THE PREVENTION OF DENTAL CARIES AND ORAL SEPSIS

BEING THE CARTWRIGHT PRIZE ESSAY OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND FOR 1906-1910, WITH SOME ADDITIONS

BY

H. P. PICKERILL, M.D.
CH.B., M.D.S. (BIRM.), L.D.S. (ENG.)
PROFESSOR OF DENTISTRY AND DIRECTOR OF THE DENTAL SCHOOL IN THE UNIVERSITY OF OTAGO

LONDON
BAILLIERE, TINDALL AND COX
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CHAPTER XV

THE DIET OF RACES RELATIVELY IMMUNE TO CARIES

ALTHOUGH no race may be said to be absolutely immune to dental caries, yet in some races—namely, the Esquimaux and the Maori—it is so extremely rare, compared with the enormously high incidence amongst European races, that a practical immunity may with reason be claimed.

It has been customary for some years now—since the researches of J. R. Mummery—to believe that those races which consumed most meat were the most immune, and *vice versa;* but, as we shall see, this is on strict inquiry by no means the case.

The Maori Race.

Instead of discussing vaguely the dietaries of all the various races more or less immune to caries, it will be much more profitable to confine our attention firstly to a detailed investigation of a single race having a high immunity. We shall, too, learn much more of value from a study of the dietetics of a people whose diet was a mixed one, with carbohydrates preponderating, and for whom climatic conditions were similar to those for Europeans. Such a race is the Maori, in whom, as we have seen, the average incidence of caries may be placed at 1·2 per cent. In Mummery's investigations the diet is inferred to be largely a protein one, since the Maoris were cannibals; and this seems to be the reason ascribed by Mummery for their comparative freedom from caries.

Such an assumption, however, is not founded upon facts; the Maori was essentially a mixed feeder, and carbohydrates largely preponderated.

The consumption of human flesh only occurred on more or less rare occasions after a war-party had returned home with prisoners, and then not all the prisoners were eaten; a large number were always reserved as slaves. But most important of all, from our present point of view, the consumption of such food was confined almost entirely to the warriors. Human flesh was strictly *tapu* —*i.e.*, forbidden—to women,* and only the elder boys were allowed a very small portion. Yet, as a matter of fact, both women and children had just as good teeth as the men. This disposes completely of any theory that the Maoris owed their immunity to caries to cannibalism.

The perfection and also the marked attrition of the teeth of this race have been also ascribed by some observers to the mastication of coarse fibrous food, such as fern-roots, mixed with sand. True, they ate fern-root, and also their "ovens" are frequently found among sand-dunes, but neither of these things justifies the above assumption.

The staple food of the Maori was undoubtedly the kumara, or sweet potato (*Ipomœa chrysorrhiza*); this was cultivated with great care. It was sun-dried and either eaten at once or stored for winter use.

The rarauhe, fern-root (*Pteris aquilina* or *esculenta*), was the next important source of food, but it is very necessary to note the method of preparation. Young roots only were selected, and of these only those having the *least* fibre. If the root did not break crisply, it was forthwith discarded. The roots were dried and roasted, the outer skin scraped off with a shell; it was then pounded to a powder, and *all fibres carefully removed.* Water was mixed with it in order to make a kind of dough, and it was then cooked. Before being eaten it

* Only one woman—the high-priestess—was ever allowed this "privilege."

was as a rule flavoured with the juice of the tutu berry, or with the juice of the ti-tree root, the former having an *acid taste*, and the latter a *sweetish acid taste*.

Taro was another vegetable cultivated by the Maori and largely consumed; it was a perennial, was therefore always eaten fresh, and had a strong and distinctive flavour.

The roots of seedling ti-trees were also eaten after being baked; these contain a sapid sugary juice much valued as a flavouring agent.

Two kinds of bread were made—one from the pollen of the bulrush, and the other from the berries of the hinau-tree; the latter had a very *pleasant taste*, and the former was said to taste like gingerbread and sweet.

Hué, a pumpkin-like fruit, was in the summer season consumed in enormous quantities. A large number of different kinds of berries were also eaten raw; these all had acid sapid properties. The berries of the following trees were the most favourite varieties: the kutukutu (*Fuchsia excorticata*), the karaka (*Corynocarpus lævigata*), the poroporo and the poporo (*Solanum aviculore* and *nigrum*).

A jelly was also made from a form of edible seaweed called karengo; the latter was first stewed, and then soaked in tutu juice before being eaten.

But it is not to be supposed that the Maori was a vegetarian: far from it. Yet since there were practically no mammals indigenous to New Zealand,* his animal food consisted entirely of fish and birds, to obtain which he went to considerable trouble. The difficulty, however, in obtaining such food must have been so great in many cases as to preclude the possibility of its forming anything but a subsidiary part of his dietary. For instance, the Maori used no projectiles of any sort, and all his birds were either snared with a loop on a long pole or

* A very small rat and a dog were indigenous at least as far back as legend and history go; both these animals were eaten, but the latter was *tapu* as an ordinary article of diet.

speared with a long light spear. In this way were obtained the following: kukupa (pigeon), kaka (parrot), putangi-tangi (paradise duck), pukeko (swamp-hen), kiwi (apteryx), weka (wood-hen), koreké (quail). Also a large number of young sea-birds, including "mutton" birds, were collected in season, and dried for winter use. The birds, however, it will be noticed, were all rather small, and, with the exception of the putangi, several would be required to make a meal for a family.

As regards fish, the Maori used small nets only in rivers and estuaries, and a line and hook in salt water. The hook was not "baited" as we understand it, but simply had a piece of iridescent paua-shell attached; and thus were caught hapuka (cod), barracouta, moki, patiki (flat fish), and also snapper, kingfish, and butter-fish. Sharks were occasionally caught, and were esteemed a great delicacy. The inland tribes depended upon fresh-water fish, of which eels were the chief variety. These were trapped as a rule in weirs constructed of reeds. Piharau (lampreys) were also caught similarly. By means of small seine nets were also caught inangi (a kind of whitebait) and upokororo (a kind of grayling).

Crayfish and shellfish also formed a part of their regular dietary, especially the paua, a large clam; these were collected, sun-dried, and stored, and also sent inland to other tribes in return for "potted" birds.

Cooking.—Most of the animal food was cooked together with "vegetables," such as kumara, taro, raruaké, by being steamed in an earth oven for about an hour and a half. Some of the larger birds were roasted on a spit. One of the chief aims in the process of cooking was to keep all the "flavour" in by wrapping the food in layers of green leaves, and covering the oven with mats and earth. The leaves having once been opened, the food was either eaten or thrown away; no food was ever recooked or touched a second time upon any consideration whatever.

The Maori was allowed to exercise his idiosyncrasies of

taste, and was not bound by any custom or law to eat what he did not relish; he simply stated that he was "wainamu" for certain food—even human flesh in many instances—and that wish or declaration was accepted by parent, host, or guest, without demur.

As a rule two meals a day were taken, at ten and four o'clock; in times of scarcity this number was reduced by half. As regards drinking, the Maori drank only plain water, or water flavoured with the juice of the tutu berry.

Masticatories were largely indulged in. The gums of the kauri and tarata trees were freely chewed, as also was bitumen, these being passed unceremoniously from one mouth to another. I have been unable to gather any evidence either from the Maoris themselves or from other observers that they ever practised cleaning the teeth by any artificial means.

Summary.

Thus it is obvious—

1. That the dietary was essentially a very varied one.

2. That the Maori could not possibly have owed his immunity to a preponderance of animal food.

3. That the methods of preparation of vegetable and carbohydrate food generally was such as to eliminate all the obviously coarse and fibrous constituents; nevertheless, since the methods of preparation were of necessity crude, a certain amount of the *finer particles* of cellulose must have remained in all their food, even in the bread. That nearly all food was steamed, thus considerably reducing its toughness.

4. That a considerable amount of fruit and berries was consumed.

5. That throughout the whole dietary one of the most important factors was taste and flavour. (The character of the food, both protein and carbohydrate, was such as

had in itself distinctive flavours—namely, fish and game, sweet-potato and fern-root, berries and fruit.) That, in addition to this, substances, such as the tutu and ti-tree juices, were constantly used to increase the sapidity of the ordinary food.

6. The use of the tutu berry juice is particularly interesting ; there is no doubt that it acted as a stimulant of alkaline saliva by reason of its acid-sweet flavour. But it also in all probability had a further influence on the salivary secretion through the action of its active principle, tutin, on the nervous system. Fitchett* found that after hypodermic injection of tutin in the cat, among the first symptoms in five cases out of six was *intense salivation.* And from the character of the saliva it was thought that it probably arose from sympathetic stimulation.

Now, although there should be very little tutin in the juice of the berry, I think that undoubtedly some is very frequently adventitiously present, judging from the cases in which toxic symptoms have arisen in Europeans after sucking the berries or drinking wine made from the berries when great care had been taken to exclude the seeds. Fitchett also showed that tutin was not excreted at all rapidly. It would therefore appear to be not at all improbable that the Maori, by the constant ingestion of even minute quantities of tutin, kept the efferent salivary nerves in a state of excitability, if not of mild excitation.

7. The use of masticatories also undoubtedly kept the salivary glands in a state of activity, and both their secretory powers and the total daily amount of secretion would be thereby greatly increased.

Moreover, the habit of chewing prevented "stagnation" within the oral cavity, and so removed one of the great predisposing factors to disease.

* "Physiological Action of Tutin," by F. Fitchett, M.D., Transactions of the New Zealand Institute, 1908.

Conclusions.

It is therefore clear that the relative immunity of the Maori was due, not to an excessive protein diet nor to a great excess of hard, fibrous, inert matter in their carbohydrates, but to the habitual and constant mastication of salivary stimulants, thus producing a constant flow of alkaline and diastatic saliva, the beneficial effect of which has been previously considered.

Other Races.

It will be found upon close investigation that similar dietetic principles to the above pervade almost every "natural" race; and although it is not possible here to consider in similar detail the foods of all other races having a comparative immunity to caries, yet a brief consideration of the various dietaries is important.

ESQUIMAUX.—It is quite usual to suppose that the Esquimaux exist entirely upon animal flesh, fat, fish, and birds. A little thought, however, will show that this cannot be so; no one can be entirely deprived of all fresh carbohydrate food without ill results, and, indeed, investigation shows that the Esquimaux themselves recognize this. Kjellmann says that no less than twenty different kinds of plants are used for food, and that "provisions of berries and of reindeer moss rich in starch are stored up for the winter." The berries are a kind of small *cranberry*, the acid-sweet taste of which is well known. They also brew a fermented liquor something like *sauerkraut*. (Incidence of caries, 1·4 per cent.)

With the *Lapps* it is customary to supplement their milk with *sorrel* or *butterwort*, and Ratzel affirms that "similar *acid* or pungent plants are welcome to all polar people."

The inland Arctic people of North Asia live largely on *bilberries*, supplemented by the products of hunting and fishing.

The *Samoyedes*, a nomad Arctic people, unlike the

Esquimaux, have numerous wives, whose duty it is, whilst the men fish, to seek for shells, *herbs*, and *berries*.

The *Indians of the North-West American Coast* are very Esquimaux-like in their diet, subsisting largely on fish, supplemented by roots, grasses, and berries, and a cultivated potato-patch is usually attached to each "house." All food is cooked by the steaming process. As a *masticatory* the wood of the sugar-pine is chewed, which travellers assert tastes as much of *turpentine** as of *sugar*. (Incidence of caries, 3·9 per cent.)

The *Fuegians*, inhabiting the other extremity of the American coast, are also said by some travellers to exist chiefly on fish partially cooked, to which is ascribed their broad zygomatic arches and powerful masticatory muscles. Darwin, however, whose accuracy as an observer cannot be doubted, says that (at least when he visited Tierra del Fuego in 1834) their staple food was a dried and hardened fungus (*Cyttaria Darwinii*), which has "a *mucilaginous, slightly sweet taste*, with a faint smell like that of a mushroom."

OCEANIANS, POLYNESIANS, AND MELANESIANS.—Here again it is popularly imagined, because many of the inhabitants of the Pacific Islands were (and some still are) cannibals, that their diet was essentially a protein one. On the contrary, as with the Maori, human flesh was consumed only on very special occasions, such as after a raid on a neighbouring island or at the opening of a "tambu" house or other high festival. Those who have lived in the islands are all unanimous that by far the larger proportion of food in all cases consists of vegetables and fruit.

The *Fijians*, perhaps, are the largest meat-eaters of all of the islanders. The greatest proportion of their animal food consists of fish, then opossums, and less frequently pigs. All meat is cooked, usually steamed

* The important pharmacological characteristic of turpentine in this respect being that in the mouth it has a pungent, bitter taste, and causes a reflex flow of saliva.

until very tender; the opossum is said to have a "strong flavour," and their roasted pig is thought by some to be superior in flavour to English bacon.* Meat is frequently eaten in a half-putrefying condition. But even the Fijians' food is principally vegetable, of which the following are the varieties chiefly consumed: taro, yams, sweet root of ti-tree, banana, sugar-cane, and cocoanuts.

Most of these vegetables and fruits are common to all the islanders, some kinds being more cultivated in particular islands than others. Poi, a kind of sour porridge, is made by most Polynesians from taro flour, by allowing it to ferment. Sago is largely eaten by some tribes; it is most carefully prepared and cooked, the coarse fibres being removed first of all by an ingenious system of washing.

In some parts of Polynesia (particularly in Tahiti) breadfruit is fermented into a sour paste and set aside to store, since in this condition it keeps well.

Fruits, of course, form a large and important part of these islanders' dietary. In addition to those already mentioned are the mango (a large pumpkin), a variety of cucumber, a species of lime, the kernels of the borolong and saori, the fruit and leaves of the asi-tree, these having a decidedly *acid* taste, and many others.

Nearly all Polynesians season their dishes with *salt* sea-water. (Incidence of caries, 5·2 to 19 per cent.)

Kava, an alcoholic beverage of *bitter or sour* flavour, is largely consumed in a great number of the islands. It is prepared from the roots of the *Piper methysticum;* in order to induce fermentation the roots are *chewed by women and girls,* then expectorated into a bowl or trough, and water is added (this method, however, is not universal).

The *Chinwans of Formosa* also brew a fermented drink from rice and millet, yeast being replaced by the saliva of an old woman in a similar manner to the above. A

* Guppy, "Solomon Islanders," 1883.

like custom is observed among the Indians of Central America in Guiana, where an intoxicating beverage called "paiwari" is made in a similar manner from cassava bread, the fruit of palms, maize, and bananas. In this case the mass is sterilized, by pouring on boiling water, before being chewed by the women. It is said to be a "cooling" drink somewhat resembling *sour* beer.

The *Papuans* have as their staple food the kumara and sago, diversified by large broad-beans and the leaves of the tree-cabbage. A kind of palm is cut down when they are hungry, and the inside leaves of the top green shoot are eaten; these are "straw-coloured and like asparagus, sweet and slightly dashed with acid;" of this the natives eat great quantities. Bread fruit is eaten boiled; this is said to be palatable, though slightly bitter. The Papuan, however, is extremely partial to animal food, but it is necessary to observe the conditions under which it is eaten.

The pig, cassowary, and wallaby are hunted by being driven into corrals made of nets set in the forest. The game is roasted, and in an incredibly short space of time every particle is eaten, and the people then lie about in a gorged condition. Such "drives" only occur at long intervals. Papuans are also very fond of a large tropical beetle (one of the Passalidæ) found in decaying tree-trunks; it is usually eaten raw, but may be just warmed in the fire; the flavour resembles that of a lemon.

Malays.—The staple food of the wilder tribes of the Malay Peninsula consists chiefly of such wild yams, roots, and fruits of the jungle as may be in season. When this fails, the men engage in hunting, trapping, and fishing. In other more agricultural tribes, rice, maize, millet, tapioca, and bananas form the staple articles of diet.

The Semang tribes exist on small birds and animals, various kinds of yams and roots, with the addition of gourds, pumpkins, chillies, maize, and sweet potatoes.

The Sakai live upon wild tubers, roots, and fruits, and some animal food; they do not, as a rule, search for game until everything else fails. One kind of apple-like fruit eaten is said to be very pleasant, but to leave a most decided "after-taste."

Jakun peoples, like the two former tribes, are markedly frugivorous. Logan gives lists of forty and sixty-nine different kinds of fruits which various Jakun tribes are in the habit of eating. The latter tribes eat more rice and less meat than the two former, but the rice is always flavoured. Skeat says: "I have myself frequently seen the latter at their meals, when their only food consisted of boiled rice seasoned with *acid fruits* obtained from the jungle." Other seasonings used are kulim-leaves (resembling onions), wild ginger, turmeric, species of eugenia, wild pepper, and various spices. When the people disperse, as they do each year, for long periods through the jungle in search of fruits, they live entirely upon tapioca root and fruit. Favre, however, speaking of these tribes, says that their diet is very varied, and nothing can be said to be regular, and when opportunity arises they will eat the flesh of any available animal. Honeycomb is greatly prized, but it is not eaten until the small bees are well formed in the cells!

The tribes on the seaboard exist on rice principally, to which is added the flesh of the hog, monkey, snake, and birds, together with vegetables and wild fruits. All these tribes have a great desire for the durian fruit, some living upon it entirely for six and eight weeks, and in one case Thomson found six boat-loads of Sea-Jakun, who had travelled 180 miles by sea to obtain this particular fruit.

THE INDIANS OF NORTH AND CENTRAL AMERICA.—It is stated by Mummery that the diet of the North American is mainly meat; with this Ratzel does not agree. Although this authority admits that animal food is eaten with avidity, yet he states that the chief article of diet is still the maize, and that large quantities

of *fruits*, *berries*, and *nuts*, are collected, and also stored for winter use. Wild *melons*, *plums*, and *grapes*, are recognized food items for tribes in the interior.

Greatly esteemed is the large bulb of the *Lilium columbianum* and the bulbs of other lilies ; in addition, the roots of the sunflower, white clover and bracken, wild onions, and wild carrots, are largely eaten.

A great variety of berries are gathered and eaten, both fresh and preserved, the most favoured being the " Service " berry—a kind of black currant (*Amelanchier alnifolia*) ; in addition, the following are also eaten : red and black currants, gooseberries, blackberries, strawberries, raspberries, whortleberries, soapberries, cranberries, crowberries, chokeberries, elderberries, bearberries, jumperberries, roseberries, mooseberries, and salalberries. (The latter is a species of Gaultheria.)

The food of all *New Mexicans* (Indians) is similar. They make pretensions to agriculture, and are used to a vegetable diet ; they seldom, however, raise sufficient to last until the new crops are available, and so have to subsist on " beans, nuts, and other wild fruits, which they collect in considerable quantities." Of animal food, comparatively small quantities of rats, lizards, squirrels, and fish are eaten.

In *Central America* also the Indians much prefer meat, but " totemism " frequently prohibits many animals. In addition, the quinoa and the potato are the chief natural food of these races ; manioc and cassava are also used ; and in Chili it is said that the *strawberry*, which covers miles of country with its runners, is an important article of food. The fruit of the carnahuba and mariba palms are, too, favourite articles of diet ; these have an *agreeable juicy, sweet flesh*, and are utilized in various ways.

Wild tribes of Central America, according to Bancroft, are essentially agricultural, living on maize, beans, bananas, and plantains, together with a variety of fruits and roots. Fish, eggs, turtles, and fowls, with the

inevitable chilli (and salt) for flavouring, compose their animal dietary.

THE "NATURAL" RACES OF AFRICA.—The diet of the negro in general may be said to be both animal and vegetable, with wide variations for the various races, some races consuming a minimum of carbohydrates, and others a minimum of flesh protein. Nearly all races, except the Bushmen, Dwarfs, Masai, and Galles, cultivate the following crops extensively: millet, maize, manioc, and banana (Equatorial). Coffee, guru, and kola nuts are habitually *chewed* by many races; *salt* (sodium chloride) is in great demand as a *seasoning* by all, and when this cannot be obtained *potassium* salts obtained by evaporation of lake water are substituted. The practices of smoking *Cannabis indica* and of brewing beer by the fermentation of maize or millet are found in very many races.

Some races clean the teeth and scrape the tongue artificially with a frayed-out stick dipped in ashes, and spend a considerable time each day on the process.

The *natives of British Central Africa* eat "surprising quantities" of a stodgy kind of porridge made from maize or millet flour, but do not at all like it without salt or some form of *ndiwo* (relish). Sweet potatoes and manioc root (raw and cooked) are also eaten, and in the spring pumpkins, gourds, and cucumbers are principal articles of diet; but comparatively small quantities of meat are eaten, and then it consists chiefly of rats, very high fish, locusts, white ants, and occasionally fowl or goat's flesh.

In *Uganda* the natives in many parts (Waganda) have advanced somewhat higher in the scale of civilization and its arts; they are "mixed feeders," living on the flesh of domesticated animals, such as sheep, goats, and fowls, together with bananas, maize, sweet potatoes, yams, and various fruits.

The *Manganga* (around Lake Nyassa) eat vegetables chiefly; they consume neither eggs, milk, nor poultry.

They catch and dry great quantities of fish, which, together with salt, they trade to other tribes in the interior at great distances.

The *Kaffirs and Hereros* are essentially cattle-breeders, but are extremely reluctant to slaughter animals merely for their own food ; at feasts, however, and on special occasions they will consume enormous quantities of meat.

The usual morning and evening meals of the ordinary Kaffir consist of a porridge and amasa (sour milk), one or other vegetable, millet " beer," and occasionally some meat. (Incidence of caries, 14·2 per cent.)

The *Negroes of West Africa* also live on grain, chiefly supplemented by aromatic herbs and much salt. Cayenne pepper is very popular.

The *Bushmen* are a fierce nomad people living chiefly on the product of the chase, supplemented by edible roots, honey—a very favourite and frequent article of diet—and a wild water-melon, juicy and *bitter* in flavour. They cover great distances in their marches, and suffer considerable privations, and the water-melon is said to be frequently their only possible drink. (Incidence of caries, 20·6 per cent.)

The *Pygmies of Central Africa* are likewise a nomadic tribe, living chiefly on the products of the chase, some of which they exchange with adjoining agricultural tribes for plantains, potatoes, etc. ; their own carbohydrate supply consists of fruit, nuts, and honey.

The *Abyssinians* are mixed feeders, and are more highly civilized than other African races (except the Egyptians). In making their bread (teff), they always include a sauce of red pepper to render it sapid.

The *Kabyles of North Africa* live chiefly on onions, cucumbers, gourds, and water-melons, and they are especially fond also of a small wild artichoke.

The *Moors of Morocco* are people of very ancient civilization, but nevertheless their mode of life is considerably simpler than ours, especially among the poorer

classes. Kesk'soo, prepared from semolina, is the national dish; zumetah (parched flour) and vermicelli are also used for making cakes; very hard doughnuts, flavoured with anise and caraway seeds, and called "fikaks," are commonly eaten. In addition, rancid butter, honey, dates, raisins, and large quantities of ripe melons and black figs form an important part of the food. "Kabab," made from chopped-up and seasoned meat, partially cooked is a very favourite dish; salt is used extensively. Various kinds of confectionery are largely eaten, so that it is not surprising to know that the native "doctors" are acquainted with, and use three different instruments for, the extraction of teeth—namely, a native instrument which is "a sort of exaggerated corkscrew without a point," and also keys of French and English pattern. The possible presence of diseased teeth and the value set upon good teeth are shown by the fact of slave-dealers always examining the teeth and gums of slaves before purchasing.

Australian and Tasmanian Aborigines. — Both of these races were nomadic, and lived largely on flesh food, such as insects, fish, birds, reptiles, and very many marsupials. Various roots, *fruit*, *honey*, and the gums of certain trees, were also articles of diet. (Incidence of caries—Australians, 20·5 per cent.; Tasmanians, 27 per cent.)

Probably altogether they employed some three hundred different kinds of vegetable or fruit food, but no crops were cultivated in the ordinary sense of the word. Yams, nardoo, and bulrush-root were staple foods in many districts. The former two were made into cakes, and the latter is said to have occupied the position that bread does to the European; but it was very coarse, and the fibrous parts were spat out after chewing. Meat was frequently flavoured with the sweet secretion from a species of Psylla.

A fermented liquor was prepared from the fruit of the pandanus. There are two things, however, which

operated adversely in the diet of the Australian: firstly, his practice of eating clay after meals, and of mixing earth with yams before eating them; and, secondly, his frequent difficulty in obtaining water, owing to periods of drought, or to his nomadic habit and the consequent necessity of passing over arid areas. The Tasmanians were not cannibals, but the Australians were; and in many parts human flesh was consumed by both sexes and all classes, and sometimes one child of a family would be killed and given to another child to eat in order to strengthen it.

THE INHABITANTS OF INDIA.—The races, tribes, and castes, of India are so numerous that it is impossible to give any concise and accurate description of a diet which will apply to all. Rice is the staple food near the coast, millet in the Central Provinces, and wheat in the Punjab and North-West. In all cases the cereal is served in a variety of ways, usually retains some of the husk, and is seasoned with herbs or *spices*, the Indians being, of course, extremely fond of the latter. Eggs, milk, *fruit* (ginger, plantains, citrons, gourds, pumpkins, and in some parts oranges and lemons), and *salt*, also form a *regular* part of meals in most instances. In some parts (*Khondistan*) "butter" is made from two varieties of sinapis. Fish is abundantly eaten on the coast, but not in the interior, the art of angling not being usual.

Among many of the *tribes of Northern India*, the women collect considerable amounts of wild vegetable food with "digging spuds." Poisonous tubers are soaked in water to render them innocuous. The fruit of the Mohwa furnishes the food of the poorer classes for several months, and is usually eaten with Sal seeds or the leaves of various jungle plants, together with a little rice. The seeds of many wild grasses and bamboos, and the leaves of leguminous plants, form, indeed, a very important part of their food.

The *Todas*, in Southern India, exist at the present

time chiefly on milk, butter-milk, ghi grain, rice, and sugar; but from their own statements they formerly lived on roots, herbs, honey, and fruit. The flesh of the calf is eaten only three times a year, but that of the sambhar may be partaken of at any time when an animal happens to be killed. During pregnancy the women drink the juice of the tamarind, which is markedly acid, but pleasant.

JAPANESE.—The principal food is rice, also buck-wheat, wheat, barley, taro, and yams. A seasoning of some sort is used with every meal, usually either a white *radish* or the fruit of the egg-plant. The *fruits* of the kaki and biwa are largely eaten, as also are cucumbers, water-melons, and parts of the chrysanthemum flower. Meat is a rare delicacy.

CHINESE.—The staple food of all Chinese is rice; it is served in a variety of forms, but is to European taste always "underdone." In addition, taro and sweet potato are largely eaten, and, of course, the Chinaman is proverbially a past-master in the art of cultivating "vegetables," which form an important part of the national menu. The Chinese are almost vegetarians by force of circumstances, and not so much by choice. Fish, salt and fresh, duck, and pig, are the chief articles of flesh food, and in this order of frequency, pig being consumed by the middle class and poorer Chinese on festive occasions only. A little mutton and beef is eaten in Northern China. Fruit is abundant in most parts of China, especially the south, but near the large towns and ports it is sold for export rather than eaten.

Missionaries are of the opinion that the Chinese, in the country districts at least, have "most excellent teeth."

PERSIANS.—There are three national dishes: chillau, boiled rice with a little grease; pillau, boiled rice with lamb; and ash, rice stewed with *vegetables and fruit.* Sherbet, the national drink, is made from iced water and *fruit juices* and essences.

General Remarks and Conclusions.

The incidence of caries in these races varies considerably—according to Mummery's figures, from 1·4 to 20·8 per cent. (of individuals) ; and according to Patrick, from 2·064 to 5·804 per cent. (of the total number of teeth). The latter figures are really the more important, since they give a more correct estimation of the *extent* of caries in any race. Now, as we have seen (pp. 9, 10), even the highest of these figures is incomparably lower than those obtaining amongst civilized races at the present time. So that we may group all the " natural " races together, and endeavour to ascertain whether there is anything common to their several dietaries which would explain their *relative* immunity to caries. Mummery and Miller believed that a larger consumption of meat explained the difference. This theory, however, although a factor, must *per se* fall to the ground, since both Mummery's and Patrick's figures (see pp. 9-12) show that several meat-eating races have a higher incidence of caries than non-meat-eating. Also it is of the very highest significance that in Patrick's list the great rice-eating, almost *vegetarian* races of South-Eastern Asia should show the *least incidence of caries :* out of 2,000 teeth, only 2 per cent. were carious.

Again, many of the people showing the highest incidence of caries (the colonials of Australia and New Zealand) consume enormous quantities of meat—namely, 240 and 250 pounds per head per annum respectively—yet the number of individuals affected by dental caries is estimated to be from 90 to 95 per cent. (by the Australian and New Zealand Dental Associations).

Therefore it is obvious that upon these considerations alone a large consumption of meat does *not* confer even a relative immunity.

From this investigation several things stand out clearly: That the diet of all "natural" races and of

those relatively immune to caries is essentially a varied one, and that although certain articles form the staple food over certain large areas, yet they in no case form the *sole* food of any race.

There re, then, two general principles to be found running through the dietaries of all the natural races. They are—firstly, *variety*, and, secondly, *sapidity*.

This inquiry was undertaken quite impartially, and it was not anticipated that the results would so amply bear out the previous investigations. The same conclusions are made by Ratzel, an eminent authority on ethnology, but who had no reason to pay any *particular* attention to any one feature of the foods of such races; yet, summing up the characteristics of the partially " cultured " people (Chinese, Japanese, Hindoos, Arabs), he says : " *Variety of food is great, and the sense of taste appeals at a very early stage.*"

The constant inclusion of articles in the food which have a direct stimulating effect upon the salivary glands is the one and only link which connects up all the races showing a relative immunity to caries. It is common alike to dwellers in the Arctic and Equatorial regions, it is found in meat-eating and in vegetarian tribes, it is present in both low and high types of uncivilized man.

Further, it will have been noticed that although a variety of sapid substances are used, yet the ones most frequently recurring are acid in reaction, chiefly fruits and berries; and, as has been previously shown, these are the very stimulants which produce the most profuse and the most alkaline flow of saliva, and to this latter I think we are justified in ascribing the relative immunity found in the races which have been considered. Only on such a basis can the order of incidence in Patrick's figures be explained.

In Southern Asiatics the percentage is least, and these are the people who have fruit in abundance, and use it as an ordinary article of food, and not merely a luxury at their meals. The Egyptians and Africans come next,

including races which employ both fruit and salt largely (and also artificial prophylaxis). Polynesians and Australians are next, the percentage doubtless being raised considerably by the inclusion of the nomadic Australians.

Central Americans follow, whose salivary stimulants are mostly sweet-acid, but whose comparatively higher incidence may be due to their consumption of cassava, which is "dry, tasteless stuff like sawdust."

North Americans and Esquimaux are grouped next, although these people are amongst the largest meat-consumers. They both eat fruit and berries (and the Indians sugar-pine), but the amount must of necessity, owing to climatic conditions, be comparatively smaller.

The highest incidence of carious teeth falls to the South Americans, including the Guachos, whose diet is mainly meat, and the Fuegians, who consume fish and fungus largely. The relatively higher incidence is also possibly caused by the inclusion of many earth-eating tribes, by the consumption of cassava bread, and by the general laziness of the Indians, who strongly "object" to cultivation. This, also, is one of the very few countries where salt was not used at all by the natives to increase the sapidity of their food.

TOTEMISM AND TABOOS.—In probably the greater number of natural races of mankind, food restrictions of one kind or another are enforced. In many cases this is due to totemism. An individual has a certain object for his "totem"; this is always some well-known animal, plant, or natural feature of the landscape. When the totem is an animal or plant, it becomes prohibited as an article of food. (There are a few abnormal exceptions to this rule, but they are unimportant.) The interesting feature from the present point of view is that the great majority of totems appear to be animals, and this, therefore, would tend to restrict the consumption of animal food. The fact, too, that the totems of individuals of a tribe or family are not the same—in fact, in many cases are necessarily diverse—would

further tend to restrict animal food. For instance, there might be six different animal totems in a family of seven or nine, so that whichever of those six animals happened to be for dinner, certain members of the family would be unable to partake of it. Other food restrictions are related to sacred rites and seasons, or are enforced at the period of puberty or afterwards for supposed sexual reasons. In these cases, also, the prohibitions relate chiefly to animal food. For instance, in certain Australian tribes there are thirteen different kinds of animal food which a boy may not eat before puberty, and eleven kinds which a girl may not eat until she becomes a mother. Amongst certain Melanesian tribes no man until past middle age is allowed to eat dog, turtle, or six particular species of fish, and no woman may ever eat the two former; whilst in some places only middle-aged men may eat pig. These latter prohibitions are enjoined because the consumption of such animals is supposed to create a dislike by the opposite sex. In many instances animal food is taboo to one or both parents for a variable period after a child is born ; in the case of the Jakun, until the little one has acquired the use of its legs.

In various countries, too, where cannibalism was practised human flesh was generally taboo for women, and not infrequently also that of certain animals, such as the dog.

Attrition of Teeth in Native Races.—Nearly all races which are comparatively immune to caries show marked attrition of the teeth. It has been assumed that this *must* have been due to an excess of coarse or gritty material in the food ; but, as we have seen, this cannot be held to have been anything like sufficient in amount, since nearly all native races are most careful, in the preparation of their food, to eliminate all the obviously coarse particles and to cook it thoroughly. It is far more probable that the attrition is due to the mechanical effect of finer fibrous particles, combined with the con-

stant action of the *acids* of fruits and berries. In fact, this " attrition " is to be regarded as in every way analogous to the " wasting " produced experimentally by Miller upon the labial surfaces of teeth by the combined action of acids and tooth-brush, and simulating erosion cavities. A similar condition of attrition or " wasting " of the occlusal surfaces of the teeth is seen in people of gouty diathesis, and, as is well known, a majority of such people are *bons vivants*, and as a rule have a preference for acid beverages (such as port wine); but it cannot be claimed that their dietary is gritty or coarser than that of members of the same household who do not suffer from gout or attrition of the teeth. Undoubtedly, also, the musculature is more vigorous in native races and gouty individuals, and the " force " of mastication therefore greater; thus the acid and fine fibrous particles are aided in wearing down the cusps of the teeth.

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CHAPTER XVI

THE DIETARIES OF MODERN CIVILIZATION: THEIR ERRORS AND CORRECTION

ATTENTION has been directed earlier to the general "softness" which characterizes modern diets, resulting in a lack of sufficient stimulus to the jaw-bones—therefore in a crowded and irregular state of the teeth, and hence a predisposition to caries. The elimination of all fibrous elements from food, too, probably tends, as Wallace* has pointed out, to the increased lodgeability of foodstuffs, by robbing them of their detergent action upon the teeth. But, as has been shown, the inclusion of a large element of cellulose in foodstuffs does not of necessity prevent them from lodging and undergoing fermentation.

It does in some cases reduce the acid production, but the reduction bears no relationship to the amount of cellulose present.

There is another characteristic, however, of our modern dietaries which has been overlooked. I refer to its comparative non-sapidity, its usual neutral or alkaline reaction, and its general uniformity, all of which are properties which have been shown to be incapable of reflexly exciting a sufficient secretion of saliva to keep the mouth free by natural means from fermentation.

One only has to reflect for a short time, to come to the conclusion that the substances of which we consume most are those which have the least taste. In fact, paradoxical as it may seem, modern communities have acquired or developed a "taste" for tasteless things. This "taste" is not evolved; it is, I believe, acquired

* "The Physiology of Mastication," London, 1903.

by a process of training and education on the part of each individual. Compare the natural uneducated " tastes " of a child with those of an adult. The child will in all cases select the most sapid substances, and eschew the insipid ones as a rule, much to the horror of its parents. Moreover, if a child be allowed to exercise its own uninfluenced choice, it will almost invariably be in the direction of a substance having an acid reaction. It is the parents who, by constant training and insisting upon other articles of food being eaten, eventually produce in the child a tolerance of insipid substances.* This is done in all good faith by the parents for the child's health ; it is prevented from eating substances which they know would in themselves produce gastralgia and dyspepsia. But it is entirely a gratuitous assumption that a like result would be produced in a healthy child by the consumption of such articles in amount proportionate to its age.

The digestive secretions of the parent have become vitiated and depressed through long years of depression or maltreatment. A normal child's are in a natural condition, and adapted to deal with food in a natural form. I have frequently noted that very young children will deal with acid substances like fruit and salad quite successfully, yet a *proportionate* amount consumed by adults causes considerable discomfort.

It is within the knowledge of all, too, what enormous proportions of comparatively sour fruit may be consumed by the schoolboy with impunity.

If the salivary glands are in a state of proper development and excitability, all the ordinary natural acids should be rapidly *neutralized*—if not before being swallowed, at least almost immediately afterwards, by the increased after-flow of a highly alkaline saliva. Not only is the " education " of the reflex salivary mechanism thus neglected, but salivary secretion is actually de-

* The following sentence in a child's story-book unconsciously reflects a real physiological principle : " It was not so much the cake as the cherries in the cake that Norah liked."

pressed by the very much increased consumption of such articles as tea and meat. There is no doubt that children at the present time consume enormously more of these salivary depressants than they did a hundred and fifty years ago, when teeth were comparatively healthy.

From a dental point of view alone, neither tea nor meat could exert any harmful action by themselves, of course; but it is when they are taken in conjunction with soft, adhesive, insipid carbohydrates, as they usually are, that the harm results: even the feeble natural protection evoked by the latter is still further decreased.

Compare the dietetic conditions in England, say, one hundred or two hundred years ago, when caries was quite a spasmodic disease, with those obtaining to-day. Then there were no elaborate roller mills for the ultra-refinement of flour, bread was very largely "home-made" from flour ground between stone rollers; then there was no wholesale importation of meat from abroad, there were no enormous biscuit and chocolate factories pouring out hundreds of tons of tooth-destroying material every year, tea and sugar were both articles of luxury and very dear.

The practically universal drink at all meals was wine, French and Spanish being drunk by the upper classes, and English wine—*i.e.*, cider—being the drink of the middle and lower classes; and these, of course, were active salivary stimulants. Pepys wrote in 1660: "I did send for a cup of tee (a China drink), of which I had never drank before." England now receives from India and Ceylon alone 300,000,000 pounds per annum, and the consumption per head is between 5 and 6 pounds per annum.

The manufacture and consumption of confectionery has developed enormously of recent years, and in this easily fermentable sugars are largely used, not the least of which is honey. The production of honey for this purpose is conservatively estimated at 300,000 tons per annum. Again, honey by itself would not be anything like so harmful as it is when incorporated with finely pulverized and cooked starches.

The total consumption of sugar per head for the United Kingdom is estimated at 77·83 pounds per annum, and, seeing that nearly the whole of this probably is uncombined with an acid, it all has a potential for initiating caries.

The method of making bread nowadays by chemical aeration conduces also to caries. In the old-fashioned method yeast more or less pure was used in the "leavening" process, and also a not inconsiderable amount of salt (as is the custom in Scotland at the present time), the result being that the bread had a distinctive flavour of salt and a just appreciable acidity, due to the presence of acetic and lactic acids. Now, however, since "aeration" is produced by the action of acids on carbonate of soda, and since excess of the latter is always added to prevent sour taste, the resulting reaction is always alkaline, and therefore the bread is a salivary depressant.

In order to have some definite facts as to the average food of a modern civilized community, I collected the detailed dietaries of 1,500 public school children on one day. The age of the children varied from ten to fourteen years. The district was one in which there is practically no poverty, in which, too, the living is known to be good amongst all classes, yet it is one, also, in which caries is known to be present in over 90 per cent. of the children.

The following tables give in concise form some of the results of the inquiry; they are self-explanatory:

DIETARIES OF FIFTEEN HUNDRED SCHOOL-CHILDREN.

BREAKFAST.

Solids.

Article of Diet.	Percentage of Meals in which it formed a Part.
Bread and butter	64·4
Porridge	53·8
Eggs	47·8
Toast	37·8
Bacon (or meat)	33·4
Jam	10·6
Cake or biscuit	5·0
Fruit	1·6
Potatoes	1·0
Pudding	0·5

Fluids.

Article of Diet.	Percentage of Meals in which it formed a Part.
Tea	59·10
Milk	15·40
Cocoa	11·60
Water	7·00
Coffee	4·00
Lemonade	0·26

DINNER.

Solids.

Meat	75·0
Pudding or pie	61·6
Vegetables	55·6
Bread and butter	40·1
Biscuit or cake	19·6
Jam	10·0
Eggs	4·8
Fruit	4·2

Fluids.

Tea	31·6
Water	28·6
Milk	14·6
Soup	7·6
Lemonade	7·6
Cocoa	5·6
Coffee	1·4

TEA.

Solids.

Scones, cakes, or biscuits	76·8
Bread and butter	68·3
Meat	49·2
Vegetables	34·2
Pudding or pie	26·0
Jam	19·7
Eggs	6·4
Fruit	4·5
Salad	3·1
Toast	2·8
Cheese	2·6

Fluids.

Tea	65·8
Milk	11·1
Water	9·1
Cocoa	6·5
Soup	3·0
Lemonade	1·5
Coffee	1·3

SUPPER.

Solids.

Article of Diet.	Percentage of Children who took it for Supper.
Bread and butter	15·9
Cake	14·8
Biscuit	13·0
Chocolate	10·3
Scone	3·4
Meat	1·2
Fish and potatoes	1·2
Salad	0·7
Porridge	0·6
Fruit	0·0

Fluids.

Milk	12·6
Water	12·4
Tea	7·0
Coffee	4·1
Lemonade	3·6

In cases where no supper was taken, the last thing eaten at tea-time is recorded in the following table:

Cake	16·80 per cent.
Bread and butter	13·30 ,,
Pudding	5·40 ,,
Bread and jam	4·60 ,,
Biscuits	2·20 ,,
Meat and potatoes	1·20 ,,
Fruit	0·80 ,,
Tea	0·30 ,,
Soup	0·06 ,,

It cannot be suggested that these tables do not show an extremely liberal dietary; it is possible that in some cases a little more than the truth was told, but for the vast majority of the cases I am satisfied that these tables represent faithfully the dietary of the district. Such diets might be criticized from other points of view than the solely dental, especially bearing in mind that it is the food of children which is being considered.

Note, for instance, the enormous proportions of meat and tea which are consumed, loading up the systems of the children with alkaloid and extractive stimulants.

From a dental point of view, the diet may be very briefly summed up as being *salivary depressant and of high acid potential.*

A most remarkable similarity will be noted between the order in which the articles of diet are arranged in these tables and the order previously noted of their capability of acid production. They are also practically in inverse order to their power as salivary stimulants.

If nothing were known about the teeth of these children, it could be said with absolute certainty from these data that they would be found to be in an extremely bad condition. This, as has already been indicated, is so ; moreover, speaking from a considerable experience in examining the teeth of the children of this district, the incidence of caries in each mouth is appallingly high, so much so as to constitute a disgrace to any well-to-do civilized community.

One of the points of most importance is the food last eaten during the day, and therefore, in the majority of cases, débris of which would remain to be fermented during the night.

It is seen that bread and butter, cake, biscuit, and chocolate, are the articles which are last consumed in the great majority of cases—articles which adhere strongly to the teeth, form the greatest amount of acid, and produce the least flow of saliva.

It is, again, one of the most significant facts brought out by this inquiry, that *not one child in fifteen hundred had fruit of any kind last thing at night,* and that only 0·8 per cent. had fruit as the last thing at tea-time.

In view of the fact that fruit has been shown to be one of the best detergents and excitants of the solvent and neutralizing powers of saliva, its practically complete absence here cannot be regarded as other than one of the greatest causes of the prevalence of caries.

Although, naturally, diets vary in different localities and countries, and vary also amongst different classes in the same districts, yet it probably would not be

wrong to take the foregoing tables as representing an average dietary of modern civilization, erring, probably, on the side of liberality; but, still, the proportions of substances to each other for various meals (excepting. perhaps, meat and tea) would, I think, practically hold good. We may therefore conclude that the dietary of civilized communities at the present time errs seriously in the direction of being too soft, of having too high an acid potential, of being not sufficiently stimulating to the salivary glands and not sufficiently detergent.

In considering how such a dietary may be corrected, social and economic conditions have to be borne in mind; it is neither possible nor desirable that any sudden or drastic change should be made. Conditions must be accepted as they are found, and an attempt made to improve them.

It is impossible, for instance, under modern conditions to ban absolutely all soft and fermentable carbohydrates. Improvement in this direction may come in time, but it will be essentially a slow and gradual process, depending upon the rapidity with which people are educated to demand such an alteration.

Sufficient has, however, been said to show how the majority of food substances of high acid potential may be rendered practically innocuous.

It has been shown that by the combination of strong salivary stimulants with such substances, either in a mixture or, much better, in sequence, the acid production may be reduced to a minimum or entirely negatived.

What is therefore to be advocated is that *all meals should contain a fair proportion of salivary excitants, and, more important still, should both commence and end with some article of diet having an acid reaction.*

This does not of necessity imply a "vegetarian" diet; in fact, many "vegetarian" meals are distinctly conducive to caries on account of their soft, pappy, and adhesive nature.

The only meal in which the principle of salivary

stimulation is usually correctly observed at the present time is a dinner commencing with *hors d'œuvre*, and terminating with *fruit* as dessert.

A similar arrangement, however, can be quite easily arranged for all other meals. When garden fruit and vegetables, particularly the "salad" variety, are in season, this should present no difficulty whatever, and the length of "season" is constantly being lengthened by the importation of fruit and vegetables from warmer climates; in fact, at all seasons of the year now, and practically everywhere, some fresh fruit at least is available.

For *breakfast*, porridge with salt may form the initial stimulant. This may be followed by anything else customary to the individual, such as fish, bacon, bread and butter, and marmalade or jam; the latter should have a distinctly acid flavour, and should not be merely syrup flavoured with fruit-juice, as too many of the factory-made articles are. The meal should be concluded with some form of fresh fruit—orange, apple, banana, pineapple, pears, plums, etc.—preferably raw, but they may be "stewed."

For *luncheon* or the midday meal, the initial stimulus may be some modified form of *hors d'œuvre*, such as a radish or a small portion of some acid fruit.

With meat some form of sauce may be taken; such things, being nearly all acid, serve as excellent salivary stimulants. (There is no objection to children taking *small* quantities of these sauces. I have never seen any ill results follow.) The meal may be concluded with stewed fruit, fruit pudding or pie, provided that in the latter the fruit predominates, and not the starchy element, and that it is not made too sweet. "Salad" should, of course, be taken wherever possible, but its good effect may be entirely neutralized by its being followed, as it too often is, by a biscuit and coffee or some form of confectionery and tea.

Tea, especially when it is the last meal of the day, is

the one most responsible for the production of caries. It almost invariably ends with cake and a second or third cup of tea, containing probably, in the vast majority of cases, a high percentage of tannin. Thus absolutely ideal conditions are brought about for acid fermentation to take place in the mouth. There are a number of salivary stimulants which may be included in this meal, such as tomato, cucumber, cress, sardines, shrimps, or fruit sandwiches. Fruit salad or any fruit in season should terminate the meal.

Last thing at night, children (and adults too) should always eat a small portion of some detergent and acid fruit, such as orange, apple, pear, or pineapple.

Taken in such a manner, the total amount of fruit and vegetable need not be large, and in no case should such a dietary be commenced suddenly; it should, especially in those who have been unaccustomed to the inclusion of fruit and salad in their dietary, be worked up to gradually, commencing with one meal a day; then, after a week or so, two meals may be terminated with "acids," and finally the principle may be extended to all meals.

Should any intestinal irritation be set up, the inclusion of boiled milk in the dietary will correct it; this I have found to be but very occasionally necessary, and only in the initial stages.

The much-dreaded bugbear "diarrhœa" is much more likely to be caused by eating fruit in an unclean condition than to be due to the mechanical or chemical action of the fruit on the bowel. All fruit, therefore, especially that of unknown source, should be well washed or have the skin removed before being eaten. The only effect of fruit taken regularly and in such moderate quantities is to insure a full and regular action of the bowels.

In special cases the reaction and amount of saliva should be estimated during the change, to see that the desired result is being produced; and when the maximum

amount and alkalinity per minute have been reached, any increase in the acidity of the dietary should be stopped, and it may even be decreased a little.

The difficulty, in many cases, of adopting such a dietary may be on account of expense and inaccessibility of fresh fruit and vegetables. Tinned fruits are, however, now everywhere available at moderate cost; and these, especially pears, pineapple, and apricots, may be substituted, not with advantage, but as being better than nothing.

In respect to fluids, children particularly should never drink tea, and the less it is consumed by adults the better, even from a dental point of view alone.

Milk, water, home-made lemonade, and weak lime-juice, are the beverages suited for children. Lemonade should not be too strong, and should contain a sufficiency, but not an excess, of sugar; that is to say, the acid should be quite appreciable to the child, and should be sufficient to precipitate the mucin and prevent the sugar from being fixed to the teeth.

If similar beverages were more consumed by adults, it would, I think, largely lessen the craving for tea and sweetmeats so prevalent at the present time.

As regards *sweets*, all are good in that they are salivary stimulants, and all are bad in that they are readily fermentable; and as a general rule it may be said that the ill effects quite outweigh the good effect. They all (practically) leave sugar behind in the mouth to be transformed into lactic acid—chocolates and caramels most, and hard-boiled sweets like toffee least. The old-fashioned "acid drops" are possibly the least harmful. Children should, however, be encouraged to spend their pocket-money on fruit rather than on sweets, and on biscuits least of all. Almost all children prefer fruit to sweets if they are allowed to exercise their choice. Of the 1,500 children whose dietaries I examined, 90·35 per cent. said they preferred fruit to sweets, and only 9·65 per cent. preferred sweets; yet the amount

of sweets consumed by these children was enormous, and the amount of fruit a minimum. I think there is no doubt that a growing child can obtain all the sugar it needs for its muscles, fat, and heat development, from consumption of it in a natural form—*i.e.*, as found in fruit and some vegetables.

Bunge * has called attention to the danger of the great increase in the consumption of pure sugar in recent times, pointing out that it must diminish the amount of vegetable foods in the diet, thus leading to a loss in the supply of calcium, iron, fluorine, and other mineral ingredients to the blood. Hutchison is also of the opinion that it may be connected with the increased commonness of diabetes.

It is commonly affirmed in textbooks that one of the articles which have been quoted as salivary stimulants—*i.e.*, cider—destroys the teeth. With this the author cannot agree, having had considerable experience of the teeth of the inhabitants of one of our cider counties, and also of those of other counties and countries. The difference between dentures from this county, and those from an adjoining county where mining was carried on, and fruit and cider were not available, was always most marked and obvious; and whenever the mining community makes an excursion into the cider county, their avidity for fruit is, to say the least, very pronounced.

It has been stated that the consumption of large quantities of grapes in those patients undergoing a "grape cure" has bad effects upon the teeth. I have no knowledge of this; but if so, it is probably attributable either to the grapes being too ripe and hence acting, as has been shown, as very feeble salivary stimulants, or, if not too ripe, to the constant presence of too much acid in the mouth proving more than the saliva can neutralize; possibly the glands get overworked, and do not have time to recuperate.

* Quoted by R. Hutchison, "Food and Dietetics," p. 280.

Black* some years ago came to the conclusion, after "a hasty examination" of dried skulls, that there was a connection between immunity to caries and sour-fruit eating, but apparently abandoned or did not follow up his conclusion; and Leon Williams † states that the Sicilians, who are large consumers of *lemons*, are particularly free from caries.

Note on the Soured Milk Treatment.

However beneficial this treatment may be for other portions of the alimentary tract, there can be no doubt that as a general rule it must be harmful to important organs of the first part of the tract—*i.e.*, the teeth. Not because the milk is sour—in that respect it can be only beneficial—but because a large number of lactic acid organisms are introduced into the mouth, and these of a variety specially selected on account of their ability to form a maximum amount of acid. The following tests with soured milk give examples of what may happen:

Two persons, A and B, drank ordinary milk, and then each insalivated 2 grammes of bread; this was incubated for forty-eight hours, and the acid formation estimated—

A = 2·83 units ($\frac{N}{5}$ NaOH).
B = 2·8 ,, ,,

Milk which had been infected with lactic acid bacilli (fermenlactyl) for eighteen hours at body temperature was then drunk, and 2 grammes of bread again insalivated by each. In forty-eight hours the acid production was—

A = 4·6 units.
B = 4·7 ,,

This considerable increase in both cases could only have been due to a considerable increase in the initial

* "American System of Dentistry," p. 730.
† Quoted by Goadby, "Mycology of the Mouth," p. 139.

number of organisms present in the mixture, and there is no reason to doubt that the figures represent the proportionate tendency to tooth destruction in both cases.

Both of the above individuals were susceptible to caries ; a similar test was made with an immune person :

After ordinary milk, the bread yielded in forty-eight hours 1·4 acid units.

After soured milk the bread yielded in forty-eight hours 1·2 acid units.

The difference between this and the two former tests is very marked ; not only is the acid protection from the control only one-half of what it was from the susceptibles, but also the amount of acid produced from the bread masticated after soured milk was less than the control. The results are to be explained entirely, I think, by the increased neutralization by the saliva of the immune. It therefore seems clear that in the average individual—*i.e.*, one susceptible to caries—soured milk may prove to be very harmful to the teeth. In order to combat this the teeth should be cleaned, and a salivary stimulant used immediately after taking the milk (or powder). To expect to remove the introduced organisms by rinsing the mouth out with water for half a minute or so would be futile. I would suggest the eating of a piece of orange as one of the simplest and best prophylactic measures which could possibly be adopted.

CHAPTER XVIII

THE NEED FOR SPECIAL LEGISLATION

THERE can be no doubt that the gravity of the disease with which we are dealing is not recognized by the laity, and therefore not by Governments. The extent of the disease is beginning to impress itself upon authorities now that the examination and possible treatment of school-children is being undertaken at the public expense. So far, however, the cost involved in the treatment of dental caries by " fillings " on a universal scale has appeared to be so great as to hinder any other than isolated efforts in this direction. But even now that it is beginning to dawn on authorities and public bodies that 90 per cent. of the children have carious teeth, the seriousness of what this means, the gravity of the ills to which the condition is precedent, is not in the slightest degree appreciated.

It is perhaps agreed that " bad teeth cause indigestion," and that is as far as the sequence of events is followed. This is bad enough in itself, for how can it be hoped to rear a nation of mentally and physically strong individuals if, during the periods of growth and development, there is indigestion, and therefore *non-assimilation of food?* Added to this is the slow, insidious, but nevertheless sure, chronic septicæmia, brought about by the constant ingestion of toxins, pus, and bacteria, from a mouth containing numerous suppurating foci. It must be recognized, too, by the public that anæmias of severe type are frequently induced in the same manner; that tubercular glands of the neck, serious

forms of Ludvig's angina, frequently fatal, are also caused by diseased teeth ; that malignant disease (cancer) of the jaws, tongue, and lips, often originates solely from diseased teeth, and from this cause alone a large number of lives is lost annually ; that a large number of disorders of the adjacent parts—*i.e.*, muscles, bones, nose, eyes, and ears—are intimately associated with diseased teeth, either reflexly through the nerves or by direct extension of the morbid process ; that in conditions of unstable cerebral equilibrium the presence of diseased teeth is frequently sufficient to excite an attack of nervous disease, such as epilepsy, tic (spasms), hysteria, and some forms of insanity ; that, in addition to all these ills, of which large numbers of cases have been, and are constantly being, recorded, there is a chronic lassitude, lack of appetite, mild headache, constipation, and *an inability to perform a normal amount of work*, almost invariably associated with extensive dental disease. It is this relationship between cause and effect which requires to be driven home in the public mind. The disease itself is not always obvious, and the channels by which its effects spread are not recognized.

If the disease were more obvious, there is no doubt that long ago the public mind would have been stirred, and legislation would have been passed to facilitate the checking of such universal suffering. Suppose, for instance, every alveolar abscess pointed on the face instead of in the mouth, the hideous disfigurement resulting therefrom would long ago have arrested attention ; yet probably in this case the harm to health would be infinitely less, because the products of disease would be to a certain extent outside the body, and not, therefore, absorbed into the system.

Suppose a similar condition affected the finger-nails—suppose that 90 per cent. of the community went about with decayed or suppurating finger-nails—the idea would long ago have been so revolting that extensive measures would have been adopted for the suppression

of such a disease; yet the total systemic disorder and the annual loss of life would have been far less than it is from dental disease.

The report of the Royal Commission on Physical Deterioration found that dental caries was a potent cause of physical deterioration, and Osler is of the opinion that in this respect the effect of dental disease is greater than that of alcohol. On humanitarian grounds alone, then, action is urgently required to suppress the advance of this most prevalent of all diseases. The principle has been recognized in nearly all communities now, that the Government is responsible in the main for the health of the nation; and in cases of serious epidemics, of widespread toxic effects, of disease affecting large proportions of the people, legislation is provided enabling authorities to cope with the evil. Surely a disease affecting 90 per cent. of the population, and as far-reaching in its effects as this has been shown to be, is a national ill, and demands legislative measures. Legislation has been enacted for diseases which affect a far less percentage of the population, and from which the loss in national health and wealth is far less. Take, for instance, the laws controlling and limiting such diseases as phosphorus-poisoning, lead-poisoning, prohibitions on the sale of alcohol and opium. But the effects of these are obvious, and therefore have secured attention and a large measure of suppression.

Legislation is demanded upon economic grounds. It must be perfectly obvious that any disease or factor which deleteriously affects the majority of the workers and wealth-producers of a nation is one which demands the serious consideration of legislators.

At the very lowest estimate, the annual economic loss in Great Britain alone from this cause cannot be less than a million and a half sterling. This is based upon the assumption that the average extent of caries is three teeth per individual, and that each of these teeth causes one hour's loss of time and work per annum, and

that the average value of this time is as low as threepence per hour. This works out at a sum of £1,687,500, taking the population at 45,000,000. As a matter of fact, the real sum must be far in excess of this, taking into consideration the prolonged economic loss incurred by the secondary occurrences of malignant disease, tubercular glands, pernicious anæmias, cerebral disorders, and the chronic debility mentioned above. The fact, also, that many of the people so afflicted become a positive charge on the community by occupying space, time, and attention in hospitals, workhouses, and asylums, tends further to increase the national loss.

There can be no doubt whatever that a very large proportion of the cases occupying the beds and attending the out-patient departments of our general hospitals are there solely because of primary dental disease, which has led to grave secondary disorders. The recovery, also, of many patients suffering from a number of diseases having other than a dental origin is seriously hindered and prolonged by the presence of a septic mouth. Especially in this respect are thousands of pounds wasted annually in the sanatorium treatment of phthisical patients, who either cannot masticate properly the food abundantly supplied, or in whose mouth it becomes incorporated with a quantity of septic and toxic material, the constant ingestion of which either prevents or considerably retards recovery.

The Form of Legislation.

It has been amply demonstrated that the prevalence of caries is due to the habitual consumption of "artificial" as opposed to "natural," articles of diet. Most of the forms in which starchy and sugary foods are taken at the present time can only be regarded as luxuries, and, moreover, as dangerous luxuries—at least as dangerous as alcohol, for instance; and, like alcohol, they should be taxed. The manufacture of sweetmeats,

confectionery, and fine white flour, should be carried on only in bond; and all such articles should be subject to Excise, either when manufactured at home or imported from elsewhere. The amount of the taxation should be sufficient to appreciably diminish the demand for such commodities, and the moneys so collected should be applied to the cheapening of other equally nutritious and less harmful forms of food—not less harmful only, but actually preventive of dental disease. Particularly the culture, carriage, freight, and importation, of fruit and fresh vegetables (and of meat in some places) should be fostered and aided, so that such articles may come (especially fruit) to be regarded as common, ordinary, and necessary constituents of every meal, instead of being, as at present, regarded as unnecessary and too expensive for common and constant use. Such legislation might well accord with a " back to the land " or " closer settlement " policy, the desirability of which, on economic grounds, is so much advocated.

In addition, *the preventive treatment of dental caries must be made one of the most important branches of the public health service. To initiate and organize a department to deal efficiently with this branch alone, would be a source of national economy.*

The present system of inspection and advice is good and necessary, and is a step in the right direction; but by itself it is futile, and almost useless to stem the tide of this national disease. The proposed system of treatment by means of fillings and extractions on the most extensive and costly scale can hardly be much better; it is to be regarded as a policy of expediency rather than of principle. No universal method of treating disease can be recognized as being upon right lines; no enormous expenditure of public money for the treatment of disease can be justified unless that treatment strikes at the cause of the trouble, and gives some reasonable hope that the incidence of the disease will be materially lessened. If the simile may be pardoned, such

schemes are as if an army of small boys were pelting a glass house with stones, and the owners, instead of attacking and dispersing the cause of the trouble, employed an equally large army of workmen to be constantly repairing the damage as it went on. There would be two inevitable results: the vigour and number of the attackers would increase daily, and the work of the workmen would deteriorate.

There is but one rational way of treating disease on a large scale—that is, by building up the resistance, active and passive, of the individual to the disease, and by removing any obvious source of disease. How this may be done in the case of dental caries we have already considered in detail, and it is along such lines that State intervention seems to be required. The national health demands legislation. The pain and suffering, the lowered mental and physical condition, of the little children cry aloud for help. The people, their parents, are for the most part blind and ignorant as to the cause and remedy. For the removal of this ignorance, for placing means for combating the disease within the reach of all, and for making disease-causing factors less accessible, the State must be responsible

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Milwaukee 3, Wisconsin