

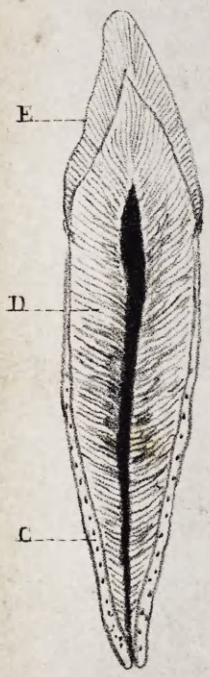


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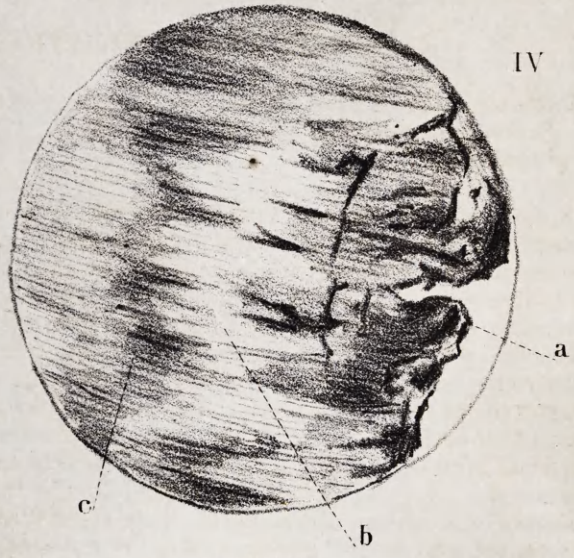


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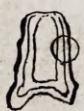
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III



MANCHESTER
ROYAL
APOTHECARY

J. Smith del.

J. G. Colclough lith.



Part First.

ORIGINAL COMMUNICATIONS.

ARTICLE I.—*On Dental Caries, and the Preservative Influence of the Saliva in that Disease.* By J. SMITH, M.D., 12, Dundas Street, Edinburgh.

IN most of those animal tissues which are in the living body exposed to the influence of external agents, there is to be observed a series of actions indicative of properties, by the operation of which a self-protecting power is manifested, whereby they are, in a great measure, enabled to preserve themselves from the effects of those mechanical and chemical forces which, acting from without, would otherwise lead to their destruction. I do not so much mean the power of assimilation and nutrition possessed by these structures, as of that action, by which a protective material is thrown out as a defence from external injury. Thus, in the skin and mucous membrane, this property is well exemplified in the increased development of epithelium, according to the necessity arising for its presence, as well as the increased flow of the secretion peculiar to mucous membranes, as occasion may render it serviceable. But in one instance, regarding which a few remarks are here proposed to be made, there appears to be no such self-protective property possessed as to enable the particular tissue in question to adapt itself to the action of external forces, although liable to be placed in circumstances at least as trying as either of these structures just mentioned. I allude to the teeth, where circumstances seem to necessitate the presence of a preservative agent acting in a different manner from the protective resources of other tissues, and not immediately connected with these organs; and where the existence of one agent, apparently in this capacity, seems to have been as yet unnoticed,—I mean the saliva.

The idea that the saliva constitutes this defence, suggests itself principally from the consideration of certain facts observed in connection with this secretion in the commencement and progress of dental caries, as well as from the alkaline and other qualities demonstrated by numerous chemical analyses. And the necessity for such a means of protection, appears to arise from the exceedingly feeble power of self-maintenance belonging to a tooth, and conse-

quent want of such means in itself as would be necessary for its preservation.

Besides the liability of these organs to mechanical injury, it must be observed, that, both by their structure and situation, they are exposed to the influence of chemical decomposition, and without the power of resisting the operation of this agency, or of repairing the injurious effect produced by it, become disorganised and broken down, exhibiting, as the result, that peculiar series of changes known as dental caries; but which, in reality, appears to be, not caries, but, in all probability, neither more nor less than chemical decomposition.

It will be recollected that three different tissues enter into the formation of a tooth:—the body of the tooth is composed of the substance termed *dentine*, which is, on the crown of the tooth, covered by *enamel*, and on the fang by *cementum*. All these structures differ in the amount of their organisation in different animals. In many cases these three tissues are seen to be mere modifications of one another; and the dentine, and even the enamel, in several instances, appears, like the cementum, to be a living substance; but in the human tooth, to which I shall restrict these remarks, the case is quite different, as the substance of the dentine, as well as the enamel, here appears, after its development is complete, to be destitute of all vital power, if not of all vitality. In these teeth, the dentine (Fig. 1, *d*), when examined microscopically, is seen to consist of a mass of minute tubes, radiating from the central or *pulp* cavity towards the whole surface of the tooth, and imbedded in a translucent homogeneous material, having in section somewhat the appearance of thin and transparent horn; while in the cavity of these tubes, and on their walls, is deposited the calcareous matter which imparts the characteristic whiteness and opacity to the substance of the tooth.

The enamel again (*e*) is composed of a solid mass of closely-packed crystalline and semi-transparent columns, appearing under the microscope of a yellowish-gray colour, and placed vertically to the surface of the subjacent dentine: The cementum (*c*) in structure very closely resembles bone, being laminated in formation, and provided with canals for blood-vessels, and with cells communicating with these and with each other by means of numerous canaliculi radiating from them in all directions. The cementum is endowed with a considerable share of vitality, as evidenced by the changes which take place in its bulk and character during exostosis and other pathological conditions of the fang.

In the human tooth, there appears to exist in the enamel and dentine, as a vital function, the power of development only; and that process being once completed, no means are left by which to maintain their condition in withstanding the changes to which they are subjected by the action of external influences. With their development, their vitality ceases.

Different views, however, have been from time to time advanced upon this subject; and at present very different opinions appear to be held regarding it, especially in so far as the dentine is concerned. There seems to be no question regarding the existence of vitality in the cementum; and it seems equally well established, that after its formation, which is very often defective, the enamel constitutes an inorganic substance, incapable of nutrition or growth, and devoid of all sensibility. These, then, may be passed over without further remark. But with regard to the dentine, the question becomes somewhat more difficult to decide, and has been the subject of much controversy. The facts brought forward in evidence of the vitality of this substance, are, its alleged vascularity and sensibility, and its being the seat of certain apparently vital actions during the progress of decay. The proofs of its vascularity are supposed to consist in the dentine becoming of a red colour, under the action of madder, given to an animal along with the food; and instances are even cited where it was alleged to become of a red colour, as the consequence of inflammation of its substance.

The madder, however, in these experiments was given during the period while the teeth were in progress of formation, and consequently when they would of course exhibit their vital functions in full activity, although, as before stated, these may become extinct with the completion of development; so that what are necessarily characteristics of this particular stage of their existence, by no means prove that the same qualities are to be found at a later period. Besides, these very experiments themselves go far to prove the reverse of the doctrine which they are intended to support, since Mr Hunter states, that such parts of the teeth as are formed before the animal takes the madder remain white; while only those which are formed while the animal is taking the madder will be found to be of a red colour.

And Mr Tomes states, that in his experiment only the pulp cavity, and cement,—the two structures allowed to possess vitality in the human tooth,—were coloured along with the rest of the skeleton. "But," he adds, "I could not discover that the colour extended further in the tubular than in the inner tubular tissue. Neither did the opaque line which marks the interior of the tubes, as seen by reflected light, seem coloured." Then as for the inflammatory redness of dentine, it goes too far to be held up as anything like a general example, since it would involve the existence, not only of vitality, but of a very high degree of vascular organisation indeed, before such an amount of blood could become collected in this tissue as to produce such marked effects.

In some instances, no doubt, traces of blood-vessels are found in the dentine of the human tooth; but these are merely abnormal modifications of the rudimentary condition of this structure, and are not to be appealed to as proofs of the continuance of this now extinct condition, but ought rather to be regarded as resulting from imperfect formation.

The sensibility imputed to the dentine, under certain circumstances, has never been satisfactorily demonstrated; nor can it well be so, for two reasons,—in the first place, because wherever caries has existed, this substance has been so much softened as in many cases to be quite elastic, and, in consequence, easily pressed down upon the sensitive pulp lying underneath; and when not so much softened as this, at all events its texture has become much more pervious to the entrance of fluid matters, &c.,—and thus, in both cases, without any absolute exposure of the pulp, pain may be excited in it, and in this way referred to the substance of the dentine. The immediate proximity of textures, such as the pulp and cementum, endowed as they are with sensation, renders the liability to this mistake very obvious; and indeed before any positive decision could be justly arrived at, determining the sensibility of the dentine, proof would be required that nervous fibres existed in the substance of this structure: the presence of such fibres, notwithstanding all the minute investigation to which the tissue has been subjected, has never been yet, in any way, recognised.

Regarding the "*consolidation of the living part of the dentine,*" next to a portion attacked by caries, as spoken of by Mr Tomes (p. 203 of his work on Dental Surgery), it appears questionable whether this be a vital or merely a chemical and mechanical change. The more probable doctrine, however, is, that it consists of one, or a combination of both, of the two latter,—since a very similar, if not the same, appearance may be observed in the decay of the dentine of the hippopotamus' tusk, employed in the manufacture of artificial teeth, when these have been worn for some time in the mouth. Here in many cases three different results are visible as the effects of decomposition, and these, occurring simultaneously, give rise to appearances which I am inclined to believe identical with those occurring in the natural teeth.

Upon making a section across the substance of such an artificial set of teeth, which have been worn for some length of time, the appearances presented to the naked eye are those represented in Fig. 2 of the accompanying plate. First, we observe the discoloured and decomposed surface of the dentine forming the external layer, as represented at Fig. 2, *a*; next, and immediately within this again, a translucent band is observed, as at *b*; while within this again, and separating it from the healthy bone *d*, an opaque white band occurs, as seen at *c*. Now, upon submitting such a portion of dentine as this to microscopic examination, these appearances, viewed by transmitted light, are seen to consist in an apparently corroded condition of the whole interior aspect of the tubuli, which appear as if their walls had fallen in, and filled up the ordinary canal in them with detritus, rendering the structure at this point dark and opaque, as seen, Fig. 3, *a*;—while the translucent line seems to be only the result of a more advanced stage of this pro-



cess, and to consist in the removal by some means of the detritus mentioned just now, and consequently of the opacity. The broken-down calcareous substance previously contained in the tubuli being thus removed, they are left widened and empty, and, with the homogeneous translucent substance in which they lie, of course appear as a transparent zone betwixt the opaque band and the superficial layer, as is represented, Fig. 3, at *b*. The external surface of the bone again appears quite demolished, decomposition having gone on so far as utterly to destroy all structure, rendering the substance a dark-brown coloured mass, as shown in the drawing at *c*. The healthy substance is seen at *d*.

These sections were taken from different artificial sets, made from the hippopotamus' tusk, and were cut transversely from that portion of them corresponding in situation to the molar teeth.

Now, in the human tooth undergoing caries, as it is termed, there may be observed not only the translucent portion of the dentine, mentioned as arising from consolidation, but also, as in the other case, the opaque boundary between this and the healthy substance, although not so well defined in this instance, the texture of the human tooth being so much finer and denser in quality. If we place a section of a carious tooth under the microscope, there will be observed, first, as in the artificial sets, the completely disorganised crust forming the outer layer, as seen, Fig. 4, at *a*. Then the translucent line appears, as at *b*, intervening between the dark mass at *a*, and an irregular opaque band of dentine, as represented at *c*. The irregular form of these semi-transparent and opaque bands in the human tooth, when compared with those seen in the dentine of the hippopotamus, as well as their occasional absence altogether, may be accounted for, as before-mentioned, by the difference in the texture of the two structures; and not only this, but even in different parts of the same tooth belonging to the human subject, there is to be found a great variety in the degree of density, so that even in one tooth the opaque line may be visible in some places and not in others, as may be observed when examining a very thin section placed upon a black ground, so as to exhibit the opacity of the more dense portions, as seen, Fig. 5, where the opaque band is also seen surrounding the hollow produced by caries in the crown. Had this occurred more towards the fang, in all probability this appearance would have been here scarcely distinguishable from the opaque substance which is seen to exist in that situation.

Thus I so far agree with Mr Spence Bate, and those who consider the translucent line to result from the solution and removal of the calcareous contents of the tubes, and not from their solidification. However, I would go still further than them, and state that a change, preliminary to this stage of the process, is to be observed in the breaking down of the contents and walls of the dental tubuli, previous to the removal of the calcareous matter as debris, and the formation of the semi-transparent zone; which pro-

cess is the cause of the opaque barrier appearing to exist betwixt the carious and healthy parts of the tooth, as shown in the annexed drawing,—none of which appearances are any proof whatever of protective powers being possessed by these bodies. In this way, then, we find good grounds for believing that the process of decomposition, and subsequent removal of their component parts, occur in the same manner, both in the dentine worn as artificial substitute and in that entering into the formation of the natural human teeth, and that in neither case are those changes, either in their progress or arrestment, dependent upon, or connected with, inherent vitality in the substance attacked, but merely the result of chemical action.

These considerations, then, and the facts with regard to the vascularity and sensibility of the dentine, certainly appear at variance with the supposition, that the tissues liable to dental caries are capable of self-maintenance in any degree adequate to their subjection to disorganisation; and the existence of this apparent defect, taken in connection with several circumstances observable in relation to the influence which the *saliva* seems to exercise over dental decay, renders it very probable that this secretion has been substituted by nature for the supply of this deficiency, as a fluid suitable for the protection of those structures from the decomposing forces, whatever they may be, to which they are obviously so exposed.

That the saliva should constitute a preservative medium for the teeth, is a doctrine at complete variance with the opinion of many authorities upon the subject of dental caries; but that this secretion, in its normal state, so far from leading to their destruction, contributes by its peculiar qualities to their protection, appears an assertion capable of being supported by most convincing and decisive proofs. Most writers, indeed, who have adverted to this subject, have considered the salivary secretion as a source of dental decay only in those instances where it exists of abnormal quality, as in dyspepsia, &c., where it assumes an acid re-action, and will then at least assist the operation of those solvent matters, the action of which upon the substance of the teeth seems to be the cause of this disease. But Mr Spence Bate, in one of his lectures, published in the "Medical Gazette" for July 18, 1851, asserts that the saliva gives rise to caries from the presence in it of carbonic acid, derived from the products of respiration, and that, consequently, this acid renders it a destructive agent even in its normal condition.

Now, as that gentleman himself denies the necessity of any flaw in the enamel for the development of caries in any particular spot, it would certainly appear, if his theory hold good, that all teeth would be equally subject to decay,—but this we do not find to be the case; and, as for surmounting the difficulty by imputing the predisposing cause of caries to the facility with which the saliva

lodges in the natural crevices present in certain of the teeth, &c., how is the commencement of caries upon the smoothest surface of enamel explained, as when it attacks the external surface of the eye-teeth, where all that is presented for the action of any destructive agent is only a smooth cone of enamel? And how is the idea of the saliva being *detrimental* to the teeth, to be reconciled with the fact, that in those very situations where this secretion lodges in the greatest quantity, the teeth are there least affected with decay? as we find in the lower jaw, and especially among the front teeth of the lower jaw, where caries, in anything like the same extent we meet with in the upper jaw, is quite an exception to the general rule. Even in the dentine used for artificial teeth, the same course appears to be followed by the decay occurring there, as in the natural teeth,—since there is a tendency to much more rapid decay in the upper pieces all over, and in the back parts corresponding to the molar teeth of the lower ones.

Another circumstance seems greatly to militate against the theory that a destructive tendency of this kind should exist in the saliva,—since the constant presence of so powerful an agent in the immediate vicinity of the teeth, as could lead to such serious consequences, would be unparalleled by any other instance in the animal economy. We do not find any danger to the parts with which it is designed to come in contact from the secretion of the kidneys,—a fluid highly irritating to most tissues, even in its healthy state; neither do we find such results in any other similar case; and it is very improbable that, without any plausible reason whatever, the saliva should constitute the solitary exception to this very general, and in fact absolutely necessary, law. Even when diseased in quality, it is far more likely that this secretion, instead of taking any active share in the development of decay, should exert only a passive influence over the process of that affection, by its not being at such times of a nature calculated for the neutralization of destructive agents, altogether apart from, and independent of itself.

We might even go so far as to remark, that in those animals whose food is of a quality more apt to originate injurious effects upon their teeth, as in the herbivora, we find the salivary apparatus much more largely developed; and there is a possibility that this arrangement may, as well as for other purposes, be for affording additional protection to the teeth under these more disadvantageous circumstances. No doubt the prolonged process of mastication performed by these animals demands and produces a greater flow of saliva; but it is not in every case found that the amount of this secretion is in proportion to the duration of mastication,—since in old persons who have lost all their teeth, and, consequently, do not chew their food, the saliva continues to flow in quantity for some time after having taken a meal. The food is probably the main source of the agent which does produce decay of the teeth,

however that agent may vary under different circumstances; but it is unlikely that the saliva, even when its re-action may be acid, possesses any very great power in originating the disease, although in this state it may act, as mentioned before, as a passive agent in the progress of the disease. That in its healthy state it should constitute the means of injury to a set of organs whose destruction from their situation would be so inevitable, appears to be a conclusion we are quite unwarranted in adopting; and when we consider the deficiency of vital power in the great bulk of the tissues entering into the composition of a tooth, which would be necessary for enabling it to withstand the effects of the numerous deleterious influences to which these organs would be subjected but for the interposition of some means of defence, there appears to be a necessity for certain of the fluids of the mouth acting in this manner, and from the facts just mentioned as bearing so forcibly upon this subject, viz., the proportionately increased amount of decay occurring according to the diminished quantity of the saliva lodging in the neighbourhood, there seems to be little doubt that that secretion acts in this capacity.

I have advanced these few remarks upon this subject as one not altogether devoid of interest; and in doing so, the mere facts, as they are observed to occur during different conditions of the dental tissues, have been more my object than any attempt at explaining the cause of them, as this is a matter which would require more investigation than I have been enabled to make with regard to it. However, it is likely that the destructive agent does not consist in the alteration of any of the natural fluids of the mouth at all, but rather in some abnormal product, arising from different sources altogether, being added to them, the nature of which has not as yet been ascertained.

Nothing further can be positively said with regard to it at present; but in another paper I may perhaps be more prepared to enter into the discussion of this part of the subject, constituting as it does the most interesting question connected with the matter.

ARTICLE II.—*On the Function of the Spleen and other Lymphatic Glands as Secretors of the Blood.* By JOHN HUGHES BENNETT, M.D., F.R.S.E., Professor of the Institutes of Medicine, and of Clinical Medicine, in the University of Edinburgh.

(Read to the Royal Society of Edinburgh, February 2, 1852.)

IN a state of health, human blood, as is well known, contains a multitude of circular, biconcave, coloured discs, with which are usually mingled a few globular colourless cells. The relation of these bodies to each other, their origin, disappearance, and analogy with the oval blood cells of birds, reptiles, and fishes, are points which, al-