PATHOLOGY OF DENTAL CARIES.

by

William Wallace, M.A., M.B., C.M., L.D.S.,
Lecturer and Examiner in Dental Anatomy and Physiology. Glasgow Dental School.

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ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

INTRODUCTION.

Whether in a practical way the hygiene of the teeth is best secured by normal mastication and non-interference as is the opinion of some, or by interference with powders, brush, soaps and antiseptics and otherwise, as is the opinion of others, the teeth form a branch of knowledge of very wide interest and of the utmost importance. Besides their use in alimentation and their beauty as a feature of the human face, and their having a part to play in the production of voice and speech, which constitute their immediate human interest, they are invaluable and essential counters for the discussion of many abstract and far reaching biological problems, and their scientific study even leads to certain maxims in conduct and taste. To whatever extent these matters might otherwise interest us, they will be here dealt with only to the extent necessary to from a proper conception of the importance and advantage of having a true knowledge of that disease of the teeth called dental caries, a proper analysis and interpretation of which has hitherto not been made.

Dental caries, or rot of the teeth, is the commonest of all diseases, and if estimated as a factor in human economy, forms at the present time, by far the most important theme in pathology. It is the disease the best suited to form an introduction to the study of medecine and pathology in general, and should be held as forming the most excellent and convenient tpye on which the methods of investigation in pathology may be based. In the near future, the study of dental caries should be an essential part of every child's education.

INTRODUCTION.

And instead of being taught tooth-brush drill, it should be taught how dental caries may be prevented by the exercise of normal mastication. Instead of being neglected as it is at present, by the general practitioner as well as by every one else, he, like the child of the future, should have an exact knowledge of the phenomena of its incidence, and of how it may be prevented.

Being in the mouth and originating on the surface of the ~~teeth~~ enamel, the disease starts and progresses in a situation where it is comparatively easy of observation, as easy at any rate, as any other disease. Among civilised races, it is practically universally present, and it is as prevalent among the rich as among the poor. It ~~may~~ should be studied in school rather than in hospital, Instead of its diagnosis being difficult, as is the case in many other diseases, not only are most of its clinical features and microspical phenomena easily rendered perfectly familiar, but when occurring in the front teeth, it is usually so painfully obvious, that even a child can recognise it without any doubt. I hope that a perusal of the definitions and account that I shall give of this disease will show, that a child might as easily understand the nature or cause of its incidence, as even although this has not hitherto been done, as recognise the disease itself.

The reason of its great prevalence is at present obscure, and is still debated:- its prevention has baffled every ~~scientific~~ empirical effort yet directed against it. By the solution of these problems this disease will

become an item of science, and only then can its nature be taught in a scientific manner, and rational methods adopted for its prevention. My opinions in regard to dental caries are the results of my own observations which have led me to make an account of them quite different from anything that has ever been recorded.

COMPARATIVE ANATOMY.

The teeth and dental apparatus of the mammals including man, are often said to have a higher organic nature than those of fishes, amphibians and reptiles, but anatomists, human and comparative, however conscious of this generalisation, have been very unsuccessful in giving this idea a fortunate, not to say a definite, expression. Whether higher or not, the several teeth of mammals have a more definite individuality or form a more independent organic unity, whether the teeth are taken individually or as a dental apparatus, than the teeth of the lower groups. The lower groups, however, frequently mimic or simulate the mammalian dentitions and fore-shadow them in their diverse structure and uses in a most renakkable way, showing, as it were, the latent possibilities of a higher ~~group~~ form and mode of life in these lowly types.

The more definite individuality of the mammalian teeth is shown in the combination and variety of certain certain differences from the lower types of which, of course, may not all be simultaneously present, by which they are distinguishable from the lower groups. They differ broadly from one another as has been shown by comparative odontologists in their form, structure, attachment to and distribution on their skeletal supports at the entrance of the alimentary canal, in their mode of succession and duration in place, in the complexity of their parts and consequently also in ~~different and~~ an increased diversity of functions.

Of the lower groups of vertebrates it is the reptiles that show the greatest affinity to the mammals and thus the evolution of the mammalian molar tooth from the conical reptilian tooth is of importance,

and has been studied especially by American Odontologists.

In the peptiles, the teeth of the upper and lower jaws typically ~~indicate~~ interdigitate with one anothern; in mammals they engage and ~~artu~~ articulate with one another. In the former, the teeth impinge on the gums opposite and if there be outstanding teeth, there may be notches or even holes, perforating the opposite jaw, for their reception. There is no alveolar process as in mammals. The teeth of the reptiles are calculated merely to wound, entangle and incapacitate their prey and are prehensile or offensive in function. In the mammal, many additional uses exist, but the principle distinguishing ~~features~~ function is mastication to which end a certain portion of the tooth, namely the masticatory area, is specially constructed for, and devoted to, and for the efficient use of which the ~~rest~~ rest of the structure of the tooth is subservient and for which indeed the whole masticatory apparatus is modified and designed.

The manner in which this masticatory area, is evolved and designed whether of the individual tooth or of the teeth as a masticatory apparatus, is perhaps the chief problem in dental comparative anatomy, and the form of this area is implicated in the incidence of dental caries.

In regard to the teeth individually, the manner in which the mammalian molar tooth is evolved from the reptilian cone is expressed in the tritubercular theory of the evolution of the teeth. Apart from whatever other uses or merits it may have, it is convenient for elucidating my contention that the mammalian tooth is primarily divisible into a masticatory and a non-masticatory portion, and that this is the true

DENTAL ANATOMY.

subdivision of the tooth and the
primary anatomical character that best distinguishes the mammalian from the tooth of the reptiles and those of the lower groups.

The first step in the change from the reptilian to the mammalian molar tooth is by the addition of a cone on each side of the tooth longtitudinally, in a line with the alvoelar ridge, forming what is called the triconodont tooth. The triconodont form of the tooth would increase the use of the tooth and would tend to protect the gum from abrasion due to the chopping action of the jaws. If the teeth were sufficiently close, they would in part at least, antagonise instead of interdigitate, which would further enhance their efficiency. As these teeth present two roots set in a line with the alveolar ridge, their stability would also thereby be greatly increased.

The next step, is the displacement transversly to the alveolar ridge of these added cones, outwards in the upper and inwards, in the lower jaw. This arrangement of the cusps of the molar teeth would obviously make them still more efficient. Instead of being spaced and interdigitating, if they became close so as to touch one another and occlude with those opposite, they would acquire additional advantages. These changes appear to have taken place in the evolution of the early mammalian teeth, and in the majority of the different groups of these animals.

The special types of crowns that characterise the different existing groups of animals, were subsequently super-induced on this

tuberculas
trie~~emodont~~ pattern which, indeed, is still widely represented among existing mammalian teeth.

To the patterns of the crowns of the different groups, distinctive names have been applied, showing that the anatomical importance of the masticatory area ~~crown~~ of the tooth has already been implicitly recognised.

But it is not only to the individual teeth that the importance of the distinction into a masticatory and a non-masticatory area refers, ~~but~~ it is also to their arrangement taken as a whole, so that the masticatory area forms a surface or platform raised from the gums on which mastication takes place. As the front teeth retain the prehensile functions, they become modified to suit the rest of the dentition, and the the special mode of life of the animal to which they belong. Hence arises the heterodont mammalian dentition, and these animals have been named in accordance with the chief characteristics of their teeth. carnivorous, herbivorous, insectivorous &c. The teeth in ~~h~~ the human dentition are not only heterodont, but what Owen calls homodont all that is, they are not alike, but consist of incisor, canine, bicuspid and molar teeth, merging into one another in ~~sub~~ such a way, that they form a continuous contiguous series:- one kind of tooth merges gradually into the succeeding tooth without any break- there being neither any outstanding tooth nor space between any teeth or diastima, as it is called. No other existing animal has a continuous and contiguous series of heterodont teeth. Owen called such a heterodont dentition "homalodont". At one time he considered homalodontism a human characteristic. When it was discovered that certain extinct forms of

animals had a homalodont dentition, that is to say, a continuous and contiguous series of teeth like man, without gap or outstanding member, he recognised that the significance of homalodontism as a human characteristic had not the same bearing or importance that he had attributed to it. However, that may be, it is probably true that some such animal was the progenitor of many genera of the mammals that came into existence shortly after the appearance of the mammalia on the earth. They had forty four teeth, the dentition being represented by the formula:- $i\frac{3}{3}$ $c.\frac{1}{1}$ $p.m.\frac{4}{4}$ $m.\frac{3}{3}$ or in the parental marsupalian dental equivalent, in which there probably were some additional upper incisor teeth, and the premolars and molars were represented by the formula:- $\frac{3}{3} \cdot \frac{4}{4}$ These animals existed at the beginning or shortly before the beginning of the last great geological period, i.e. the Eocene or tertiary period. At any rate about the beginning of this period a mammal with forty four teeth, apparently made its sudden appearance on the earth. and soon came to have an extraordinarily wide geographical range and dominance.

A vertebrate animal having a heterodont dentition, would have a great advantage over its near congeners, the then dominent reptiles, in which the teeth were homodont or nearly homodont or all very much alike. It could in the first instance, select and then divide its food wi with greater precision and ease with the front cutting, paring or tearing (incisor) teeth, and then the food would be gradually comminuted as it was transferred towards the back of the mouth before being

swallowed. The tax upon the stomach and intestines in digesting food in an unprepared condition would be taken off these organs and put on the teeth; the other organs of the animal would share in the economy thus secured and for this group of animals the prospect of a wider range on the terrestial globe would be opened up. The value of the proper preparation of food was thus early demonstrated at this ancient age in the world's history, and the utility of the art of cookery fore-shadowed. Indeed we will see later on that the anatomy of the human teeth is the determinant of the proper consistency of our food and that cookery is the art of preparing food in such a manner that its consistency should suit the morphology of the teeth of man.

All the other distinguishing features of the mammalian tooth are subsisiary to and have come into existence to secure the form and function that attach themselves to the masticatory area, which is the effective feature of the tooth, and for which the tooth exists.

This interpretation of the evolution of the mammalian tooth from the reptilian tooth was long subsequent to the time of Hunter, who had accepted the then and still existing anatomical division of the tooth, but who carefully, however avoided, probably having teeth of persistent growth in view, calling the neck a structure, and described it thus:- "Each Tooth is divided into two parts, viz., First, the body, or that part of it which is thickest, and stands bare beyond the Alveoli and Gums; Secondly the fang or root, which is lodged within the Gum and Alveolar process: and the boundary between these two parts, which is grasped by the edge of the

Gum is called the neck of the Tooth." Hunter was prone to philosophic analysis, and if a better division of the parts of the mammalian tooth had occurred to him, he certainly would have stated it. In the very next paragraph he for the first time divides the Grinders into Bicuspids and Molars.

Owen, as fond of analysis as Hunter, merely varies the customary division of the tooth, but with a suggestive commentary, thus:- "The ordinary teeth of the Mammalia have so much more definite and complex a form, than those of Fishes and Reptiles, that three parts are usually recognised, viz:- the fang, the neck, and the crown," and adds, "those teeth which grow uninterruptedly have not their exposed parts separated by a neck from their implanted part, and this generally maintains to its extremity the same shape and size as the exposed Crown." And he further adds, "It is peculiar to the class of Mammalia to have teeth implanted in sockets by two or more fangs; but this can only happen to teeth of limited growth and generally characterises the molars and premolars." ~~But the question whether anatomi~~ Anatomists have failed to properly describe the mammalian tooth, so that it can be distinguished from the Reptilian. Owen does not substantiate the prelude of his definition, viz., that Mammalian have a much more definite and complex a form, than those of Fishes and Reptiles. The tooth of the labyrinodont is as definite and complex as any Mammal, yet it would not be mistaken for a mammalian tooth.

The truth of the matter is, that the crucial and most important distinction between Mammalian and the lower vertebrates has been overlookd

or rather not embodied in words and that is, that the tooth presents a masticatory ~~a-d~~ area raised from the gum and to which end the mammalian modifications of the tooth have come into existence. The foldings in the strucrure of all complex teeth of the conical lower vertebray type is arranged radially, no complex ~~tooth~~ mammalian tooth is so arranged. The foldings in mammalian teeth are all arranged vertically. They start with additional papilliform folds first in a line and then as a trigon. In this way the exposed portion, the body or crown, always presents a masticatory and a non-masticatory area. This principle will be further fully referred to and how it throws light on the pathology of dental caries.

INTRODUCTION.

Whether in a practical way the hygiene of the teeth is best secured by non-interference, as is th opinion of some, or by interference with brush, soaps, antiseptics and otherwise, as is the opinion of others, the teeth form a subject of very wide interest and of the utmost importance. Besides their use in alimentation, their beauty as a feature of the human face, their implication in the production of voice and speech, which constitute their immediate human interest, they are invaluable and essential counters for the discussion of many abstract biological problems. Their scientific study leads to certain maxims in conduct and taste. These matters will interest us, and be dealt with only to the extent necessary to form a proper conception of the importance and advantage of having a true knowledge of that disease of the teeth called dental caries, a proper ~~analy~~ analysis and interpretation of which hitherto ~~has~~ has not been made.

Dental caries or rot of the teeth, is the commonest of all diseases, and if estimated as a factor in human economy, forms at the ~~presh~~ present time, by far the most important theme in pathology. As a disease it is the one best suited to form an introduction to the study of medecine and pathology in general, and forms the most excellent and convenient type on which the methods of investigation in pathology may be based. In the near future, the study of dental caries should be an essential part of every child's education. And instead of being taught tooth-brush drill, it should be taught how dental caries may be prevented by the exercise of normal mastication. Instead of being neglected as it is at

present, by the general practitioner as well as by every one else, he, like the child of the future, should have an exact knowledge of the phenomena of its incidence and progress, and of how it may be prevented.

Being in the mouth and originating on the surface of the teeth, the disease starts and progresses in a situation where it is comparatively easy of observation. Among civilised races, it is practically universally present, and it is as prevalent among the rich as among the poor. It may be studied in school rather than in the hospital. Instead of its diagnosis being difficult, as is the case in many other diseases, not only are most of its clinical features and microspical phenomena perfectly familiar, but when occurring in the iron teeth, it is even painfully obvious, so that even a child can easily recognise it. I hope I may be able to show that a child might ~~be~~ easily understand ~~it~~ the nature ~~and~~ or cause of its incidence, even although this has not hitherto been analysed. The reason of its great prevalence has baffled every scientific effort yet directed against it. By the solution of these problems this disease will become an item of science, and only then can its nature be taught in a scientific manner, and its prevention rationally accomplished.

PATHOLOGY OF DENTAL CARIES.

DEFINITION OF DENTAL CARIES.

While all parts of the enamel or exposed surface of the tooth are in themselves equally vulnerable to one another, dental caries begins where a microbic infection takes place at a spot or spots on the enamel, the location of which is readily, nay absolutely definable. The points of incidence or infection are determined by the form or morphology of the tooth in relation to the exciting cause of caries, that is, either to the intermittence or abnormal variation of the energy expended on the food in mastication, from greater to less energy, which is germain to the function of the teeth themselves, or of any intermittence or similar variation in any adventitious force from greater to less habitually brought to play upon the teeth. These forces lay bare the enamel at these definite points, and the acid-bearing cario-genic micro-organism, which is probably habitually present in all mouths, is brought into direct contact with the enamel, and in virtue of the intermittence or abnormal lessening of the forces above referred to, the micro-organism is allowed to remain at these points on the surface of the tooth undisturbed for a sufficient time to germinate, to dissolve and feed upon the organic salts of the tooth, and becoming ensconced in the enamel, and thus infecting the tooth, to give rise to the primary cavity of dental caries. Thus, one microbe may, probably frequently does, become the progenitor of a colony that leads to the formation of a carious cavity. This is why the initial lesion may be and usually is,

confined to a very small point, and a little hole is formed which will at first admit of only the point of the finest probe, which is then said to bite. A sensation familiar to every dentist and of which no proper explanation is extant, but which now will be accounted for.

It is only at points on the enamel where these conditions are satisfied that carious cavities ever occur, and when these conditions are satisfied, caries sooner or later does occur. Caries therefore originates on what to all intents and purposes, may be called a clean spot on the enamel, and when caries is referred to as due to the kind of food eaten, it is therefore its physical qualities, not its chemical qualities that are at fault.

There are two predisposing causes of dental caries, (1), defect in the physical qualities of the food affecting mastication, and (2), loss of appetite pain in the dental apparatus or mouth affecting mastication. The prevalence of caries is chiefly due to the existence of these two predisposing causes, which, when they are absent, the teeth are free from caries, or as it is called, though improperly, immune. The incidence of caries is a problem in dynamics. ~~The~~ The progress of the disease becomes a bio-chemical problem only after the infection has taken place, and is concerned with the disentegration of the salts of the tooth, through the agency of a specific microbe.

Dental caries does not originate as is usually taught, where food or debris lodges or tends to lodge, nor is it due to the lodgeability, or tenacity of the food stuffs, in themselves. It is not due to any abnormal state of the saliva or fluids of the mouth, as many teach. Nor is it due to a

combination of these conditions. It is not due to acids set free by fermentation of carbo-hydrates in the mouth, or to acids secreted by and set free in the neighbourhood of the enamel by acid forming ~~microbes~~ micro-organisms. Certain fluids or menstrua may either favour or retard the incidence of caries, or may even arrest caries. Iron salts may, rightly or wrongly, have the reputation of favouring caries, but these salts or any ~~other~~ acids do not excite caries, for if they did, their action would be more general and would not be so confined and partial as the direct attack of the cario-genic micro-organism makes it. Previous theories have all failed to explain why the incidence of dental caries is, to begin with, confined to such a minute and definite a space as it is.

After infection has taken place, dental caries is a slowly progressive bio-chemical or bio-molecular disentegration of the calcium-phosphates of the tooth, beginning on the exposed surface of the enamel, which the acid-bearing micro-organism attacks from without, and which it dissolves and feeds upon, and peretrating the enamel ~~in a certain~~ to the of which little attention has been paid manner, it then attacks the dentine in a characteristic way, which has been repeatedly elaborately described, and unless stopped by surgical interference or by natural arrest, invades and destroys the whole of the hard tissues of the tooth.

The efficient cause of dental caries is thus a specific calceo-phosphatophile or calceo-phosphate-loving, acid-bearing micro-organism, and is therefore a specific, parasitic, infectious disease. The

surface of the microbe is permeated by an acid, by means of which it becomes parasitic on the salts of the tooth which it itself dissolves and assimilates, just as osteoclasts dissolve and assimilate the salts of bone. It is the salts not the organic matter of the tooth that attract the microbes. It is a specific disease, for if there are more than one species of micro-organism habitually present, the others are symbiotic, and are not co-efficient factors in the solution of the salts of the tooth. All the p phenomena of dental caries militates against the present accepted doctrine that there are more than one cario-genic micro-organism, concerned in the process.

CLASSIFICATION OF DENTAL CARIES.

An analysis of the intermitting or abnormally varying forces - the exciting causes - renders dental caries divisible into four definitive, almost perfectly mutually exclusive groups. The situations or the points on the surface of the tooth at which these various forces manifest the result of their action are also different;- and so different, that these four groups are also in respect of their sites on the enamel, easily distinguishable by simple observation.

The four groups of carious cavities are:-

(1). Cavities due to mal-mastication, that is, to a variation from more to less expenditure of energy in mastication, which for brevity may be called masticatory cavities. Mal-mastication exposes to infection, and gives rise to cavities at certain points between the teeth, (a) interstitial cavities,

and to cavities at certain points in pits and fissures within the masticatory area of the teeth ; (b) pit and fissure cavities. All interstitial and all pit and fissure cavities, and none else, are masticatory cavities. These form the great majority of all dental cavities. They never occur except by the variation in mastication just defined, and they never occur outwith the normal masticatory area. They are confined to certain points or nodes on the margin of the masticatory area of the tooth, to be immediately defined. Mastication determines absolutely the incidence of these two sub-classes of cavities, that is, cavities in the masticatory sphere. As the morphological and dynamical conditions that give rise to interstitial and pit and fissure cavities, are very similar, these two sub-groups occur with about equal frequency;- that is, a cavity is as likely to occur in a pit or fissure as it is likely to occur interstitially between two teeth. Interstitial cavities never occur when teeth become spaced, and pit and fissure cavities never occur when the antagonistic tooth is lost, nor is the interstitial masticatory node liable to infection if the opposite impacting tooth is lost. An isolated tooth which has lost its antagonists never becomes the subject of masticatory caries and will not decay if left alone, but appears to elongate from want of an antagonist.

(2) Cavities due to mal-brushing or mal-clensing of the teeth. These cavities for brevity, may be called brushers cavities. They

are caused by the brush removing the mucoid film from certain areas of the enamel in the non-masticatory area, over which the ~~ttth~~tooth brush habitually passes, and leaving them bare and exposed to infection. If the brushing is intermitted for a sufficient time for the ~~c~~ario-genic microbe to settle and germinate, caries occurs or tends to occur. If brushing is sufficient to completely disturb and remove the mucoid film which covers the tooth on the non-masticatory area, and is not persisted in regularly enough, then caries may supervene. The position of these cavities is to some extent, more or less, influenced by mastication. On that account they are usually situated quite near to the gum margin on the labial or buccal aspect of the teeth, as that is the side of the tooth to which the tooth brush is usually vigorously applied. If a curved line be drawn on the labio-buccal aspect of the tooth from one interstitial point of contact or masticatory node to the next, festoon fashion, sub-parallel to and a little way from the gum margin, a line is described in which, or in the vicinity of which, cavities caused by the tooth brush originate. It is just about the middle of the festoon and where the tooth is prominent, that caries of this type tends first to make its appearance. The shape of these cavitis is typically semilunar. The lower front teeth, the teeth otherwise freest from caries, frequently exhibit brushers cavities, and notably the lower canines, otherwise the teeth the freest ~~from~~ of all from caries, perhaps most frequently exhibit brushers cavities. Thus it happens that all labio-buccal cavities or gingival cavities are due to brushing.

CLASSIFICATION OF DENTAL CARIES.

Consequently, when one or more of these cavities are present, one can always predict with certainty, that the patient has for some considerable time used the brush, albeit irregularly, to the teeth. Even when I have found buccal cavities on the buccal aspect of wisdom teeth, enquiry has always proved that they had been the subject of brushing. Brushing neither prevents or causes caries. Brushing does no good to the teeth in preventing decay. It only improves the appearance of the teeth. Should brushing be persisted in, it should be confined to the teeth that are visible. The fingers and tooth picks are equally efficient, and in some respects are more so, in respect of improving the appearance of the teeth than the tooth brush, and are free from the dangers of the tooth brush. The improvement in the appearance of the teeth got by by the tooth brush, is got not only at the risk of causing brushers cavities, but also at the risk of both dental erosion, should a gritty powder be used, and at the risk of microbic infection of the gum, either by auto-infection or otherwise. Brushing is the most frequent cause of peridental infections and perhaps the exclusive cause of infective pyorrhoea, which disease, next to masticatory caries, has puzzled dentists most.

It is true that while brushing has properly been absolutely condemned by a very few dentists, and has by others, under certain circumstances been held to cause carious cavities, it has been condemned accidentally or inadvertantly, for the rationale of brushers cavities in both cases, as explained by them, has been ill conceived and erroneously stated or defined.

(3) Cavities due to the use and retention of dental

apparatus in the mouth. When these occur, they are observable where such apparatus come into contact with the teeth, especially where catches and clasps are situated. By their friction, the enamel is laid bare and the microbe, gaining direct contact with the enamel, and being undisturbes for a sufficient time, forms a nidus of decay. This group of cavities has also by some authors been associated with caries, but in an erroneous manner, as to its proper exciting cause. The defective manner in which dental apparatus are habitually made, especially by the exponents of modern thought, is itself an elegant proof of the prevalent ignorance of the origin of caries from this source. These cavities frequently simulate brushing cavities, but by inspection they can usually be readily distinguished from one another.

(4) Cavities due to any other force or combination of forces falling on points of the teeth other than those above enumerated, that might lay bare the enamel and afford the microbe, after being brought into direct contact with the enamel of teeth, sufficient time to germinate and form a colony on the enamel, and thus a carious cavity. As these condition are rare, this class of cavity is also rare.

MASTICATORY AND NON-MASTICATORY AREAS.

The mechanism of the incidence of the group of cavities due to mal-mastication, the commonest variety- the intimate nature of which,

hitherto, has been the most obscure, by assuming and postulating the following anatomical and physiological characteristics, hitherto overlooked and undescribed, but common to all heterodont mammalian teeth, may the more readily be understood. Generally speaking, the exposed portion of such teeth differs from the exposed portion of ~~homodont mammalian teeth, and the exposed portion of~~ homodont or the conical tooth of the lower groups of vertebrates, in that the so called crown of the heterodont mammalian ~~teeth~~ tooth is divisible into a masticatory and a non-masticatory area, whereas the conical shaped tooth is not so divisible. The evolution of the heterodont mammalian tooth from the lower vertrbrate tooth- the reptilian tooth- as well as the comparative anatomy of these teeth, shows that this is a well founded and correct description of the higher mammalian tooth. The masticatory area which corresponds roughly to what is sometimes called the articular or occlusal surface in surgical dentistry, is that portion of the crown raised some distance from the gums upon which the forces of mastication are expended in breaking up solid food, before swallowing. The mastiactory area is thus exposed to ~~infection~~ the friction of the food and the impacts of the opposing teeth upon themselves, ~~of the upper and lower jaws~~. The non-masticatory area is that portion of the tooth bwtween the raised or masticatory area and the gum margin, by the intervention of which, between the masticatory area and the gums, the softer gums are thus effectively protected from the brunt of the forces

of mastication. The masticatory area of the bicuspid or molar teeth normally have pits and fissures, and if these are of such a depth that the deeper moiety is not disturbed by mastication, then small additional insular non-masticatory areas exist on those teeth.

Because of the movements of the jaws and the forces brought to play on the teeth while eating, the masticatory and non-masticatory areas are obviously exposed to two quite different sets of conditions. The one area is disturbed at regular intervals by mastication, by food coming constantly in contact with it which prevents the micro-organism of decay from lodging on the exposed enamel; the other area being relatively undisturbed, becomes coated by a persistent mucoid film which the cario-genic microbe does not or cannot penetrate. Both areas are thus naturally kept free from caries, but obviously from quite different causes.

These anatomical and physiological features of the heterodont mammalian teeth have never hitherto been scientifically considered and described. They may have had a certain implicit, but never an explicit recognition. But the distinction of a masticatory and a non-masticatory area in the crown of the tooth, has a pathological significance also, apart from which the incidence of this disease on the teeth cannot be readily understood. In fact it was the difficulty in making the inciting cause of dental caries easily understood that lead to the discovery that the accepted anatomical description of the mammalian heterodont tooth was defective.

MASTICATORY AND NON-MASTICATORY AREAS and nodes

Masticatory caries always occurs at certain points in the line that demarcates the masticatory and the non-masticatory area. That may be a curious and astounding statement, but it is ~~a fact~~ true. These points are either between the teeth where contiguous teeth touch one another, and form what may be called a masticatory node, as that is where the line of demarcation between these areas in one tooth meets the ~~line~~ corresponding line in another contiguous tooth, or in the case of pits or fissures, if these be deep enough on the line between the two areas where the fissure emerges from the non-masticatory island area, forming pit and fissure masticatory nodes. When masticatory caries occurs, it always and only occurs at these masticatory nodes, because it is at these nodes or points where, when there is a variation in the forces of mastication, the variation is most marked. When the variation in mastication is from the expenditure of ~~from~~ more to less energy, at these nodes, small areas that were in the masticatory area, and habitually disturbed, cease to be in the masticatory area and become undisturbed. At these points and at these times, the enamel becomes liable to the direct contact of the cario-genic microbe where it may germinate and infect the enamel. This pathological phenomenon seems never to have been thought of before, but it is quite self evident whenever it is properly understood.

The infection takes place in the focus of rest on the masticatory side of the node but spreads chiefly to the non-masticatory side

In regard to interstitial cavities, portions of the surfaces of

of the teeth converge to the points where the contiguous teeth touch or knuckle against one another, which are obviously also intersected by the line between the masticatory and non-masticatory area:- That is to the masticatory node above referred to. So it happens, that food, in eating, instead of simply shearing off the masticatory area, as it does elsewhere, tends to be wedged or impacted towards these nodes, where it becomes diverted towards the tongue or lips and cheeks. This wedging or impacting of the food interstitially, is intensified and subsequent divertion facilitated rather than otherwise by the fact that a cusp of the teeth or the opposing jaw normally articulates into the valley formed by the converging planes in question. The forces of mastication are thus concentrated where the teeth knuckle against one another, that is, at the points of contact or masticatory nodes. My contention is, that a small area just slightly towards the direction of the masticatory forces, becomed undisturbed by these forces if they are lessened, and the small area is therefore transferred from the masticatory to the non-masticatory area, and an opportunity is given to the cario-genic micro-organism to come into contact with the enamel and germinate.

Again in regard to pit and fissure cavities, in the masticatory area of the teeth, a similar set of conditions exist. Certain surfaces converge towards the pit or fissure and the food tends to be impacted into the valleys th us formed. Cusps on the teeth of the opposite jaw also normally articulate into these pits or fissures. Food likewise

micro-organism is a phosphate loving one. Leber and

here also tends to become impacted and the forces of mastication intensified. If the pit or fissure be shallow and is constantly disturbed, there will be no masticatory node. But if the pit or fissure be be as deep as or beyond the masticatory disturbed area, variation from more to less force in eating makes a part of the pit or fissure sometimes disturbed, at a masticatory node, and infection may take place.

Hence it follows that if there is a ~~force in the variation of~~ in the force of mastication, the amount of variation will be greatest where the forces are most concentrated, and it will be there where first an area that was once in the masticatory area, will cease to be in the masticatroy area, and it is during this change at these points or masticatory nodes that infection takes place, and carious cavities are afterwards formed.

GENERAL FEATURES OF MASTICATORY CARIES.

Although interstitial and crown and fissure cavities are apparently substantially different and have been considered so by many writers, it is thus obvious that their pathology is fundamentally the same. The interstitial contact of contiguous teeth and the crown pits and fissures, at any rate in bicuspids and molars, are certainly normal morphological features of the teeth. Therefore this disease is not due to defects in the teeth themselves, but essentially to a defect in the use to which they have been put, that is, to an error in mastication. But even where there are morphological defects in the teeth, these defects do not tend to, or

morphological defects which act concomitantly with a variation in mastication. In mouths where there is no caries, it is because there has been no variation in mastication, or any variation there may have been, has been within normal limits. When a child is free from caries, it is so by accident, so far as it is concerned not by good guiding:- it is because in eating, any variation in the force of mastication has not exceeded the normal limits. It is from this cause, and this cause only, that ~~they are~~ it is free from caries. As this law has not hereto fore been thought out, the freedom from caries of any child has been brought about unwittingly by the parents, although they may have thought otherwise. Even those who now assert that the precautions ~~that~~ they may have taken are the cause of their success, are mistaken, if they think they have acted by reason, for their action has merely conformed by accident to a law that they were unaware of, and they have been only empirically right. They were no more cognisant of the real reason of their apparant success, than the children themselves were, or as a wild animal is conscious why its young are free from this disease, which happily for ~~them they are~~ themselves they always are. Man, when he acts rightly, more frequently falls upon the right mode of action instinctively or empirically, than does he acts rightly consciously, because he has revealed intelligently to himself a law of nature. Except in that it has been vaguely surmised, or in a wrong manner asserted, that dental caries is in some way related to some error in the nature of food and mastication, there has been no allusion to the proper exciting cause

micro-organism is a phosphate loving one. Leber and

of caries. The exact nature of the error in mastication has not been correctly defined. The crucial point is, to clearly describe the antecedents that lead up to the incidence of dental caries and to determine how, by having control of these, the disease can be minimised or prevented.

IMMEDIATE PREDISPOSING CAUSES.

~~(1) Variations in the physical qualities of food~~. Anything that will bring about a change from more to less energetic mastication will predispose to caries. There are two chief causes which excite irregular mastication and which predispose to caries. (1) Variations in the physical qualities of the food. The physical qualities of the food should be in conformity with the morphology of the teeth. Because so many possible variations in the physical nature of food they pertain to him, civilised man is more liable to eat food that is unconformable with the morphology of the teeth, that makes him specially liable to caries than uncivilised man and domesticated and wild animals. ~~The first cause is that~~ He has more food at his disposal, and more control over its production and preparation, and consequently more opportunity of falling into errors in carrying out these functions from time to time. In consequence of this, he is more liable to indulge in a change of food from more consistence or firmness or hardness, to foods that are deficient in those properties. Hence a change from more to less energetic mastication. This is usually the cause of the first attack of caries among the teeth, and the chief cause at first or least of caries of the temporary teeth. This is also why an illness is often accompanied by an onset or increase of this disease, because when a man is ill he is erroneously put on soft food. Similarly, women, during pregnancy, notoriously fastidious, verging on hypocohndria concerning their feeding, resort to soft and sloppy food. It must be remembered that human food, if constantly so given, may be

relatively soft and need little mastication and yet cause no caries, as is proved by the fact that frequently in adults we find perfect sets of teeth that show very little wear from eating- the trident appearance of the newly irrupted incisors persisting and being still visible and the cusps in the molar region unworn. Conversely, a ~~very~~ few very much worn teeth themselves showing carious cavities, are found in other mouths where the rest have been lost primarily from the effect of carious infection. It is in varying the consistency of food, not that it is merely soft or hard, in which the danger lies. Again during the period in which the temporary teeth are functional, the medical treatment of children's diseases is habitually accompanied with directions ordering a change from ordinary to sloppy food, as if this should constitute part of the treatment of disease at this or at any other time. Thorough mastication lightens the task of digestion by the insalivation of food, and is therefore indicated in digestive disorders. Even although the patient may be resting in bed, this is no reason why mastication and insalivation should be in abeyance, especially if the nutrition of the body is one of the objects aimed at. But if soft foods be exhibited there is always the danger of an inadvertent return to food co-ordinate with the actual morphology of the tooth, and hence the teeth when exhibited constantly softer than the morphology indicates.

(2) The second cause of a change from more to less energy expended in mastication, is diseases of the teeth themselves, and the

peridental structures or any irritation or discomfort in the mouth that interferes with mastication. Tenderness or pain in a tooth causes mastication to be performed by teeth furthest away from it. This renders those near the affected tooth liable to attack. Then again, when an affected tooth ceases from troubling, mastication becomes less energetic on the ertswhile overtaxed teeth. This accounts for, and is the real cause of asymmetrical decay, which other theories of caries have failed to explain. Pain in the mouth obviously may influence location of mastication among the teeth, and is thus the only factor of dental decay that can be imagined to make the forces that fall on the teeth act asymmetrically. Pain or discomfort in the teeth ~~and in the mouth~~ although ~~predisposing~~ subsequent to the other predisposing causes, in all likelihood the predisposing cause of the greatest number of masticatory dental cavities, and is the predisposing cause which has been most entirely overlooked. Hence, if the mouth is freed of pain, and the food is maintained at a constant consistency, it will immediately become hygienic. The first step therefore, in dental treatment is to relieve and get rid of pain, and so far as man's peridental apparatus is ~~cons~~ concerned, luckily dental science is so equipped, that this can be done with certainty. The second step is to instruct the patient to have his food cooked in such a manner that it will require the normal amount of mastication to break it up, and make it fit for swallowing, and if he is in the habit of bolting his food, to consciously take time to chew it.

SPECIFIC NATURE OF DENTAL CARIES.

If caries is due to a single organism, this doctrine is very different from the presently accepted one that many organisms are concerned in dental decay. If there are more than one microbe, there should be a corresponding number of kinds of caries. The whole phenomena of caries points to the conclusion that it is a disease due to a single species of microbe, and is therefore a specific disease. It only occurs where there is a direct clinical evidence that the enamel where the lesion takes place has been laid bare by some definitive force which may intermit its action for a time sufficient for the microbe lighting on the bare enamel to lodge and germinate. It is extremely improbable that several microbes of different species would occupy the same habitat and be able to take advantage of such exceptional conditions in such a highly specialised structure as the tooth. There is no other microbic disease where the mode of attack is highly specialised, that is due to a number of species of organisms. When the microbe penetrates the enamel, and reaches the dentinal tubes, it does so in a well defined manner. The micro-photographs of the microbes in the dentinal tubules do not warrant the conclusion that there are a number of species concerned. They are short rods of varying length and of about the diameter of the tubes which they infest; but the variation in form exhibited by these micro-organisms is not outwith the amount of variation that a single microbe might be expected to present. There is no conclusive evidence that there is more than one species of microbe, and the notion merely exists because several micro-organisms in the mouth produce acidity of the mouth and everything

that contributed to the acidity of the mouth has been held to produce caries. Whether true or not, Miller determined that the acid secreted by the microbe was lactic acid. This finding has not been seriously questioned, and as a substantive fact has been generally accepted. In any case it is unlikely a number of species of competing organisms would secrete the same acid.

SPECIFIC ORGANISM.

Caries is at present habitually represented as being due ao acid fermentation occasioned by any micro-organismthat by the decomposition of carbo-hydrates produces free acid in the mouth in the neighbourhood of the teeth. From the preceding discourse however, it may readily have been gathered, that the actual mode of attack has a definite same-ness wherever it occurs, and is due to one kind or micro-organism acting at confined foci and not to many kinds of arganisms in lodgement areas. The phases that the ~~diduse-~~ disease goes through arter infection are in all cases virtually the same, except when caries becomes arrested, but the arrest of caries is always a manifestation that we should expect of a special microbe, that by its own nature, may under certain circumstances, die out, or become auto-toxic. Arrest of caries is a proof as will be shown, that mastication in the vicinity or the cavity has reached an activity incompatible with the life or the micro-organism. Therapeutically, arrest of caries might be induced by introducing an anti-toxine into the cavity, which indeed may be shown to be true, but apart from sterilising a cavity, after preparation for filling, this mode of causing arrest has not yet been studied or advocated, and consequently it has not been brought into vogue. This method of arresting decay ought however, to be practiced, especially in the case of temporary teeth, where a tedious process of restoration may be an inadequate compensation for the strain that the child would have to undergo in otherwise treating the tooth.

The next point of our definition that requires discussion, and in which I am at as lively variance with the opinions of others, as I am in regard to the incidence and specific nature of caries, is in that the

believed that the enamel was more or less directly attacked by the micro-organism, but that the solution of the enamel was due to acid secretion and accidental to, or incidental to the presence of the micro-organism. They were however, inadvertently right in thinking that there was only one micro-organism essentially concerned in caries. Leon Williams more recently also believes in the more or less direct application of the micro-organisms to the enamel, but the felt-like masses described by him, do not appear to contain the true micro-organism of caries, any more than those described by Leber and Rottenstine. They exist where no caries supervenes. His description of an in-lying bicuspid extracted for prosthetic purposes, ~~which was~~ coated by this felt-like mass of micro-organisms, shows that he at least, as I will further demonstrate, has not the slightest suspicion as to the nature of the incidence of caries as I understand it. The caries of the bicuspid alluded to is doubtful, as it has no external lesion. "There was no actual breaking down of tissue on the surface."(Sewill).

But the authors who have advocated the chemico-parasitic theory and who have written in the period dating from Leber and Rottenstine till the present time, have held that the acid is formed by many species of micro-organisms, which have the power of decomposing carbo-hydrates and forming free acid, which acts on the enamel and destroys it. The destruction of the enamel thus paves the way for their further ~~progress~~ ingress, and when they reach the dentine, the micro-~~organi~~

organisms ~~that~~ are apparantlymore at home,that is their capacity for tooth destruction becomes ~~mor~~ increased. None of these writers,perhaps no investigator,has hitherto held the doctrine that the microbe of dental caries is a phosphate-loving one. The simple botanical truth does not ~~ever~~ seem to have occurred to any of them that the enamel is wholly made up of plant food,containing phosphates of calcium,magnesium and potassium:- essential or valuable mineral plant foods. Miller calls his doctrine the "chemico-parasitic theory of caries",but as he uses the phrase,it is a misnomer,because he describes the micro-organism as existing wholly on the carbo-hydrates of the mouth,not on the phosphatic salts of which the teeth are composed. Miller's micro-organisms are really symbiotic with ~~the~~ man,sharing man's carbo-hydrate food. These writers also either implicitly or explicitly deny that the microbes attack or have the power to attack the enamel directly. Black,apprehending the possibility of the enamel being directly attacked by micro-organisms,~~and~~ specifically argues against it. As he refers to a certain experiment by Sachs,he presumably was was aware of the reason for adducing the doctrine that the dental microbes might be parasitic on the ~~teet~~ salts of the teeth. In describing the ~~proce~~ processby which plants obtain non-soluable salts from the earth,Sachs makes the following observations,which Black,in "The American System of Dentistry" actually epitomises and enlarges upon. "These food materials," says Sachs",can only be taken up at the points of contact of the hair roots with these particles;and they are there rendered soluable by the carbon dioxide exhaled by the

the roots. This action of the root is limited to the points of contact; only those particles of substance which come directly in contact with the root hairs are dissolved. The root system comes gradually into contact with innumerable particles of earth, and can thus take up the necessary quantity of the substance in question. This power of the roots of taking up by means of the acid sap which permeates the walls of even their superficial cells, substances which are insoluble in water, presents itself in an extremely evident manner, as I was the first to show, when polished plates of ~~mab~~ marble, dolomite or ostoolite(calcium phosphate) are covered with sand to the depth of a few inches, and seeds are then sewn in the sand. The roots which strike downwards soon meet the polished surface of the mineral, and grow up and in close contact with it. After a few days an impression of the root-system is found corroded in rough lines on the smooth surface; every root has dissolved at the ppints of contact a small portion of the mineral by means of the acid water which permeates its outer cell walls." Sachs, further, defines and characterises the physiological features of parasitism as follows:- " The absorbing roots of parasites penetrate into the tissue of the host, and often grow into it in the most intimate manner. It is certain that the exciting cause of the transport of the products of assimilation from the host to the parasite, resides in the latter; the parasite acts on the conduct in masses of tissue of the host like a growing bud of the host itself; the food materials penetrate into it because it consumes and

changes them." This description of parasitism exactly corresponds to the manner in which the cariogenic microorganism infests and transforms the phosphates of the dentine.

In spite of being fully aware of the fore-going biological principles, especially the discovery of Sachs referred to, which profoundly modified the whole of agricultural science, for it was thought before this time, that only mineral substances in solution were available for plant food. Black proceeds and makes the following statement:- "It has been held by most of those who have written on this subject, that the fungus is incapable of attacking enamel. If by the term "attack" is meant an invasion or growth of the fungus into the substance of the enamel, this view is correct. No signs of the fungus are to be found in the enamel, until after it has become so far disorganised that its chrystals are loosened and begin to fall apart. Except that of localisation, and in some instances discoloration, the softening of the enamel in the first stages of caries presents no other phenomena than those produced on that substance by acid action out of the mouth." The last two sentences of the quotation are logically weak. First, the fungus could not easily be conceived as making any progress in its invasion of the enamel unless the chrystals had begun to loosen and fall apart, and secondly, it is the constant special localisation of the softened parts of the enamel that proves the existence of an agency., viz. the microbe that controls and prevents the immediate diffusion of the acid other than the action of free acid secreted by the microbes, and which permeates their surfaces just as the surface of the root hairs are permeated by an acid.

The dental micro-organism attacks the enamel just as the

the rootlets do solid rocks, their action virtually being limited to the points of contact. They do not spread widely over the enamel, that would be inimical to their existence, but being, so to speak, virulently parasitic, they penetrate the enamel more or less perpendicularly, from the point of infection forming a small tube-like hole, as is proved by the manner in which a cavity, which has just begun to form, grows and which a sharply pointed steel probe penetrating the cavity, is said to bite. This sensation of biting is familiar to every dentist, and by most writers it is alluded to as a stumbling block, and justly so, to the contention that free acids initiate decay on the enamel. After all, the literature and more especially the research upon caries of the enamel, has been of the meagrest possible description, viz., the invasion of the enamel that is the crucial one as determining the nature of the incidence of this disease. Having ignored or slurred the problem of the incidence of caries on the enamel, these writers have described and figured their observations on caries of the dentine with undue minuteness, which however true, is secondary in importance to the mode of attack on the enamel. If it is not for the sake of the calcium-phosphates, why do these micro-organisms penetrate the enamel and infect the dentine tubules? If it is not for the sake of these salts, caries is a gratuitous and purposeless destruction of the salts of the tooth, a phenomonen that is at least extremely difficult, perhaps impossible to parallel in organic nature, but if they attack the tooth for the sake of the salts the reason of their attack is easily intelligible.

The contention that the teeth are directly attacked by the microbe is favoured by another phenomenon even more familiar to physician and dentist that the direct absorption of insoluble salts by the roots of plants, a phenomenon which process may be observed in the teeth themselves, namely the process of absorption especially in the roots of the temporary teeth when they are being shed. The process of decalcification not only of bone, but also of dentine, cementum, and occasionally even of enamel, is a normal physiological process. The shedding of the temporary teeth is due to decalcification. The active agents in this process are called osteoclasts. Like the cells of the growing terminals of the rootlets of a plant, the surface of their bodies is penetrated permeated with an acid which enables them to assimilate the phosphates of the bone structure which they attack. Decalcification is the converse of calcification, and in all probability the same cell at one time can form, and at another time can destroy bone. There is, however, no question of the decomposition of a third foreign body like carbo-hydrates, to supply the acids that carry on the process of decalcification. The osteoclast is in intimate relation with the root of the tooth for the purpose of absorbing the phosphates, otherwise it derives its nourishment from the blood. It is for the time being a parasite on phosphates of the bone. The invasion of the tooth substance by the cario-genic micro-organism proves that it is also parasitic on the phosphates of the tooth. If it merely existed on the carbohydrates of the mouth, it would follow where no

most carbo-hydrates were, not where there was none. The osteo-clast derives its nourishment from the blood, but for the time being it secrets acid which enables it to assimilate the phosphates and return them to the blood. The cario-genic micro-organism may get its organic requirements from carbo-hydrate substances in the mouth, but it would not attack the enamel, and subsequently the dentine, nor would it invade the organic matter of which is proteid in nature, and according to hypothesis, useless, unless the phosphates constituted the inorganic moiety of its food.

Let us compare the definition of caries that we have now made, with the following one:- " The variable condition or antecedent, which when present, caries inevitably follows, and which when absent, caries cannot take place, must be more fully noted. This antecedent or condition is the undue logement or stagnation of fermentable carbo-hydrates in ~~the undue~~ more or less immediate contact with the teeth and undisturbed by the free access of saliva." This definition of the incidence of caries is substantially the outcome, and in harmony with the conventional teaching of the nature of caries, and may be taken as representing its latest development. The ~~general~~ objection to the theory of the free formation of acid, is, that free acid is never present in the mouth in sufficient quantities and strenght to dissolve enamel. The acids of caries are so weak that they are imperceptible to the tongue, although the tongue can easily and readily taste acids. The tongue, insensible to a microbe

whose surface applied to the enamel and permeated by acid was able to attack the enamel directly would ~~not~~ be sensible to free acid sufficient in quantity and strengthh to affect the enamel. "caries susceptables" never complain of acid taste in the mouth. Again cavities would certainly occur, more constantly than they do, in contiguous pairs, if they were due to free acid generated near the points of contact, and a tooth ~~would not permanently escape~~ would not permanently escape with an acid producing cavity opposing it as frequently happens. Whereas, if there is a direct microbic infection, there is a greater ~~cahn~~- chance of one tooth being affected interstitiall and its neighbour escaping permanently if once it does escape.

Just beneath the points of contact, of the first six upper and lower teeth, there is a pyramidal space between the teeth which never shows primary caries. Many of the micro-organisms of the mouth are habitually lodged here, and food also lodges here, but no caries takes place. Not only is there interstitially a small pyramidal space, but in these teeth, there is a marked depression, sometimes actually a pit, at the vortex of the V shaped ridge that forms the free edge of enamel at the neck of the tooth, where if the theory of food lodgeability were correct, caries should habitually occur. No one has recorded caries originating in directly beneath the points of contact and this normal depression, displayed on both sides of the twelve front teeth, simply because it is outwith the masticatory areas. These depressions exist there as if they were sent by divine fore-thought, to show that caries was not due to the fermentation of carbo-hydrates "in more or less immediate contact with the teeth and undisturbed by the free access os saliva."

It is difficult to imagine, if we were not aware, that any superstition is capable of becoming an unalterable conviction, that anyone would believe that decomposition of carbo-hydrates by fermentation would take place in the fissures and pits on the crowns of molars and bicuspids, where masticatory activity is so incomparably greater than in the interstitial spaces and depressions just referred to, and in the sulci between the teeth and gums, surfaces in the non-masticatory area, and that caries should originate in the former and not in the latter. A very moderate estimate of the number of bites taken at a single meal, is ~~3999-1999~~ one thousand closures of the mouth. That happening three times daily would surely prevent the generation of acid in ~~the~~ a crown pits and fissures where acid would be readily diffusible, in a sufficient quantity and concentration to dissolve enamel.

PREVENTION OF CARIES.

If caries is due to a variation in the forces of mastication, and the microbe germinates at nodes in the margin of the masticatory surface of th the enamel exposed to infection, it follows, that it is the physical qualities of the food, i.e. its general consistency and not its chemical composition that ~~has~~ is chiefly concerned in the prevention of caries. Food should be prepared so that its physical properties induce a proper agreeable amount of mastication conformable to the structure of the human teeth, for its proper breaking up and insalivation. Although insalivation is concerned in the chemical changes necessary to digestion that the food will

subsequently undergo, it is not concerned in decay. It has nothing to do with the breaking up of the food except moistening it, as a masticatory act. Insalivation has certainly nothing to do with caries, except in so far as the food, incidentally and concommitantly becomes intimately mixed with this digestive fluid.

The qualities of food that best induce mastication, are a certain consistence combined with a certain friability or crispness, to which may be added the flavour or taste which conduces to the prolongation of food in the mouth. Food of any kind if it is properly prepared as to consistency, does not lead to caries. In fact, the ultimate test of properly cooked solids is that they should excite a certain normal amount of mastication. Provided the food is palatable, the chemical composition has got to do neither with the incidence nor with the arrest of caries. Carminatives and condiments only tend to the preservation of the teeth, in so far as they tend to excite a constant normal amount of mastication. Food should be prepared so that its physical ~~qualities~~ properties induce an agreeable amount of mastication for its proper breaking up and insalivation, and so long as hunger does not lead to bolting, hunger is perhaps still the best condiment. Tough and fibrous foods are by implication unsuited for human teeth. It is the preparing of food of a certain crispness and friability that

that constitues the function of the cook,and this will be the main objective of thode,who in the future,will rationally solve the practical problem of the prevention of caries. Those who care to investigate thia matter on these lines,will find that caries has been prevented only when this principle has been adhered to,and they will find also,that caries does not appear in other places after this principle has been adppted,if the mouth is free from discomfort.

It may be said that nearly all advertised foods,especially those in medical journals,are foods incomformable to the morphology of the teeth,and being widely prescribed by physicians who are ill informed or ignorant of the cause of dental caries.,they are perhaps the most general specific cause of modern caries. In this sorry system of child-feeding,we have education of mothers by physicians in the wake of science of perniciously prepared preparatory foods.

Many foods are spoiled in the making. It does not militate against the interests of those who are concerned in the preparing of food to confer on it that consistency that will make it shear off the masticatory area in a constant manner after a definite amount of mastication,conformable to the morphology of the teeth,has been spent on it.It is because the amount of mastication conformable to the morphology of their teeth,keeps the shearing line constant for each species in the lower animals,that caries does not exist among them. All sorts of food are consumed by them,but each species has its own kind of food,as well asi its own type of teeth. Some are almost constantly eating,some devour their food in quite a short time. But in the teeth of all

animals there is a constant masticatroy on shearing line. Man is an omniverous animal, and he prepares his food. The test of the preparation of the food or of cookery, is, how well the prepared food conforms to the principles here laid down. There have always been those who vaguely perceived that health if not specially the health of the teeth, was in some way connected with mastication, but it is questionable if the exact way in which it acted as regards the teeth was ever heretofore definitely grasped. It is foreshadowed in the following extract from Marcus Aurelius." We ought to observe also that even the things which follow after the things which are produced according to nature, contain something pleasing and attractive. For instance, when bread is baked, some parts are split at the surface, and these parts which thus open, and have a certain fashion contrary to the purpose of the baker's art, are beautiful in manner, and in a peculiar way excites a desire for eating." These sentiments point to eating conducing to the health of the body, and we may add to the teeth. The crust of the bread should be eaten, but it should be eaten constantly of every day.

Now let us test ou r principles by some well established practices in the culinary art. Flesh meat is kept to mature several days, because it would be tough and fibrous if it were used sooner. Fish on the other hand, cannot be used too soon. Fish breaks into pieces if cooked when taken fresh, and becomes tough and fibrous by keeping. Game is kept longer than even the flesh of the ox, for a

similar reason,and so on for all animal diets. They are suitable for human foods when they cease to be fibrous,but have not started to ~~decomp~~ decompose,i.e.they are in a friable condition. The same test is applicable to all baked meats. Rice is easily marked or marred by cooking. Solid fruits and nuts are tested as to their edibility by their friability,and so on to the end of the list of solid foods. It is not the sequence of the dishes in the meal that is of importance, it is the constancy of the consistency of an appropriate amount of solids at each meal,so that the masticatroy area will be regularly and constantly disturbed by being exercised at each meal up to its proper functional activity,so that the masticatroy area is regularly and constantly disturbed.

THE ART OF COOKERY IN RELATION TO THE TEETH.

The art of cookery,so far as it relates to the preservation of the teeth, has only to do with the physical qualities of the solid food. It consists in preparing food in such a manner,that it becomes friable and crisp,or so that it will have a certain frimness and consistency,which,while it makes it inimical to immediate swallowing will excite a sufficient and

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THE RELATIVE LIABILITY TO CARIES OF THE DIFFERENT TEETH.

Many writers on dental caries have studied the teeth both individually and in groups, in regard to their liability to decay, in the hope of throwing light on the cause of this disease. The teeth, of course, vary remarkably in this respect and any combination of decayed teeth may be found. One evening in the Glasgow Dental Hospital, a patient with every tooth perfect except the upper left canine, presented himself, and the next patient but one, had these conditions exactly reversed. I have brought up, ostensibly, under exactly the same conditions seen two sisters, one with a perfect set of teeth, the other with every tooth decayed or lost through decay. The first permanent molars are the most liable, and the six or eight lower anterior permanent teeth are the least likely to decay. The relative liability of the front ~~teeth~~ and back teeth varies greatly in different mouths, and sometimes decay is symmetrical and sometimes asymetrical. The explanations which have been advanced to account for the apparent vagaries of the incidence of disease on human teeth are very open to adverse criticism, and they have not thrown light on what they were expected to explain.

It has long been recognised that to a great extent the incidence of decay was symetrical, but that asymetrical decay was also common. It is not easy to see how ~~thes-e-fat~~ these facts could be explained, if the disease were caused by substances acting in the mouth in a general way, such as, some pervertion of the saliva, the chemical composition of the food, or any changes residual food might undergo owing to its lodgeability, such as acid fermentation or liberation of free acids. These conditions would lead to symmetrical decay which we should such happen.

should expect might simulate such markings as we recognise in hypoplastic teeth which are due to certain systematic disturbances during the calcification of the teeth. That such conditions do not explain asymmetrical decay is another obvious defect of the various existing theories of caries.

Confining our attention to interstitial and pit and fissure cavities, we have contended that these cavities are due to irregular mastication, and that irregular mastication is brought about by two chief causes, namely, defects in the physical qualities of the food, and pain in the teeth or in the mouth, or secondarily, to want of care in fully chewing the food. So long as it is merely the consistency of the food that is leading to variations in the quantity and quality of the mastication that it gets, the incidence is general and symmetrical, but immediately the variation is due to pain in the mouth, the food will be diverted as far as possible from the seat of the pain., which is bound to cause asymmetrical mastication and hence asymmetrical decay. We have thus in the mouth an agent that can act symmetrically and also asymmetrically, and are prepared to analyse and explain how the variations in the liability of the teeth in any mouth may come about.

Luckily for the dentist, the teeth in man do not begin to irrupt until about the sixth month, and it is usually very much after that time before he is brought into contact with the teeth, hence he is deprived of the material for observing the progress of events regarding the teeth.

THE RELATIVE LIABILITY TO CARIES OF THE TEMPORARY TEETH.

The temporary teeth appear at short intervals after that, and complete their eruption before the end of the second year. The teeth at this time are usually complete in number, regular, and articulate properly. The diseases of childhood that frequently lead to deformity of the upper jaw have not yet made their impression on the alveolar ridge and the teeth. If the teeth of a child may be taken as a criterion of the food that should be eaten; as the temporary human teeth resemble closely the permanent teeth in every way, except in size and number, the food should be the same as that of adults, except that it should be less in amount. and the size of the pieces smaller, at any rate from two years old, when th the temporary teeth have fully erupted. If by cahnce, and there are numerous chances, on account of the ignorance of mothers and physicians, in regard to dental decay, to give the child badly prepared, that is, too soft solid food, the expenditure of masticatory energy will be lessened and the teeth become liable to ~~decay~~ infection. The temporary teeth are thus in the first instance found to decay symmetrically. Repeatedly ghanging from harder to softer food os sure, sooner or later, to expose the enamel to infection either between the teeth or in the pits and fissures at the masticatory nodes. As the jaws of the child grow and expand, the front teeth separate, which renders the temporary front teeth relatively less liable to infection than the back ones. A tooth, after infection, may so quickly decay, that within a year the pulp may be exposed and while the masticatory nodes are symmetrical and equally exposed to decay, the

infection may not be actually ~~symmetrical~~ simultaneous, and the subsequent rate of decay may not be exactly at the same rate, even should there be symmetrical cavities so that pain ~~may~~ should be set up it will occur on one side of the mouth before the other. Should this happen, toothache will interfere with mastiaction on one side, and asymmetrical mastication will take place and increasing the irregularity of mastication, lead to further liability to caries. Thus even in the temporary teeth, dental decay may not be perfectly symmetrical. So universal is caries among the temporary that some at least are affected befor these teeth are shed.

CARIES OF THE SIXTH YEAR OLD MOLARS.

Of the permanent teeth, the teeth most of all and soonest affected by caries are the first molars, especially those of the lower jaw. This fact has afforded great curiosity and much speculation to writers on this topic. The first molars are situated immediately opposite the orifice of the duct of the partoid, the largest of the salivary glands. The secretion of this gland is greater in amount and probably more alkaline than that of any of the other glands, both factors which are usually held tp prevent caries. Being a terminal tooth, at this period it cannot suffer from crowding. From its position mechanically, in regard to the muscles and joint it is exposed to the greatest masticatory forces;- these conditions are all factors which are universally held though erroneously by dentists to be antagonistic to the incidence of caries. It is the largest of the permanent teeth and the first to irrupt, it should also become the guardian of the rest. Because of its great and early liability to decay,

Some have advocated its early extraction for the sake of ~~preventing~~ the preservation of the others, but the folly of such a procedure is evident for the reason just stated. Theoretically, if modern theories were correct, the first lower molars, the very teeth which are most liable to caries, should be the most exempt from caries.

If however, caries depends on a variation in the force of mastication, the reason why the sixth year old molars and especially the lower molars, are most liable to caries, becomes intelligible. Being situated where, from mechanical considerations the forces of mastication are most effectively exerted, variations in the force of mastication ~~induc~~ induced from any cause will be most marked. Tenderness in the mouth, caused by shedding of the temporary teeth, and changes in the consistency of the food, which are frequent during the eruption and immediately after the eruption of the sixth year old molars due to children's diseases, and pain caused by decay of the temporary teeth themselves, all tend to cause variations in the force of mastication at every lull in the pain in the other teeth stress would be put on the newly erupted teeth. Indeed there is no period in the child's existence where there is more likelihood to so many conditions existing likely to cause a variation in the force of mastication as at the time of the eruption of the sixth year old molars. No clinical episode could more clearly point the truth, that the decay of the teeth is due to a variation in the force of mastication, and that this is therefore the cause of the habitual

liability of this tooth to decay. The cusps and fissures of these teeth by dental anatomists are described as constant and well marked and consequently, when a variation in mastication takes place decay should supervene. Every conceivable effort should be made to maintain their constancy in mastication in order to protect the sixth year old molars from decay, and every care should be taken to prevent discomfort in the mouth from any cause, and especially that food of a constant consistency should be given at this period, i.e. before, during and immediately after the eruption of the first permanent molars. If loose, the temporary incisors should be removed and the temporary molars should be made comfortable by obtundants, antiseptics and temporary fillings. It is the tooth that deserves and demands the greatest effort to secure its preservation. Being preserved, it will in turn tend to render the greatest protection to all the other permanent teeth, for its preservation will lead to equability of mastication on which the preservation of the teeth ultimately depends.

These observations show that the conditions under which decay may occur, and under which it may be arrested, involve a fairly though perhaps less fine distinction than the more anomolous condition of deposition and destruction of bone in contiguous ~~teeth~~ areas.

Let us suppose that caries depends on a highly specialised microbe, which seems to be a necessary assumption in this case, i.e. a microbe that can only exist under a well balanced set of conditions that form its special habitat and suit its peculiar mode of life:- that microbe will perish if the balance of these conditions ∅ is disturbed. It is much more likely that the balance of conditions should be upset for the existence of one microbe than for half a dozen or more that are known to exist in the mouth which are commonly said to be cario-genic, and are able to produce acid products. An important dental problem is to discover something that will disturb the balance of the conditions favourable to the carie-genic microbe.

When teeth show spontaneous arrest of decay, it is a sign that treatment will be easily successful, for the conditions favouring the microbe have been ~~successful~~ disturbed. The cavity where spontaneous arrest has happened, may turn intensely black, even where the teeth happen to be naturally clean and no artificial caries ~~has~~ is taken ~~from~~ of them. The ~~micro~~ microbe in such cases, seems to die out and completely disappear. The dis diseased surface becomes polished and is said also to become harder than ordinary dentine, but I think this is a mistaken impression. The tooth usually then becomes functional, but it seems improbable that the restoration of function was a primary cause of the arrest. This

intense blackening and arrest very often happens in crown cavities, but in interstitial cavities, arrest also takes place apparently from another cause. When, say a first bicuspid has been extracted for caries, and leaves a small mesial cavity in the contiguous second bicuspid, that cavity often becomes arrested. On the death of the microbe in these cavities blackening also takes place, as in the crown cavities. The necessary conclusion from these facts is, that both a too great activity of mastication and also an insufficient activity are inimical to the life of the microbe. The microbe flourishes best where there is what may best be described as a moderate play of forces bringing a certain current of fresh pabulum to the microbe in addition to the phosphates of the tooth in which it finds suitable mineral nourishment for its mode of life. As on the margin of the masticatory area it maintains itself between a Scylla and a Charybdis, so it has a special habitat on the very edge of the masticatory area, and like bent, that thrives on the driven sands of the sea-shore, but can neither live inland nor with the tidal line.

After the arrest of caries in many cases, there is a reversion from whstever cause, to normal mastication. This subject, resolves ~~itself~~ into the problem of keeping the energy used in masticating food up to a normal efficiency.