

**On the development of the enamel in the teeth of mammals : as illustrated by the various stages of growth demonstrable in the evolution of the fourth molar of a young elephant (*Elephas indicus*), and of the incisor teeth in the foetal calf (*Bos taurus*) / by George Rolleston.**

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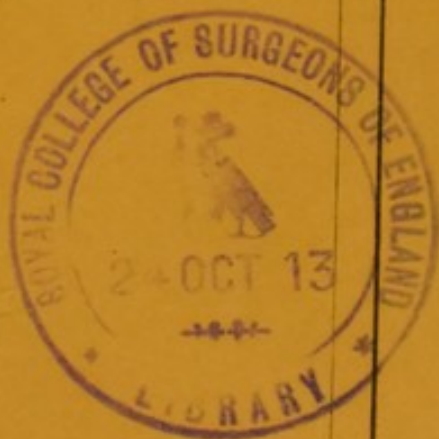
*As Illustrated by the various Stages of Growth demonstrable in  
the Evolution of the Fourth Molar of a Young Elephant  
(Elephas indicus), and of the Incisor Teeth in the Fœtal Calf  
(Bos taurus).*

BY

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*Reprinted from the "TRANSACTIONS OF THE ODONTOLOGICAL  
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*On the Development of the Enamel in the Teeth of Mammals, as illustrated by the various Stages of Growth demonstrable in the Evolution of the Fourth Molar of a young Elephant, Elephas indicus, and of the Incisor Teeth in the Fætal Calf, Bos taurus.* By Professor ROLLESTON.

GENTLEMEN,—

A NAKED-EYE examination of a spirit preparation of a developing molar tooth of an Elephant, such as is represented in fig. 1, appears to be sufficient to show that in development the dentine takes precedence of the enamel in the tooth. In such a tooth a certain number of the more anteriorly placed denticles may be seen to be formed of caps of dentine, of a yellowish colour, encrusted, for various distances from their apices downwards, with opaque white deposits of enamel. Posteriorly to the denticles of this composite character, we see a few denticles consisting of dentine alone, upon which no deposition of enamel has as yet taken place; and, most posteriorly of all, we see processes of the dentinal pulp, which, as yet, are devoid of any covering of dentine.

If, in the second place, we proceed to take note of the capsular processes in which the denticles are enclosed, we shall observe that the inner (reflected)



surfaces of certain of these capsules are roughened over by deposit, in correspondence with the enamel deposit already noticed on the denticles which they surround. The deposit on the inner surface of the capsule is soft, and consists of cylindriform cells packed closely together, and forming, when their interior surface is looked down upon, a mosaic arrangement by their apposition, whilst in the immediate neighbourhood of their exterior (their still attached) surface, numerous blood-vessels are seen ramifying. There can be no doubt that we have here the often-described proximal, and, as yet, but imperfectly calcified ends of the enamel-cells, which have broken away in the preparation from the more thoroughly calcified segments constituting the enamel deposit on the denticles. It is, in fact, the layer which has been supposed to be at once the functionless "*membrana præformativa*" of Raschkow, and the functionally protective, however otherwise physiologically inert, "*cuticula dentis*," or "Nasmyth's membrane."

If now, in the third place, we take a thin microscopic section of the anterior part of the lower jaw of a foetal calf (*see fig. 2*), made in a sagittal direction, so as to show several developing teeth of various ages *in situ*, we are enabled easily to recognize the representatives of the various structures visible to the naked eye in the molar tooth of the elephant, and to harmonize the



apparently conflicting statements which have been made as to the relations held by the tissue forming the enamel prisms, on the one hand, to the stellate tissue of the non-vascular enamel organ, and, on the other, to the vascular tooth-capsule. In such a section of a tooth, in which the enamel has already begun to be deposited, we can see (fig. 2, c), the factor of the enamel organ, which is made up of stellate, loosely-compacted anastomosing cells, the so-called "spongy substance," occupying or forming a triangular area with the apex upwards. The apex of this triangular space marks the lowest level to which the formation of enamel has advanced in its progress downwards from the summit of the tooth. Above this point, or, in other words, where the formation of the enamel has called for an abundant supply of mineral matter, the non-vascular stellate tissue has disappeared, and allowed the vessels of the tooth-capsule to come into close relation with the enamel-forming cells which draw so largely upon what they contain. Below this point the stellate tissue gradually re-assumes its original proportions, and in a section of the lateral portions of the spoon-shaped incisors of the calf it may be seen to pass completely round the calcifying dental pulp from its buccal to its lingual surface. The area occupied by this stellate tissue in fig. 2 corresponds, of course, to the parts of the cavities of the capsular processes of fig. 1, which lie below



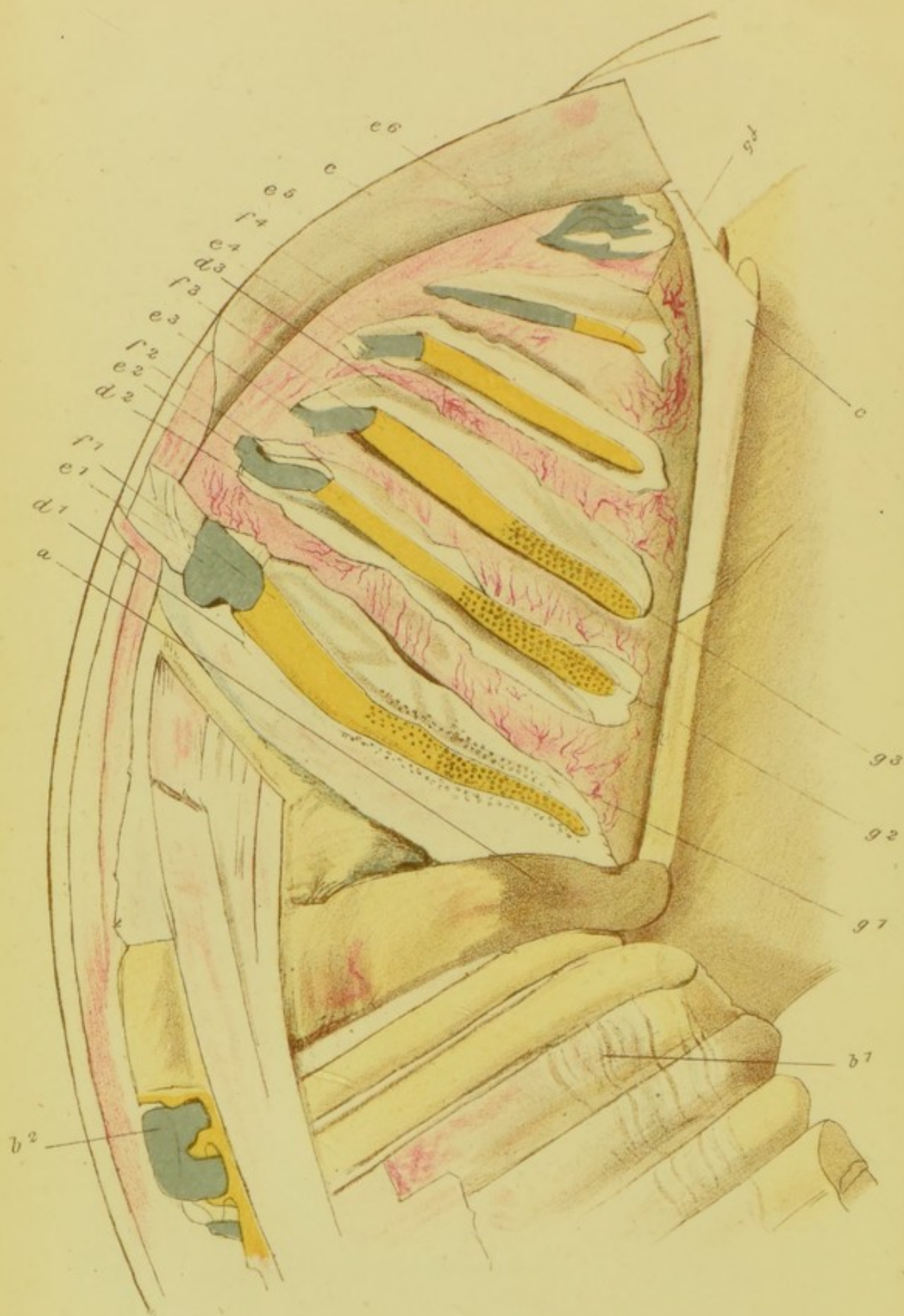
the level of the enamel deposit on the denticles ; the disappearance of the stellate tissue in the molar of the elephant, and the separation in that preparation of the upper part of the capsule from the depositing enamel, are alike what the Germans call *artefacta*.

Much of what has been advanced in this short paper may be found explicitly or implicitly stated in some one or other of the numerous memoirs or treatises on the development of the teeth which have appeared of late. It is believed, however, that as yet it has not been recorded that the enamel of the Elephant's molar, as also that of the Mastodon's, presents the very same decussating arrangement of the inner portion of its enamel which Mr. Tomes has figured ("Phil. Trans.," 1850, pl. xliv., xlv., xlv.), as noted by him in the Rodentia, less the Leporidæ and Hystricidæ. Thus the rodent affinities of the elephant, which have so often been commented upon, receive a fresh illustration.

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Fig. 1.





## DESCRIPTION OF FIGURE 1.

FIG. 1. Portion of left half of lower jaw of young Elephant, *Elephas indicus*, showing the fourth molar in course of development, and a part of the third molar, some of the denticles of which were in use, and some still within their socket. The teeth are seen from the inner side, the bony wall having been removed, and the capsule of the posterior tooth having been reflected. The dentinal pulp is coloured blue, the dentine yellow; the vessels are represented as seen when filled with a red injection. From a preparation made by Mr. C. Robertson.

a. Part of inner side of lower jaw interposed between the posterior denticles of the third and the anterior denticles of the fourth molar.

b<sup>1</sup>. Part of third molar tooth. Its anterior denticles were in use; some of its more posteriorly placed were just about to cut the gum, and the most posteriorly placed were still within the bony socket.

b<sup>2</sup>. Processes of dentinal pulp, dividing to supply the denticles of third molar.

c. Sac of tooth reflected and fastened out over the jaw above and below.

d<sup>1</sup>, d<sup>2</sup>, d<sup>3</sup>. Capsular processes surrounding denticles. On the internal or dentinal aspect of the most anteriorly placed of these, d<sup>1</sup>, a granular deposit is observable. This deposit corresponds to a deposit, g<sup>1</sup>, of similar appearance, which encrusts the upper part of the cap of dentine, f<sup>1</sup>, and it represents the proximal ends of the enamel columns which have broken away from the more perfectly calcified segments which constitute the (enamel) deposit, g<sup>1</sup>, on f<sup>1</sup>.

e<sup>1</sup>, e<sup>2</sup>, e<sup>3</sup>, e<sup>4</sup>, e<sup>5</sup>. Processes of the dentinal pulp passing up to form the successive denticles of which the composite molar is made up.

e<sup>6</sup>. A number of processes homologous with those similarly lettered, but differing from them in having as yet formed no cap of dentine upon their exterior surface.

$f^1, f^2, f^3, f^4, f^5$ . Caps of dentine which have been formed by the processes of dentinal pulp,  $e^1, e^2, e^3, e^4, e^5$ . Upon the three most anteriorly-placed of these caps of dentine,  $f^1, f^2, f^3$ , a deposit of enamel has taken place, the area occupied by which diminishes in length from before backwards, in correspondence with the lessening evolution of the denticles. Upon the two most posteriorly placed,  $f^4, f^5$ , of the dentinal caps no deposition of enamel has as yet taken place.

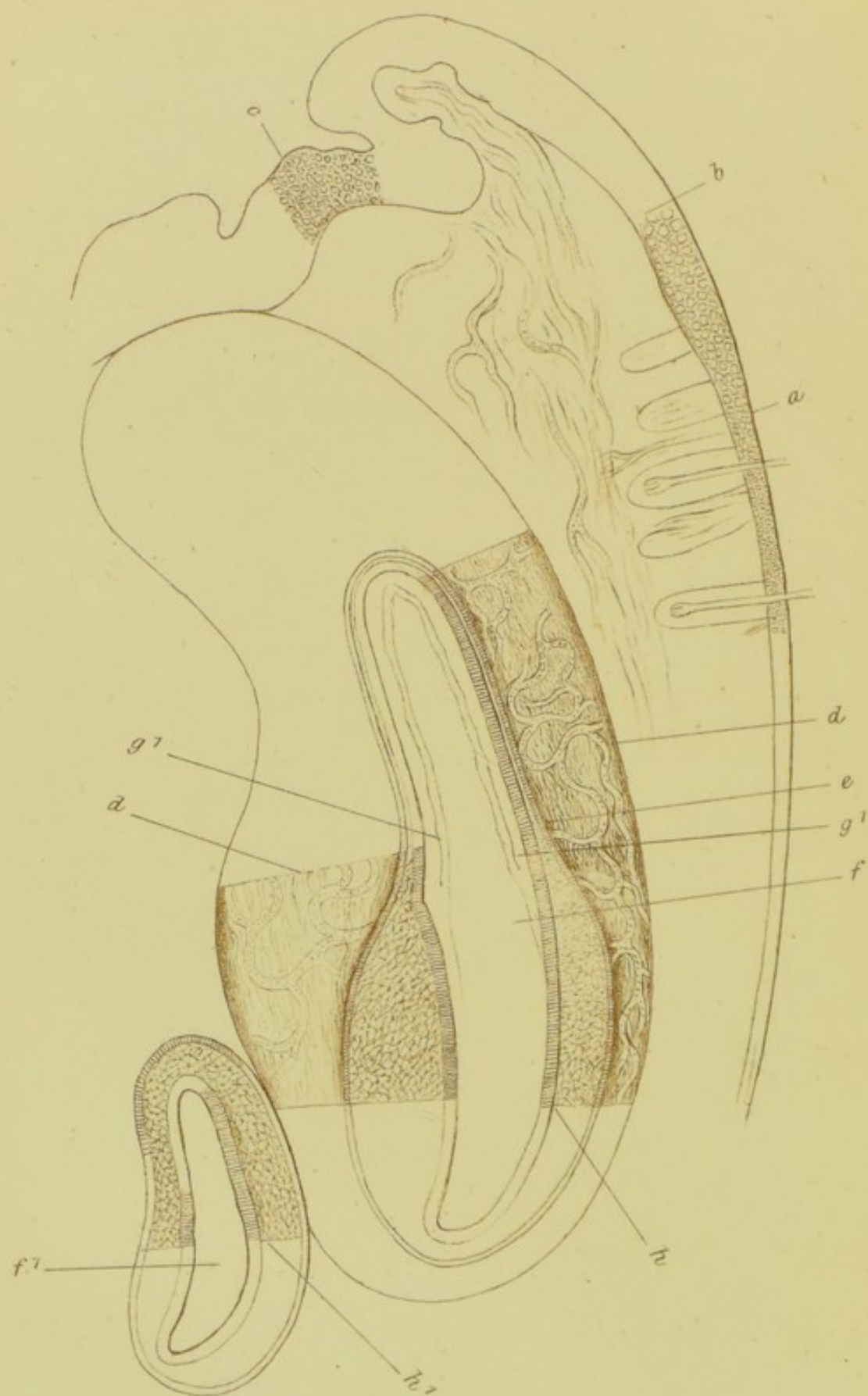
$g^1, g^2, g^3$ . Level to which the deposit of enamel has reached upon the dentinal caps  $f^1, f^2, f^3$ , respectively.

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Fig. 2.



## DESCRIPTION OF FIGURE 2.

FIG. 2. Section of anterior portion of lower jaw of foetal calf, *Bos taurus*, taken in an antero-posterior or sagittal direction; showing the enamel organs of two teeth, one larger and the other smaller, *in situ*. The section has passed through the lateral portion of each tooth; and as the incisors in this species have their crowns laterally expanded, whilst their fangs are compressed from side to side, the central stem of the dentinal pulp is not seen in this section, and the enamel organ passes entirely round its lateral expansion. The dentinal pulp itself is not represented in either of the two teeth; two contour-lines, bounding the apical half of the space which it occupied in the larger of the two teeth, show the extent to which the deposition of enamel and dentine severally had proceeded upon it. In the smaller of the two teeth the deposition of enamel has not commenced, and the enamel organ has as yet suffered no diminution of its "spongy," or "gelatinous," or "stellate" tissue. This drawing being semi-diagrammatic, segments only of the histological elements making up the epithelium of the gum, the epidermis of the lip, the tooth-sac, and the enamel organs, have been given; the contour-lines prolonged in each case from the external boundaries of these segments, appearing to indicate sufficiently the relations held in nature by the several structures.

a. Anterior surface of lip.

b. Epidermis of lip.

c. Epithelium of gum.

d. Tooth-sac, which at this stage in the development of the tooth, and before it receives any support from the bony structures in the jaw, is clearly marked off by layers of condensed cellular tissue from the strata of *cutis vera*, which are interposed between it and the external epidermis. The loose spongy central portions of the tooth-sac bear some resemblance, when viewed with the unassisted eye, to the similarly placed stellate element of the enamel organ; they differ from it, however, by



being vascular, and even highly vascular; whilst they differ from the *cutis vera*, not merely by their greater looseness of texture and their greater vascularity, but also, as seen in the figure, by the absence of glands, of hair-bulbs, and of muscular tissue.

- e.* Enamel organ. From the point to which the line *e* is drawn, downwards, the enamel organ of the larger tooth is seen to possess all the three structures; viz., the inner epithelium, the stellate or spongy tissue, and the outer epithelium, which the enamel organ of the smaller tooth (*h*<sup>1</sup>) still possesses. Above the point to which the line *e* is drawn, the stellate tissue has disappeared, and the two layers of the enamel organ's epithelium have come into apposition. Thus the epithelial cells of the inner layer, which produce the enamel prisms, or "fibres," come into closer relation with the bloodvessels of the tooth-capsule, whence alone, in the absence of vessels in the enamel organ, they can provide themselves with the requisite mineral matter.
- f.* Space in the larger tooth occupied by the laterally projecting portion of the spoon-shaped dentinal pulp.
- f*<sup>1</sup>. Corresponding space in the smaller tooth: in neither tooth did the central stem of dentine come into view in this section.
- g*<sup>1</sup>. Contour-line indicating the extent to which the deposition of enamel has proceeded in the larger tooth. This line corresponds to the similarly lettered granular deposit in fig. 1. Internally to this line, a second line is seen describing a similar contour, but reaching considerably further down. It indicates the extent to which the cap of dentine reaches downwards upon the exterior of the pulp; this extent being considerably greater (as is seen also in fig. 1) than that attained to by the deposit of enamel at this period of development.
- h* and *h*<sup>1</sup>. Line of junction, in the larger and smaller tooth respectively, of the stellate tissue of the enamel organ to its inner layer of epithelium. In both enamel organs the outer layer of epithelium is drawn as more nearly columnar than it is in nature.



