

NOTES ON THE OSTEOLOGY AND DENTITION OF THE GENERA DESMOSTYLUS AND CORNWALLIUS.

By OLIVER P. HAY,

Associate of the Carnegie Institution, of Washington.

From Dr. Edward M. Kindle, of the Canada Geological Survey, the writer has received for examination a large tooth of *Desmostylus*, which was presented to the Victoria Memorial Museum, at Ottawa, by Dr. C. W. Newcombe, of Victoria, British Columbia. It had been purchased from a dealer in curiosities and was reported to have been brought from Alaska. This report may be true, but it is hardly to be depended upon. The tooth no doubt belongs to *Desmostylus*, but inasmuch as neither the locality nor the formation is known it would be unsafe to identify it specifically. It appears to be a left upper molar.

The tooth sent from Victoria (pl. 1, figs. 1, 2) had not yet come into use, the unabraded summits of its columns showing each the peculiar depression and central nipple-like elevation. Only the base of the root is present, and there are indications that it consisted of two fangs. The greatest length of the tooth is 61 mm.; the height 57 mm., including the base of the root. From the edge of the enamel to the summit of the columns is 51 mm. The thickness, where greatest, is 38 mm. The tooth consists of eight columns. Of these, three form a front transverse row; then come two rows, each of two columns; and at the rear is a single column. The transverse rows are oblique to the axis of the tooth, being directed from the outside inward and backward, as may be seen by figure 1 cited.

As will be observed, the intervals between the columns are occupied by cement, and this is of a lighter color than the surface of the enamel. This cement rises from the root to the summit of the columns. Below the bases of the second and the third columns the cement continues to the center of the base of the root, lying evidently in a valley which seems to mark the division of the root into two fangs. The front of the tooth presents two tracts of cement, one on each side of the median column, and it spreads over the front of these anterior columns nearly half way to their summits. It is probable that originally a large part of the crown was

covered with a thin coat of cement. On the inner face of the tooth there still adheres a part of the maxillary bone. So far as the writer sees, it is impossible to determine where in the molar series this tooth belongs. No surface shows contact with a tooth in front or behind.

The determination of the dentition of *Desmostylus* is a matter of great interest. An examination of Yoshiwara and Iwasaki's figures¹ shows that there is, in front of their first molar, a small tooth consisting of only four columns. In the skull from Oregon, which the writer described in 1915,² there is in front of a molar (pl. 57, 23) apparently corresponding to that figured by the Japanese authors, and composed of the same number of columns, 8, the base of a smaller tooth which was regarded as the first molar (pl. 57, 22). This supposed first molar, instead of being made up of eight columns, appears to have only five. The tooth in front of this (pl. 57, 21) is represented by the base of the crown and the root, and it has a diameter of 17 mm. On plate 58 of the paper cited, was presented the figure of a tooth which had four columns and which was believed to be the fourth premolar. This appears to correspond to the hinder premolar described by Yoshiwara and Iwasaki. Now, according to these identifications, the Oregon skull differs from the one found in Japan in having between the supposed last premolar with four columns and the molar with eight columns another tooth possessing apparently only five columns. It is improbable that the two species differed in such an important respect.

An examination of my figure³ shows that the molar indicated by 23 was emerging behind and above the supposed first molar 22. This tooth 22 can hardly be a premolar, for this might be expected to appear only after the molar behind it had come into action. One might insist also that it is not a milk tooth, because there appears to be no premolar to replace it, as shown by Yoshiwara and Iwasaki's figure. Plate 2 of the Japanese authors shows that another molar (their M²) was moving downward and forward to take its place against the molar then in action—that is, it appears that the upper molars, on coming into place, move downward and forward as in the mastodons and elephants.

If, now, we grant that, as the supposed first molar (22) of the Oregon specimen became worn down, the next molar (23) moved forward, pushed it out, and took its place, the condition seen in Yoshiwara and Iwasaki's specimen would be produced. According to this interpretation, the hinder premolar of the paper last cited

¹ Journ. Coll. Sci., Japan, Imp. Univ., vol. 16, 1902, pl. 2; pl. 3, fig. 4.

² Proc. U. S. Nat. Mus., vol. 49, p. 381, pl. 57.

³ Idem, pl. 57.

would be the fourth premolar and the tooth immediately behind it the second molar, while the molar shown at a distance behind would be the third.

In 1923⁴ the writer proposed the new name *Cornwallius*, based on *Desmostylus sookensis* Cornwall.⁵ Through Director Francis Kermode, of the Provincial Museum of Natural History, Victoria, British Columbia, the writer received for examination both of the teeth figured by Cornwall. These teeth are illustrated on the plates (pl. 1, figs. 4, 5, and pl. 2, figs. 1-5).

It has occurred to the writer that these teeth may be milk teeth of *Desmostylus* and that the larger one (pl. 1, figs. 1, 2, pl. 2, figs. 4, 5) may correspond to that called in my paper of 1915 the first molar. The tooth is of appropriate size. The length is 48.5 mm., the width 34 mm. The corresponding dimensions of what the writer regarded as the first molar⁶ were estimated to be in length 40 mm., and width 28 mm., but the measurements were taken at the somewhat narrowed base of the tooth. The low crown of the tooth of *C. sookensis* accords with the idea that it is a milk tooth.

It seems certain that the tooth which in my paper of 1915 (pl. 57) was designated by the numeral 21 is either a milk molar or the premolar which would follow it; also that it corresponds in position to the tooth Pm of Yoshiwara and Iwasaki's plate 2, and to the small tooth of their plate 3, figure 4. The Oregon skull belonged evidently to a younger animal than did the Japanese skull. In the latter it seems that the premolar, if such it is, had not yet been pushed out to the level of the molar behind it. In the Oregon specimen it is possible that the milk tooth 21 had not yet been replaced.

As already said, the tooth designated 23 was lying immediately above the greater part of the tooth 22. The former might, therefore, be taken as fourth premolar. Because of the great size of the tooth and the number of its columns, this appears wholly unlikely. The tooth 23 must be a molar.

We may possibly get an explanation of the dentition of *Desmostylus* from that of the mastodons. In some of these the premolars are retarded in their development, in others even wholly suppressed. The suppression of premolars began with the hindermost one. The same modification of the dentition has been demonstrated in the *Sirenia*. In the earliest members of the group, as *Protosiren frassi*,⁷ the tooth formula was the typical one, i. 3, c. i, pm. 4, m. 3. According to Andrews⁸ the dental formula was the same in *Eotherium aegypticum*. Abel tells us that since the middle Eocene there has

⁴ Pan-Amer. Geologist, vol. 39, p. 106, text-fig. 4.

⁵ Canad. Field-Naturalist, vol. 36, p. 122, 4 figs.

⁶ Proc. U. S. Nat. Mus., vol. 49, pl. 57, 22.

⁷ Abel, Jahrb. Min., Geol., Pal., 1906, vol. 2, pp. 50, 51.

⁸ Cat. Tert. Vert. Fayum, 1906, p. 207.

been a progressive reduction of the replacement teeth. In *Halitherium* the hindermost premolar was not developed, and the corresponding milk tooth assumed the form of a molar.

We may then regard it as possible that the tooth 22 of my plate 57 is a milk tooth which was assuming the form of a molar, and which was not to be displaced by a premolar, but by the first molar. The tooth in front of it is then the third premolar, or the corresponding milk molar. A deep pit in front of it represents the second premolar or milk molar, and a minute pit in front of that represents the first juvenile tooth.

As to the tooth on which I based the genus *Cornwallius* it is then possible that it is the hindermost milk tooth of *Desmostylus*; but this is for the future to determine. I proceed to give a description of it:

The tooth (pls. 1, 2, figs. 4, 5) has suffered some loss of enamel on two columns, as shown by the figures. All of the columns have suffered some wear, but that they were of small height originally is evident. In two of them the wear had not reached the core of dentine. The columns taper rapidly from the base to the summit. Text figure 1 presents a view of this tooth before a fragment of the second inner column had been cemented in its place. It shows that the dentine core, broad at its base, tapers rapidly to its summit, as was necessary in a low-crowned tooth. As

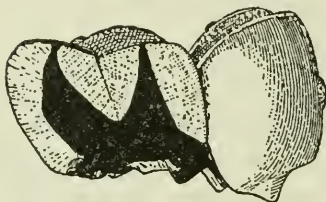


FIG. 1.—TOOTH OF CORNWALLIUS
SOOKENSIS. VIEW FROM INNER
SIDE. TYPE.

seen from the figures, there are in front two large columns, and behind these two somewhat smaller ones. At the rear is a column of which a part is gone. It appears quite certain that the snag of enamel at the right of the gap (pl. 1, fig. 4) formed part of a cusp which adhered to the hinder column. Whether it could be counted as the sixth column is doubtful. The tooth is taken to belong in the right maxilla.

The length, measured in the axis of the tooth, is 45 mm.; the total length 48.5 mm.; the greatest thickness, 34 mm.; the height of the crown in front, 23 mm. On the front end there is a cingulum which does not occupy the whole width of the tooth. At the inner end of this are two small cusps. Rootward from the edge of this cingulum there is a surface 10 mm. long and 4 mm. deep, which is worn from contact with a tooth in front. Between the cingulum and the grinding surface there is on each of the two anterior columns an extensive worn surface. No such surface is seen on the hinder end of the tooth. The cingulum is not developed on the sides and rear of the tooth; but at the outer end of the first transverse valley there is a large tubercle, worn at the summit and showing a pit of dentine. At

the inner end of the same valley is a much smaller tubercle. A single tubercle appears at the outer end of the second valley and is closely applied against the hindermost column. The rear of this column is missing.

There belonged to this tooth quite certainly two roots, but these are broken off (pl. 2, fig. 5). A considerable pulp cavity remains, 27 mm. long and 15 mm. wide. It is slightly constricted near the middle of the length, indicating thus the parting of the roots.

From Director Kermode was received also the tooth which was described and figured in 1917⁹, as *Desmostylus hesperus*, and which Cornwall, in his paper cited, figured as *Desmostylus sookensis*. It was found in the sandstone cliffs near the mouth of Coal Creek, British Columbia, by Miss M. Egerton. It was sent to L. M. Lambe, paleontologist in the Geological Survey, Ottawa, whose remarks on it are published on the page above cited. Mr. Lambe identified it provisionally as the upper right first molar. He did this possibly relying on my identification of the first molar in my paper of 1915.

The length of the tooth (pl. 2, figs. 1-3) is 33 mm.; the width 24 mm.; the height of the crown, 16 mm. It is somewhat more worn than the tooth described in the previous paragraph, but it is evident that the columns were originally low. It had two well-developed roots (pl. 2, fig. 3) of equal size. These are now broken off squarely just below the crown. The transverse diameters of these roots are close to 18 mm. At the plane of fracture they are not entirely separated from each other. The tooth is supposed to belong to the left side of the lower jaw, because the cingulum is better developed on the left side of the tooth. It consists of six columns arranged in three transverse pairs. Of the anterior pair the inner column is the largest of all. The inner column of the third pair is very small and the wear had not exposed the dentine. Cornwall, perhaps correctly, did not count it as one of the columns. On the front of the tooth, in the midline, is a broad tubercle which may be regarded as a talon or a part of a cingulum. On the outer face there is a slight cingulum-like ridge at the bases of the two front columns. Between the second and third columns is a tubercle or cusp. On the inner face there is little or no trace of the cingulum. On the front end of this tooth there is an extensive surface polished by contact with a tooth in front. This begins at the level of the grinding surface and descends not only to the talon, but in a narrowing strip nearly to the base of the crown. Above the talon the polished surface is 15 mm. wide from side to side. A small polished surface is found on the hinder end of the tooth.

⁹ Rep. Provincial Mus. Nat. Hist., Victoria, B. C., for 1916, p. 42, pl. 9, figs. 2, 3.

This tooth does not agree in structure with any yet described. It most resembles the teeth described by Yoshiwara and Iwasaki¹⁰ as lower second premolars. In those teeth, however, there are three columns in the hinder transverse row.

There are some reasons why the larger of the two teeth referred to *Cornwallius sookensis* can not be regarded as identical with the tooth 23 of the Oregon specimen. These are as follows:

(1) The outer border of the Oregon tooth is straight; in the Victoria tooth this border is strongly curved. (2) The transverse rows of columns in the Oregon tooth appear to be arranged more obliquely to the long axis of the tooth than in that from Victoria. (3) The hinder end of the Victoria tooth is considerably broader than in the one from Oregon.

Until some lucky discovery shall decide the matter one way or the other, the writer proposes to maintain the genus *Cornwallius* and to regard the larger of the two teeth (pls. 1, 2, figs. 4, 5) as an upper molar, and the smaller one (pl. 2, figs. 1-3) as a lower molar, not the hindermost. The larger tooth is taken as the special type of *Cornwallius sookensis*.

The cliffs in the vicinity of Sooke, Vancouver Island, ought to be carefully and frequently searched for additional materials of this sirenian.

In their description of the skull of *Desmostylus* Yoshiwara and Iwasaki attribute to *Desmostylus* two pairs of lower tusks and one pair of upper ones. The lower tusks projected some distance from the jaw. The upper tusks were said not to have yet come into full growth, only the left tooth being slightly visible beneath the ruptured surface of the maxilla. Their figure¹¹ shows what was seen of this tusk.

In my description of *Desmostylus* from Oregon I referred to what seemed to be an upper tusk. Although this was said¹² to show only on the right side, there is on each side a projection at the front of the specimen which represents the same structure. As shown by my figures, a fragment of the snout about 30 mm. long had been broken off in exhuming the skull and had later been cemented in its place. Recently, wishing to come to a decision regarding this supposed tusk, the writer removed the fragment and cleaned off both surfaces of the break. The view presented was not satisfactory. The circumference of the supposed tusk could not be traced on the side next the mid-line. Next, the matrix was ground down and polished to see whether any structure was hidden. What was revealed is shown in figure 3 of plate 1. On each side there ap-

¹⁰ Pl. 3, figs. 2 and 3.

¹¹ Journ. Coll. Sci., Japan. Imp. Univ., vol. 16, 1902, pl. 1, Up 1.

¹² Proc. U. S. Nat. Mus., vol. 44, p. 391.

peared a number of cell-like spaces separated by thin walls of bone. It is evident that we have here a section across the right and left maxilloturbinal bones. There is no trace whatever of any upper tusk.

The writer is led, therefore, to question the existence of an upper tusk in the Japanese specimen. What the describers very naturally took to be a tusk may be only the sandstone cast of one side of the nasal cavity. Over the surface of the cast naturally adhered some flakes of bone. Had a section been made across this region, the maxilloturbinal would probably have been discovered. The formerly supposed tusk of the Oregon specimen where it projects in front has the appearance of the end of a turbinal bone. In this specimen the bone seems to end a little behind the middle of the length of the nasal opening. Although in the Japanese specimen the supposed tusk is shown as continuing nearly to the front of the

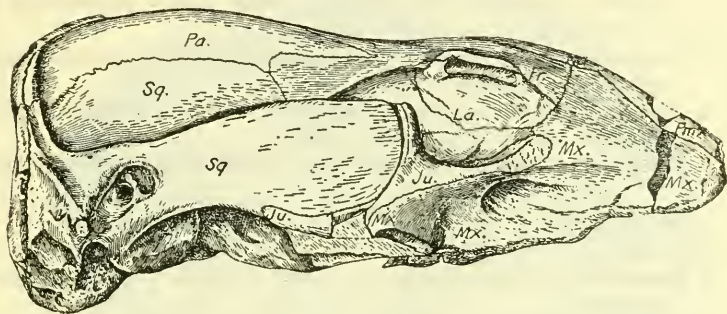


FIG. 2.—SIDE VIEW OF SKULL OF *DESMOSTYLUS HESPERUS*. *Fr.*, FRONTAL; *Ju.*, JUGAL; *La.*, LACHRYMAL; *Pa.*, PARIETAL; *Mx.*, MAXILLA; *Na.*, NASAL; *Prox.*, PREMAXILLA; *Sg.*, SQUAMOSAL.

nasal opening, it is possible that only the rounded surface of the matrix was seen.

Recently¹³ in the discussion of the position and connections of the jugal bone in *Desmostylus*, the writer published a figure illustrating the right side of the skull of the Oregon specimen. Through inadvertence the lower branch of the hinder end of the frontal bone was represented as cut off by a suture and was lettered *os.* This figure is here reproduced (text fig. 2) with the necessary correction. It will be seen that the jugal terminates at about the middle of the lower border of the zygomatic process of the squamosal.

In his paper of 1923 just cited the writer proposed to divide the Sirenia into two suborders, *Desmostyliiformes* and *Trichechiformes*. Some of the characters of the *Desmostyliiformes* may be expressed as follows:

Postorbital part of the skull broad and depressed. Preorbital part narrowed and moderately decurved. Temporal ridges feebly

¹³ Pan-Amer. Geologist, vol. 39, p. 108, text fig. 5.

developed. External nares far in front of the orbits. Nasal bones well developed, embraced by the premaxillae. Periotic bones tightly wedged among the adjacent bones. Grinding teeth composed of closely adhering columns, usually hypsodont. Enamel very thick. Two pairs of tusks in lower jaw; none in upper jaw. Genera *Desmostylus* and *Cornwallius*.

EXPLANATION OF PLATES.

PLATE 1.

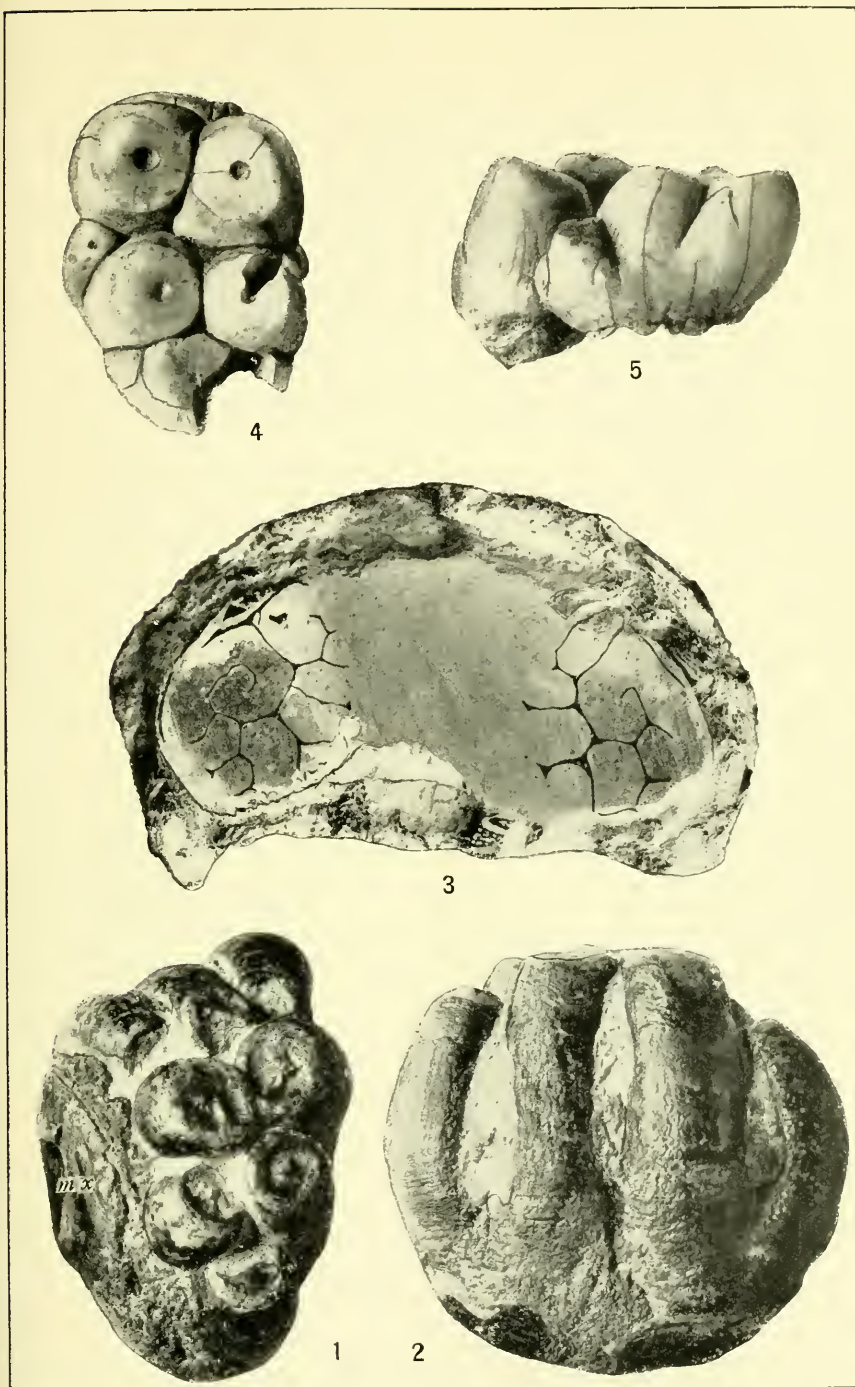
FIGS. 1-3. *Desmostylus*. Teeth and part of skull. $\times 1$.

1. Upper left molar of undetermined species of *Desmostylus*. Showing unworn grinding surface. On the left is a patch of the maxilla, *mx*. Between the columns of the teeth is seen the cement. Front end upward.
2. View of same tooth showing the outer face. Front end toward the left. Between the columns are seen the tracts of cement. At the bottom of the figure the layer of cement passes between the bases of two fangs of the root.
3. Section across the snout of *Desmostylus hesperus*. Showing sections across maxilloturbinal bones.
4. Supposed upper molar of *Cornwallius sookensis*. Showing grinding surface. Type. Front end upward.
5. Same molar showing the outer face. Front of tooth toward the left.

PLATE 2.

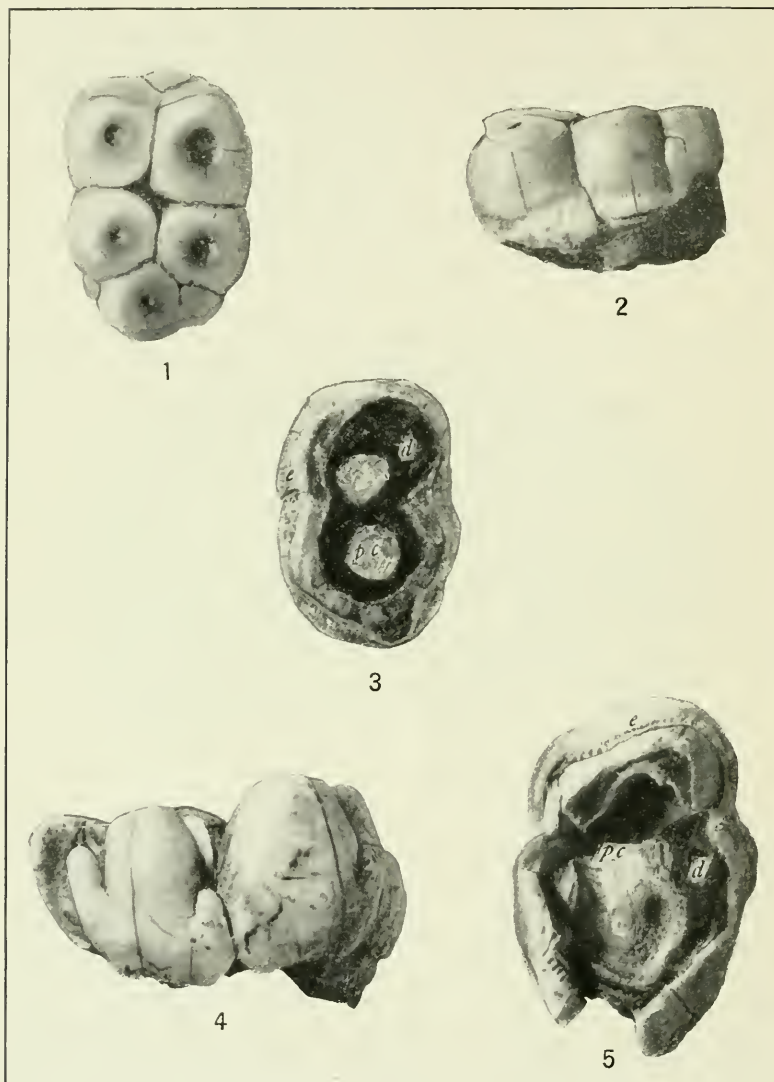
FIGS. 1-5. Teeth of *Cornwallius sookensis* (Cornwall). $\times 1$.

1. Supposed left lower molar. Showing grinding surface. Front end upwards.
2. View of same tooth. Showing outer face. Front end toward left.
3. View of same tooth, showing a section of fracture across the base of the root. Surrounding all is the enamel (*e*) of the crown. Inside of this is seen the blackened dentine (*d*). In the center of each fang is seen the matrix filling the pulp cavity (*p. c.*). Front end upward.
4. View of supposed upper molar. Showing the inner face. Front end toward right.
5. View of same molar. Showing, around all, the base of the enamel *e*. Within this is the blackened layer of dentine, *d*. Within this is seen the yet large pulp cavity, *pc*. The front part of this is in a deep shadow. Front end upward.



DESMOSTYLUS AND CORNWALLIUS

FOR EXPLANATION OF PLATE SEE PAGE 8



TEETH OF CORNWALLIUS

FOR EXPLANATION OF PLATE SEE PAGE 8