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ON THE METHODS OF STUDY OF THE CROWNS OF THE HUMAN TEETH, INCLUDING THEIR VARIATIONS.

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THE mammalian tooth has been described almost entirely as a topographical area. It possesses "hills," "valleys," "islands," and "boundaries." Lyddeker describes the teeth of the rhinoceros with the terms "crochet," "costa," "valley," and "collis or hill." Fred. Cuvier treats all depressions as the essential elements, and to a great extent ignores the cusps,—a disposition that is still followed by writers who state that the lower human molar is distinguished by a cruciform sulcus. Salter ("Dental Pathology and Surgery," London, 1875, p. 28), in speaking of a deformed tooth, says it is "bulged in forming a pit." Even so careful a writer as Prof. Flower ("Encyclo. Britannica," art. "Horse") describes the incisor of the horse as undergoing "an involution of the external surface of the tooth by which what should properly be the apex is carried deeply into the interior of the crown, forming a fossa or pit." In this account the morphological integer is a space which performs a definite action. The fact that two cusps exist, and that the "pit" is simply the interval between them, is not alluded to. I have undertaken elsewhere (DENTAL COSMOS, 1874, xvi, 617) to show the importance of describing the cusps of teeth only, and of ignoring the forms of the interspaces.

Apart from the insistence that the cusp is the dental integer, each mammalian tooth can be studied from as many as six different points of view. That these are not too minutely considered will be evident from the following statements. The illustrations will be taken, for the most part, from the human subject.

(1) The study of the size of the tooth when taken in connection with the development of the skin is of importance. In the human subject hirsute states of skin are associated with small brachyodont teeth. The small size of the teeth of the sloth cannot be separated

from an excessively dense hairy growth. The subject requires careful elucidation, for if it be accepted that a connection exists between the skin and the teeth, other states besides mere hairiness enter into the problem if we are to form conclusions from groups so far removed from one another as are the Sirenia, the Cetacea, and the Edentata.

(2) The study of the anterior and posterior borders,—the "yokes" of the tooth,—the "yokes" especially of the premolars and molars, is of great morphological importance. The "yokes" are best developed in the teeth of the mandible. The anterior "yoke" has a distinct history from the posterior, and is infrequently the seat of development of a separate cusp. The posterior "yoke" often furnishes a separate cusp. The yoke cusps are always placed in the lines of the greatest impact, being commonly on the outer side of the tooth and passing thence to the middle of the center of the posterior border but never to the inner. Their position thus becomes to the observer a delicate test of the directions of attrition-movements on the crown.

I have found it convenient to represent the positions of the "yokes" in strict connection with the true cusps, and in enumerating them to regard them as parts of fractions. Thus the first molar of the right side of the lower jaw in fifty-two examples of human teeth exhibited three cusps on the outer and two on the inner side,—the tooth of course having five cusps. The formula $\frac{3}{2}$ expresses the number and positions of the cusps if we arbitrarily accept the numerator as representing the outer and the denominator as the inner part of the tooth.

The formula $\frac{2}{2}{\circ}$ represents that the posterior "yoke" is not on either the outer or the inner border of the tooth, but in a position midway between them. The formula $\frac{2}{2}$ expresses the fact that the posterior "yoke" is absent.

In 50 examples the first molar yielded the following expression:

$\frac{3}{2}$ present 34 times.
$\frac{2}{2}{\circ}$ present 4 times.
$\frac{2}{2}$ present 9 times.
$\frac{3}{3}$ present 3 times.

In 56 examples of the second molar the following was met with:

$\frac{3}{2}$ present 5 times.
$\frac{2}{2}{\circ}$ present 14 times.
$\frac{2}{2}$ present 32 times.
$\frac{3}{3}$ present 5 times.

In 30 examples of the third molars the following was seen:

$\frac{3}{2}$ present 6 times.
$\frac{2}{2}{\circ}$ present 6 times.
$\frac{2}{2}$ present 13 times.
$\frac{3}{3}$ present 5 times.

On the left side the results were so similar that they need not be separately tabulated. If the shifting of the cusp from the outer side to the center of the posterior border be accepted as a test of the position of the greatest impact, it follows that this method of studying teeth presents a means of determining that the lateral impact is greater in the first molar than in the second, that the posterior impact is greater in the second than in either the first or the third, and that in the third it is indifferent.*

(3) The foregoing considerations are closely related to the manner in which the teeth were worn. I have found it a useful method of studying the effects of attrition to observe that the $\frac{3}{2}$ type will present the greatest attrition on the outer border, and the $\frac{2}{2}{}_{\circ}$ or $\frac{2}{2}$ type will show a distinct disposition to posterior wear,—a fact not mentioned by Topinard ("Anthropology," Eng. Trans., p. 138), who assumes that the "wear" is always on the outer side.

If attempts be made to correlate the manner of wearing down of the crowns of the molars in man with those of the shapes of the condyloid processes and of the glenoid fossæ (points which have been especially elucidated in quadrupeds by Profs. Cope and Ryder), great difficulty will be experienced. After making many observations of human crania, I am compelled to acknowledge that, with our present means of study, no coördination can be established.

(4) In every mammalian tooth a disposition exists for the main cusp to be duplicated by a second placed to its inner side. It is constantly seen that the second cusp is the smaller and is at first placed in line with the main cusp. In states of specialization the inner cusp in many groups becomes larger than the external, and passes backward so as to encroach upon the privileges of a second pair. In this manner two lines of changes are detected by which complex forms of teeth are evolved from the simple ones,—viz., a duplication of the initial cusp on an interior line, and a development of the duplicated part posteriorly. As in the case of the "yoke," it is the hinder part of the cusp which gains. This variety of tooth-structure, while best presented in the tertiary mammals, particularly as studied by Cope (see Hayden's "Geological Survey of the Territories," iii, 1884), is also seen in the variations of the molars of the human subject.

(5) Yet another method of study of the teeth pertains to the relative size of the members of the same series. Thus the comparisons of the sizes of the incisors and molars are of first importance. That

* In "Anthropologia," p. 434, it is stated on the authority of Hamy that in 59 first mandibular molars 29 were pentacuspid, and in 50 second molars but 10 were pentacuspid—the remainder being quadricuspid. The relative positions of the cusps are not given.

the first molar should be greatly larger than the second, while the third proves to be as large if not larger than the first, forms a heterodont series which is opposed to the gradual loss of size from before backward. The abrupt is also the unusual, and the breaks or "faults" in the series are indicative of vital failure in more than one direction.

(6) The order of congenital loss or excess constitutes the last method which will be here named. I need only allude to the labors of W. Turner, Spence Bates, W. H. Flower, and lately of Schlosser, in this connection. A true method would compel an acknowledgment that the missing factors in the dental formula of each and every species should be carefully considered by the odontologist. In a word, that the determination of the missing teeth in the formula would be a part of his method of study.

Series of forms which are constant in one group but variable in another closely-allied one are always to be carefully observed. The rugæ of the mouth in the human subject may be named in this connection. The dispositions of these folds are variable on the two sides, —*i. e.*, the right and the left,—each being disposed in its own way to adapt the folds to the conformation of its own parts. The entire series would appear to be in coördination to the disposition of the facial bones to grow downward rather than forward, and to the fact that the involution of the sacs of the permanent incisors takes place on the palatal side of the deciduous teeth and creates elements of variation in the anterior portion of the hard palate as contrasted to the posterior part. The lateral incisors in a normal condition always enter the dental arch from the palatal aspect, and this entrance most probably is a disturbing element in the arrangement of the rugæ, especially at or near the premaxilla.