, the Modern Egyptians or Copts, and the Barâbra, the teeth, which are said to be white and regular, do not project to the same extent as in the Negro races. Belzoni, however, describes the teeth of the Ababdeh, a Nubian tribe, as being fine—white, protuberant, and very large. Attention was drawn by Blumenbach to what he conceived to be a peculiarity in the teeth of Egyptian mummies. He describes the incisors as thick and round, not, as usual, flattened into edges, but resembling truncated cones; and the cuspidati are not pointed, but broad and flat on the masticating surface, like the neighbouring bicuspides. He was inclined to think that these peculiarities were not acquired, but depended on a natural variety. Mr Lawrence, who investigated the subject, came, however, to a different conclusion; and his opinion was confirmed by Dr Prichard and Mr Estlin, who examined the teeth in two mummies containing the remains of children whose death had occurred between the completion and loosening of the first set of teeth. In one of the mummies all the first set were cut, and the rudiments of the second were to be seen under the gums. "Each jaw contained, with the exception of one tooth which had dropped out, the usual number of incisors, cuspidati, and molars; and all of these had precisely the form of the teeth of European children of the same age." There can be no doubt that the condition in question is due to the process of natural attrition; and it is, perhaps, partly to be accounted for by the large proportion which vegetables, roots, cereals, and fruits contributed to the diet of the ancient Egyptians. It is certainly not peculiar to them as a race, for it is a most common condition in the teeth of the Oceanic tribes, both amongst the Amphinesian and Kelœnonesian varieties. It has been noticed amongst the Esquimaux, and we have seen the same condition in the skull of a Laplander, in a Gentoo, and frequently in crania belonging to the early

inhabitants of Great Britain. It may be that peculiarities of diet will not account in all cases for this extreme wearing down of the teeth, but that further research may show a deficiency in the earthy constituents of the dentine and enamel. Be this as it may, we have before us the upper and lower jaws of an Anglo-Saxon in which the incisors and canines are worn down to exactly the condition Blumenbach has described. The incisors are reduced to mere cylindrical stumps, the upper surfaces displaying a central oval mass of dentine surrounded by a layer of enamel, and the canines are worn down to resemble the bicuspids. Our examination of skulls from Egyptian mummies has convinced us, moreover, that this peculiar state of the teeth is not always to be found. Of three crania, in one only did we find the teeth worn away to the same extent as those in the skull of an ancient inhabitant of Britain which we selected for comparison. In the other two, the effects of attrition were moderate. In two of these crania, the third upper molars were found to be nearly as large as the penultimate ones, and to exceed the usual dimensions of the same tooth in Europeans, in this respect agreeing with the general African conformation. In the third specimen, although the molar teeth were large, the dens sapientiæ in its relative smallness accorded rather with the European character. We found caries affecting a molar in one Egyptian skull, proving that the Professors of the Dental Art in Egypt mentioned by Herodotus might not have been entirely useless members of society.

The remarks we have made apply equally to the condition of the teeth, which have been found similarly worn away in the Guanche mummies of the Canary Isles. In one specimen of this race, we have seen the grinders worn down to the roots. In another, we found the anterior surface of the inferior incisors worn off obliquely. The central superior incisors were absent, but the lateral and canines appeared comparatively unworn. The molars were worn relatively according to their order of succession, and the first superior molar principally on the inner part of its grinding surface. Nothing is known of the manners and habits of the ancient Guanches, but we may well suppose that the cookery of an imperfect civilization necessitated the imposition of severe tests on the consistency and strength of the dental tissues.

The Oceanic nations are referred by Ethnologists to two varieties or stocks—the Malayo-Polynesian, or Amphinesian, and the Kelœnonesian, or Negrito. The first has spread from the

Malayan Peninsula to Madagascar on the one side, and as far as Easter Island on the other. It has peopled Borneo, Sumatra and Java, Formosa, Celebes and the Moluccas, the Philippines, the Pelew Islands, the Caroline and Marianne Islands, the numerous islands of Polynesia, Easter Island, and New Zealand. The type of this widely-spread race may be characterised as modified Mongolian; but although the affinity of the languages spoken throughout the vast area indicated points to a common origin, as might be expected the physical conformation of these insular tribes presents many diversities. In the colour of the skin, in the shape of the skull, and in other particulars, variations are met with, referrible to differences of climate, of soil and geological structure, of altitude above the sea-level, and of diet and mode of living. Into these it is not our province to enter. We at once proceed to an examination of the dentition of the Malayo-Polynesian race.

We have had an opportunity of examining the teeth in skulls from the Malayan Peninsula, the Philippine Islands, the Sandwich Islands, and New Zealand. We found a general correspondence with the type of dentition in the xanthous and leucous varieties. In the crania of individuals having the teeth unworn, the incisors, canines, and premolars presented no aberration from the standard configuration and proportions, whilst the true molars were of varying but usually moderate size. In the upper jaw, the fore and aft measurement of the true molar series varied from 1 inch 1 line to 1 inch 3 lines; in the lower jaw, the true molar series averaged 1 inch 3 lines in length. In some of the New Zealand skulls, an exact accordance of the true molars with the European type was noted; but in others we thought we perceived, not only in the greater length of the series, but in the breadth of the individual teeth, an approximation to the Melanian conformation. The dentes sapientiæ, which of all human teeth are subject to the greatest variety, are usually, in the Malayo-Polynesian, of typical proportions—that is to say, they are considerably smaller than the penultimates. Differences in the complexity of their implantation are of constant occurrence. In many instances they are inserted by distinct fangs, whilst occasionally the fangs of the third molars may be found as connate as is more usual in the Celt and Saxon. In this race, as in every other, the upper molar tooth becomes first worn on the inner half of the grinding surface; the lower, on the outer. We may notice, in passing, an abnormity which exists in one of the New Zealand skulls preserved in the Museum of the Royal College of Surgeons. In the lower jaw, only three incisor teeth

are present; one occupying the median line, whilst a natural interspace exists between the left canine and the anterior bicuspid.

Amongst the inhabitants of the Malayan Peninsula, the East Indian Archipelago, the Moluccas, and Philippines, the practice of filing and dyeing the teeth appears to be universal. Of the former operation there are, according to Dr Latham, three varieties. The first consists in filing off the enamel from the anterior surfaces of the teeth. We have seen several crania of Malays, and also one skull from the Philippine Islands, in which this has been effected. In general, the operation appears to be limited to the incisors, canines, and anterior premolars. The practice is said to facilitate the reception and retention of the appropriate dye, which, in Sumatra, where a jetty blackness is aimed at, is the empyreumatic oil of the cocoa-nut. Even, however, if no dye be used, the constant habit of chewing the betel-nut is sufficient to stain the teeth thus filed of a black colour. Another form of the operation is the filing of each front tooth to a point; a third, which is practised among the Sumatran women of Lampong, is the filing away of the entire crowns down to the gum. It may be doubted, however, as Dr Latham observes, whether this complete destruction of the tooth be due wholly to art; for in most of the Oceanic tribes, including both the Malayo-Polynesians and the Negritos, it is no uncommon thing to find the teeth worn away to an enormous extent by attrition. So remarkable is this amongst the New Zealanders and some other islanders, that it is noticed by Captain Fitzroy, in his narrative of the surveying voyage of the Adventure and Beagle, in the following terms: "Before closing this slight description of the personal appearance of the Zealanders, I must allude to the remarkable shape of their teeth. In a white man, the enamel usually covers all the tooth, whether front or double; but the teeth of a man of New Zealand are like those of the Fuegians, and at first glance remind one of those of a horse. Either they are all worn down — canine, cutting teeth, and grinders—to an uniform height, so that their interior texture is quite exposed, or they are of a peculiar structure." He adds, in a note, "This apparent wearing away of the teeth is not found in the New Zealanders alone. The Fuegians, Araucanians, and Society Islanders show it more or less, and it is very remarkable among the natives of New Holland. I have seen some white men (Europeans) with similar teeth, but they were all elderly; whereas, in some young savages, I have noticed incisors shaped rather like those of a horse." We may observe

that this remarkable destruction of the teeth by attrition is not constant among the New Zealanders. In only two of seven New Zealand skulls did we find the teeth in the extreme condition which Captain Fitzroy describes; in one the teeth were unworn and remarkably fine, in the others the effects of attrition were moderate. Again, the worn condition of the teeth in the Maori and other Oceanic tribes differs in no respect from that which we have already noticed as occurring more or less constantly in the Egyptian and Guanche mummies, and frequently in early British skulls; whilst, as has been before remarked, the unworn teeth present no exceptions to the common configuration and structure. We are informed by Dr Dieffenbach, that the Maori living on the borders of the lake Roturua have the enamel of the front teeth of a yellow colour. He attributes this to the action of the thermal waters, and remarks that the change produced does not appear to involve any impairment of the integrity of the teeth. Other differences also prevail among different branches of the Amphinesians. Thus, Mr Ellis describes the teeth of the natives of Tahiti as being always entire, except in extreme old age, and adds that, though rather large in some, they are remarkably white, and seldom either discoloured or decayed. On the other hand, in his description of the natives of the Gambier Islands, Captain Beechey asserts that the teeth, in one class especially, are not remarkable for evenness or whiteness, and seem to fall out at an early period. Again, the inhabitants of the Tarawan, or Gilbert Isles, are said to have small teeth—a characteristic which is certainly not common amongst the Oceanic tribes.

The survey of the dentition of the natives inhabiting the African Continent was commenced by some observations on the teeth of the Bushmen and Hottentots. It was demonstrated that no specific departure from the standard of human dentition accompanied their physical and mental degradation. But, although the lowest of African nations in the scale of humanity, the Quaiquœ race, in many points of structure—for instance, in the pyramidal shape of the head, the flatness and breadth of the face (dependent on the development and breadth of the zygomata), the obliquity of the eyes, and the lighter colour of the skin—exhibits a departure from the true Negro type, and an approximation to the Mongolian conformation. In the island continent of Australia, and in the neighbouring archipelago, on the other hand, we meet with a variety of Man geographically far distant from the African Negro, but physically presenting in many particulars a remarkable approximation to his type. Equalling,

or, according to some, surpassing, the Bushman in moral and mental abasement, the Negrito or Kelœnonesian races of Australia, Tasmania, and New Guinea present, in the contracted cranium, the prognathous jaws, the black colour of the skin, and, above all, in the large size of the molar teeth, a nearer approach to the Negro of the Western Coast of Africa than is to be found on any other portion of the globe's surface. It is to the dentition of the Australian and Tasmanian branches of the Kelœnonesian variety that we now invite the reader's attention.

Professor Owen we believe to have been the naturalist who first called attention to the large size of the teeth, especially of the grinders, in the Australian. So remarkable and constant is this peculiarity, that, in a late Report on a series of Nepalese skulls, made to the British Association for the Advancement of Science, this distinguished authority alludes to it as one of the most characteristic of the differential points of structure by which a cranium of an Australian may be recognised. After some remarks which completely overturn the generally-received doctrines with regard to the ethnological limitation of the different types of crania, he observes: "Only with regard to the Australian and Tasmanian aborigines do I feel any confidence of being able to detect, in any single skull, offered without comment to scrutiny, the distinctive characteristics of a race. The contracted cranium, flat nose, prominent jaws, and more or less protuberant cheek-bones, are associated, in the Australo-Tasmanian race, with a peculiarly prominent supraciliary ridge, and deep indent between its mid part and the root of the nose: and still more peculiar and characteristic is the large proportional size of the teeth, especially of the true molars."

This characteristic at once strikes any observer who may examine a collection of Australian crania; but the questions then arise,—allowing its great frequency in this race, is it absolutely constant, how far is it liable to variation and limitation? And again, are the Australian dimensions never equalled in other races? As far as our field of observation has supplied data, we propose to answer these inquiries.

In the first place, the dimensions of the true molar series vary in Australian crania, not only in the length of the entire series, but in the breadth of the individual teeth. In twelve Australian skulls we found the antero-posterior measurement of the true molar series in the upper jaw to range from 1 inch 2 lines to 1 inch 4 lines; in five lower jaws we found the same series measuring from 1 inch 2½ lines to 1 inch 5 lines in length. The breadth of the moderately worn first upper molar varied

from 4½ to 5½ lines. In one instance, in which this tooth was much worn down, the breadth of the upper surface was found to be 6 lines. Now, in the West Coast African negro, the true molar series of the upper jaw occasionally attains the length of 1 inch 4 lines, that of the lower jaw 1 inch 5 lines, in both cases equalling the extreme longitudinal measurement in the Australian. In the skulls of an Affghan, a Hindoo, a New Zealander, an American Indian of the Chenook tribe, a Patagonian, an Indian of Tierra del Fuego, and in an Early English skull, the fore and aft measurement of the same series in the upper jaw was 1 inch 3 lines respectively: in the lower jaw of the Affghan it was 1 inch 4 lines; in an Anglo-Saxon, 1 inch 4 lines; and in the Chenook Indian mandible, 1 inch 4½ lines. It will be observed that these measurements are all greater than the minimum noticed in the Australian. The greatest antero-posterior measurement of the true grinders we have noted is in the lower jaw of an Englishman, of abnormal stature, in the Museum of the Royal College of Surgeons: it is 1 inch 6 lines. Again, with regard to the breadth of the molar teeth, if we take the first molar, upper jaw, as an example, we have found its transverse measurement in the African Negro, the Sandwich Islander, and the New Zealander to be frequently 4½ lines, whilst in an Early English skull and in the skull of the Chenook Indian the transverse dimensions of the grinding surface of the same tooth were 5 lines, the latter being the average in twelve Australian skulls, in three of which the breadth of this tooth only equalled the former measurement. Admitting, then, to its full extent this peculiarity as a general characteristic of the Australian savage, we find it impossible to base on it a line of demarcation which shall isolate him from the human family—first, on account of the considerable variation to which the characteristic is liable in the Australians themselves; and secondly, because the attainment of considerable dimensions by the molar teeth is occasionally met with in the most widely separated varieties of Man.

Again, the bicuspides of the Australians are undoubtedly large: but they are not equally so; neither do they exceed the dimensions observed in some African skulls, or in exceptional cases amongst European populations.

The canines and incisors are usually thick and strong in the Australian, although it is not unfrequent to find them worn away almost to the alveoli. With regard to the unworn cuspidati, an extended comparison of Australian with African, Asiatic, and European skulls has not enabled us to say that they are

more conical or acuminated, or that they present in any degree an approximation to the laniaries of the Gorilla or Orang. The incisors appear rarely to equal in size the incisors of the West Coast Negro; and when compared with the large grinding teeth, so far from exemplifying any approach to Quadrumanous proportions, they illustrate in its highest phase that contrast which is characteristic of Man. Lastly, the dentes sapientiæ, although smaller than the penultimate molars, are usually of large size, and their posterior tubercles attain greater development than is common in European races.* The complex implantation by distinct fangs is also the rule in the Australian. But even in these particulars exceptions occur. We have seen an Australian skull in which the upper wisdom exactly resembled the same tooth in the cranium of a Celtic Scot with which we compared it. It was considerably smaller than the penultimate, whilst the diminution, as in Europeans, principally depended on the minor development of the posterior internal tubercle. Again, we have observed an instance in the same race in which the three fangs of the upper third molar were conjoined; and we have noticed the same thing in a skull of an allied variety, the Papuan of New Guinea. Allowing that these are exceptions, they have occurred in a comparatively limited field of observation, and they must, at least, be supposed to represent numerous instances amongst the hordes which have peopled from time immemorial the vast Australian Continent.

The dentition of the almost extinct Tasmanian Negritos of Van Diemen's Land appears to conform closely to the Australian type. In one skull, however, the fore and aft measurement of the true molar series in the upper jaw was found to be only 1 inch 1½ lines. A similar abnormity to that already noticed in the dentition of a New Zealander exists in two female Tasmanian crania in the College of Surgeons. In each there are but three inferior incisors, the central one being implanted on the line of the symphysis and corresponding with the two upper central incisors. In these skulls no interspace

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* It is remarked in the Odontography of Professor Owen, that in the third upper molar "a fissure extends, in many instances, especially in the Melanian varieties, from the middle of the grinding surface, at right angles to that dividing the two outer cusps, to the posterior border of the tooth." The passage does not imply any limitation to the dark-skinned races; but lest such a construction should be forced upon it, it may be remarked that the point of structure referred to is not unfrequently found in xanthous and leucous varieties. It has come under our observation in both European and Asiatic crania.

accompanies the departure from the ordinary formula. In another female skull of the same race, the incisive alveoli are of the usual number. Caries appears rare amongst the Australo-Tasmanian tribes: in only one Australian and one Tasmanian skull have we found decayed molars.

Allusion has already been made to the curious fact that amongst a race in physical structure so remarkably resembling the Negroes of the African Continent, the same expedients for disfiguring the countenance are in vogue. Dampier, the earliest voyager who has described the Australians, mentions having met with a tribe on the coast in whom the two upper incisors were invariably wanting; and in several of the crania which have fallen under our own notice the right median incisor has been extracted. How far the existence of such practices may be held to favour a community of origin, we must leave to be decided by Ethnologists.

The third division of the Kelœnonesian variety includes the Papuans of New Guinea, New Ireland, New Britain, Solomon's Islands, New Caledonia, and the New Hebrides. These races differ from the Australians, but resemble the Tasmanians in the character of the hair, which is strongly frizzled, or even woolly, whilst amongst the Australian tribes it is usually long and silky. The hair of the Papuans of New Guinea grows in separate tufts, and in this respect bears a striking resemblance to that of the Bushmen and Hottentots. The teeth of this division of Negritos, when compared with those of the Australian, display a marked diminution in the size of the grinding series. We have found in Papuan crania the antero-posterior measurement of that series in the upper jaw to range from 1 inch 1 line to 1 inch 3 lines, whilst the breadth of the first upper molars did not exceed 4½ lines. The wisdom teeth are also usually smaller than in the Australian, and appear to present in a larger proportion of instances a greater or less degree of union in the fangs. In the skull of a native of Erromanga, an island of the western division of the New Hebrides, preserved in the Osteological department of the British Museum, we observed that the fore and aft measurement of the lower molar series was only 1 inch 1½ lines, whilst in the upper jaw the same measurement was 1 inch 1 line. The upper third molar was small, and its fangs were connate for a considerable distance. Amongst the crania of the Papuan race we have not noticed that excessive amount of wearing away of the teeth which is so common in the Oceanic tribes. They resemble the Malays and Sumatrans in their constant use of the areca or betel-nut as a

masticatory: this practice has the effect of staining their large mouths and lips of a blood-red colour, whilst at the same time it blackens the teeth.

The Fiji Islanders may be said to form a link between the Kelœnonesian and Amphinesian stocks: in physical conformation and colour they resemble the former, whilst their language is unequivocally a Polynesian dialect. There is a skull of a female from the Fiji Islands in the British Museum, in which the molars are as small as in the European: in another specimen of the same race we found that all the teeth were of European proportions, with the exception of the third upper molar, which was also inserted by three fangs. The length of the true molar series in both jaws in this instance was 1 inch 1½ lines.

We have dwelt thus long on the teeth in the Negrito races, because we are aware that they may be held by some to present ground for debate. We trust, however, it has been shown that the dentition of this isolated and degraded branch of the human family affords no sure basis for specific differentiation, whilst its peculiar features admit in no degree of being construed into a declension towards the dental characteristics of the Anthropoid Simiæ.

Our opportunities of investigating the condition and varieties of the teeth in the American Aborigines have been but limited, yet the specimens of various tribes which have come under notice have been fully sufficient to prove a close correspondence with the dentition of the inhabitants of the Old World; and this is especially to be noticed, as it is well known that the dental formula of the Quadrumana of South America differs from that of both living and extinct Apes and Monkeys of Europe, Asia, and Africa. It is stated by Professor Owen, in the Catalogue of the Museum of the College of Surgeons, that whilst the American skulls manifest an inferiority in the size of the molar teeth as compared with the Australian, the incisors, canines, and premolars are not smaller than in the black races. We may add, however, that it is equally true that individual differences are common. Reference has already been made to the large size of the grinders in the skull of a Chenook Indian: in this specimen the premolars, incisors, and canines conformed to the European standard. In the skull of a male Carib, from the Caribbee Islands, on the contrary, the premolars and canines were found to be as large as in Africans and many Australians. In some crania of flat-headed Indians of the Columbian River, the teeth which remained were of European proportions. In one of these we observed the upper third molar implanted by three fangs; in another, the roots of the same tooth were connate.

The upper wisdom teeth in American crania have appeared to us generally large, especially in the antero-posterior diameter of the crown, in this respect offering an approximation to the Melanian conformation. This we have noted in the skull of a Patagonian, in some Peruvian crania, and in the Chenook before referred to. The dentition in an elongated skull of an Ancient Peruvian did not present any considerable variation from the ordinary standard; the premolars were large, and the central upper incisors very concave posteriorly: this last peculiarity, however, was not repeated in other specimens. A curious abnormity presents itself in one Peruvian skull in the College of Surgeons' collection: one of the canine teeth has developed a second cusp on its inner side, giving it the appearance of a premolar.

Loss of teeth would seem to be more common amongst the Indians of the New World than amongst the Melanian races of the Old. We have noticed in an American Indian cranium the loss of the entire lower molar series on one side, with complete absorption of the alveoli: we do not recollect to have met with a similar instance in a Negro or Australian skull. Humboldt, indeed, asserts that the teeth of the North American Indians are but little subject to caries, although they are often worn down by the mastication of hard substances. We have it on good authority, however, that amongst the Potawatomi, a branch of the Algonquins, individuals of feeble habit or a scrofulous tendency rapidly lose their teeth by decay. Dentition is also said to be a painful process amongst the North American Indian children.

M. d'Orbigny states that the teeth amongst the Quichuas or Inca race of South America are always beautiful, even in old age: the same integrity of the teeth at an advanced period of life is attributed to the Charruas, and other midland nations of that continent. Wearing down of the incisors is, according to Captain Fitzroy, general amongst the Patagonians. The most degraded of the American tribes is that inhabiting Tierra del Fuego: in a skull of this race the teeth generally were observed to be of the ordinary configuration, and of moderate size; but the antero-posterior measurement of the upper true molar series was considerable—1 inch 3 lines. The molars were worn in the usual manner, the inner sides of the grinding surfaces of the upper, and outer of the lower, being principally abraded. Captain Fitzroy remarks the frequent wearing away of the incisors amongst the Fuegians. Dr Lund, a Danish geologist, who professes to have discovered fossil human skeletons in the Brazilian bone caves, characterizes the incisor teeth of the fossils as having the upper surface oval, and of longer antero-posterior

than transverse diameter. On the supposition that he has not been mistaken as to the human character of the remains in question, it is most probable that he has fallen into a similar error with Blumenbach, in confounding the worn with the natural condition. Such a configuration of the unworn incisor teeth is not to be found in any known tribe of Indians: neither, as far as our information reaches, has it been discovered in any accredited skulls of extinct races.

The Esquimaux are to be considered as one of the principal links binding together the populations of the Eastern and Western hemispheres. In the skulls of this race the grinding teeth vary in size; in some instances they attain somewhat greater dimensions than is usual in the so-called Caucasian variety. In one specimen, although the first and second upper molars were not of inordinate proportions, the third was as large as the penultimate, and of the same size as in many individuals both of Oceanic and African Melanian stocks. Considerable wearing down of both cutting and grinding teeth, and caries of the molars, may be found in Esquimaux crania. In two skulls of Greenlanders, the dentes sapientiæ were observed to be of large size, with implantation by distinct fangs.

Turning now to the continent of Asia, we find but little in the dentition of the various Mongolian stocks which people the greater portion of its wide area to elicit comment. Amongst the Chinese we have noticed that the teeth are generally of moderate size, albeit displaying in individual instances those differences of proportion we have so frequently noted elsewhere. The premolars in some Chinese skulls are as small as the average in Englishmen; in others they may be characterised as large. Mr Tomes, in his Lectures on Dental Physiology and Surgery, notices an instance of a Chinese skull in which the upper anterior bicuspid has an implantation by three fangs, like a molar. This anomaly, although comparatively very rare, is peculiar to no race of Man. In the European, African, and Aboriginal American it has come under our own notice: the divided outer fang is often to be seen on one side only; it sometimes occurs in the anterior, sometimes in the posterior premolar, but rarely, if ever, is the abnormity developed in both. The molars in the Chinese are seldom of excessive size, but the greatest difference may be detected in the dentes sapientiæ: the upper wisdom may be nearly as large as the penultimate, and implanted by three fangs; or, on the contrary, as in one instance that has fallen under our own observation, it may be found of the smallest European size, almost reduced to the dimensions of a premolar. In no instance amongst a semi-

civilized or barbarous people have we seen the upper third molar so small as in the example here referred to. The inhabitants of Eastern India, Cochin China, and Siam constantly indulge in the use of masticatories of betel and quicklime, the Siamese adding catechu to the preparation. In the skull of a Veddah or aboriginal of Ceylon, we noticed the teeth stained, apparently from this practice. A black colour of the teeth, however, is not held in that island to enhance female beauty; for in a Singhalese description of a *belle*, we are told "that her teeth should be small, regular, and closely set, and like jessamine buds." In the Nepalese crania in the British Museum, the molars, as is remarked by Professor Owen, do not differ in size from the ordinary standard in the light-coloured races. In one of these skulls, that of a Murmi, we observed the upper wisdom inserted by three fangs, and quadricuspid. This complex implantation of the third molar will be found to be common amongst Hindoos, Mussulmans, and Turks. It is, therefore, as an ordinary characteristic, by no means confined to the Melanian variety. Neither does an oblique implantation of the incisor teeth alone occur amongst the Negroes and Negritos. The most remarkable case of obliquity of the front teeth we have ever met with is in the cranium of a Thug in the College of Surgeons.

The dentition of civilized Europe has throughout this sketch been assumed as the typical standard. We have, therefore, constantly alluded incidentally to its characteristics. The fore and aft measurement of the upper true molar series in the white races we have found to vary from 1 inch $\frac{1}{2}$ line to 1 inch 3 lines; of the lower, from 1 inch $1\frac{1}{2}$ lines to 1 inch 4 lines. The maximum in both cases has been obtained from crania of early inhabitants of this island. The greatest diminution of the third molars that has occurred to us has existed in modern English skulls. A complex implantation of the wisdom tooth is the exception; but as an exception it is not very rare. The remarkable wearing of the teeth which is so frequently noticed in Ancient British and Anglo-Saxon crania, is in the present day witnessed amongst the Esthonian Finns and the inhabitants of the Faroe Islands. In the latter case it is attributed to their diet, which consists of coarse barley bread, made without yeast, and baked in the hot ashes of peat fires, and of "rast," a putrid compound of the flesh of fish, fowl, Cetacea, and other Mammalia.* Messrs Thurnam and Davis notice that the molars in Ancient British crania are more obliquely worn than in the Anglo-Saxon. They attribute this

* Thurnam and Davis, 'Crania Brit.,' p. 33.

to the fact that the Ancient Briton subsisted principally on imperfectly-cooked animal food, with instruments for the division of which he was ill provided; the Anglo-Saxons, on the other hand, lived to a great extent on cereals. Probably there is some truth in this, although instances of Anglo-Saxon crania in which the molars are worn very obliquely are not uncommon. But in all the varieties of Man, the manner in which the molar teeth are worn is essentially the same, however in degree the effects of attrition may differ. In the upper molars the internal tubercles, and of them the anterior one first, in the lower molars the external tubercles soonest exhibit the effects of use. It is interesting to notice that the crania of the more civilized Romans, which have been discovered in England, in the minor degree in which the molar teeth indicate the marks of rough work, differ from those of the conquered British and ruder Saxons. Caries is common amongst all civilized populations, but it has been from time immemorial peculiarly the scourge of the northern races of Europe. It was a frequent disease amongst the Aboriginal British and Anglo-Saxons; it is, probably, still more frequent amongst the modern Germans and English, whilst in the Anglo-American population it is said to form the rule rather than the exception.

In laying before our readers this necessarily imperfect survey of the dentition in the varieties of Man, we are aware that it may be urged that no striking facts have been elicited, no new discoveries have been made—that the results obtained are mainly negative. For our own part, we shall be contented if the impression it may leave on other minds be that which the necessary investigation has produced on our own. We rise from it convinced that a study of human dentition affords an argument of the highest scientific value in favour of the declaration which, eighteen hundred years ago, reproved the national assumption of the self-styled Autochthones of Athens—"God, that made the world and all things therein, hath made of one blood all nations of men for to dwell on all the face of the earth."