had dwindled, in later Roman times, to a condition not unlike that of the marshes of Bellegarde before they were drained in the eighteenth century. History, in fact, seems to have repeated itself twice in this period, and the great spread of water which may be inferred as having been originated by the eighth-century subsidence, was preceded by a similar one, resulting from a subsidence, not greatly

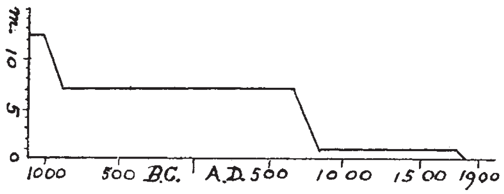

FIG. 3.—Variations, during the last 3000 years, in the height of the Rhone delta above sea-level.

differing in magnitude, at somewhere about 1000 B.C. In both cases succeeding centuries saw the lake gradually diminishing as it became filled up and narrowed by the alluvial deposits of the Rhone.

Accepting this interpretation we may draw a graph of the level at which the delta stood, relative to the present level of the sea, for the period during which there is any historical record. The result is an instructive and interesting one, for we see that, while the change has been always downward, uninterrupted by any appreciable upward movement during the last three thousand years, it has not been slow and continuous, but limited to three periods during which the change was more or less rapid, separated by much more prolonged periods during which no change took place, or only to an inappreciable extent.

It is natural to inquire whether these changes were localised in the delta of the Rhone, or formed part of a widespread change in the level of the Mediterranean. It is scarcely possible that a change of 20 feet at Passon would not have extended so far as Fos, only ten miles away, and this may well be the explanation of the fact that an important and prosperous town, such as was Fossae Marianae in its prime, has left no remains of buildings adequate to its former importance, the site of the docks, warehouses, and public buildings having sunk beneath the sea. Farther afield, however, the evidence becomes contradictory and unconvincing; on one hand there is the existence, at several places along the coast, of Roman constructions, which archæologists have described as the remains of piers, harbours, and fish-stews, but the interpretation is a matter of opinion and open to argument; on the other hand, there are structures which must originally have been built above sea-level, and are now partially submerged, but none of these gives positive proof of more than a very few feet of change, though they are not inconsistent with movement of larger amount. The question calls for fuller investigation, and until this has been carried out it is impossible to assert that the changes of level which can be recognised in the deltas were not localised to that region; for the present they cannot with safety be regarded as having any bearing on the question of whether there has been a widespread change in the relative level of land and sea, affecting simultaneously and as the result of a common cause any large fraction of the Mediterranean, to say nothing of the Atlantic Ocean as well.

Diet and the Teeth.[1]

IN the course of Prof. E. Mellanby's researches on rickets in dogs, which led to the discovery of the antirachitic vitamin, now known as vitamin D, it was noticed that defects in calcification were not confined to the long bones, but occurred also in the jaws and teeth of animals maintained on defective diets. Mrs. Mellanby followed up this point, and during the last decade has published numerous papers upon the influence of the diet upon the teeth, and also upon the relationship between dental structure and disease. A detailed account of this work is in preparation, and is being published in three parts: the present volume is the first of the series and is being followed by Part II., upon dental structure in other animals than the dog, and upon the production of dental disease, and by Part III., upon the structure of human teeth and the relationship between structure and caries.

The dog was selected as the experimental animal of choice, since wide variations of dental structure can be readily produced: it is, moreover, omnivorous, like man, and can be readily kept in health under strict laboratory conditions; it is easy to handle, and its teeth can be readily examined at any time. Like man also it shows a deciduous and permanent dentition.

The report describes in detail the various points to which attention was paid in each of the experimental animals; notes were made of the general health as well as of the condition of the mouth; macroscopic examination of the teeth and radiographs of the jaws and teeth during life were followed by microscopic examination of the teeth and related structures post-mortem, special attention being directed to the large carnassials in the upper and lower jaws. The various grades of calcification are best studied in photomicrographs of ground sections of the teeth, of which numerous excellent reproductions are included in the report; at the same time enlarged photographs of the crowns readily show up deficiencies in calcification of the enamel.

The standard basal diet used throughout had the following composition: cooked cereal 100-200 gm., separated milk powder 10-30 gm., raw 'lean' meat 10-20 gm., oil or fat 10 c.c., orange juice 3-5 c.c., brewer's yeast 5-10 gm., and sodium chloride 1-4 gm. If 3 c.c. of the oil consists of cod-liver oil, perfect health and perfect dental structure are observed, indicating that the diet is now adequate. Small quantities of fat-soluble vitamin occur in the milk

[1] Medical Research Council. Special Report Series No. 140: Diet and the Teeth, an Experimental Study. Part 1: Dental Structure in Dogs. By May Mellanby. Pp. 308+109 plates. (London: H.M. Stationery Office, 1929.) 17s. 6d. net.

powder and in the fat remaining between the fibres of the lean meat, but not sufficient to prevent the development of marked rickets and gross defects in dental structure when the fat used contains little or none of this factor.

The following influence the structure of the teeth: the diet, especially its vitamin D, calcium and phosphorus and cereal content; the rate of growth and previous dietetic history of the animal or its mother and certain environmental conditions. Of these the most important is the vitamin D intake.

When this work was begun, vitamin D had not been differentiated from vitamin A; many experiments were carried out to determine the distribution amongst foodstuffs of the calcifying factor; in general it was found in foods which were known also to be sources of vitamin A, but certain discrepancies were observed, which in the light of later knowledge are readily explained by the fact that the two vitamins are different entities. In some respects the tooth of the dog appears to form a more delicate test for the calcifying vitamin than the rickety rat, differences in potency among a series of vegetable oils being readily observed; thus coconut oil contains a fair quantity, and it is also present in some samples of arachis oil; rapeseed, palm kernel, and cottonseed oils contain little or none, and it is absent from olive and linseed oils and vegetable margarines. Certain animal fats form much richer sources, most notably cod-liver oil; it is also present in beef-suet and butter, but is absent from lard and hydrogenated animal fats.

Calcification of the teeth and jaws is also greatly improved by whole milk and egg-yolk; cabbage may have a slight effect, but no calcifying vitamin was detected in carrot; and extensive experiments showed that protein, such as meat protein, caseinogen, eggwhite or legumes, carbohydrate, such as glucose or a diastatic digest of a cereal, lemon-juice (as a rich source of vitamin C) and yeast (as a rich source of vitamin B) had no influence in improving the structure of the teeth of puppies on the basal diet.

Mammalian liver-fat, which contains abundant vitamin A, had little effect on calcification; complementary to this result is the more recent finding that irradiated ergosterol, a source of vitamin D unmixed with vitamin A, exerts an extremely powerful influence upon the calcification of the teeth.

Vitamin D was found to be destroyed by prolonged exposure to heat with simultaneous oxygenation of the fat containing it, the actual conditions necessary depending on the fat treated; at the same time some evidence was obtained that harmful products were actually produced by this treatment in cod-liver oil and butter. Methylation of cod-liver oil also resulted in considerable destruction.

Since the hardness of bones and teeth is due to their content of calcium and phosphorus deposited as inorganic salts in the original organic matrix, it is clear that the diet must contain both these elements if calcification is to proceed normally. The experiments of Mrs. Mellanby have indicated, however, that the amount of each present in the diet and the Ca : P ratio are of little significance in promoting or hindering calcification as compared with the intake of vitamin D. In the rat, on the other hand, rickets cannot be produced unless the Ca : P ratio is high. In puppies, when vitamin D is abundant in the diet, perfect calcification of the teeth occurs even when the calcium intake is very low; on the other hand, when the vitamin D intake is moderate or low, addition of a calcium salt, such as the carbonate or phosphate, results in definite improvement of calcification. Thus butter containing moderate amounts of vitamin D is more effective as a calcifying agent when separated milk is added to the diet, the latter acting as a source of calcium, and butterfat which contains no calcium is less efficient than butter. The effect of the addition of calcium depends not only on the absolute vitamin D intake, but also on that relative to the nature of the cereal in the diet.

One of the most interesting results obtained in the course of the work is the fact that varying the nature of the cereal in the diet, all other constituents being the same, also varies the degree of calcification of the bones and teeth. With oatmeal as the cereal the structure of the teeth is the most defective, with white flour the least; other cereals lie between these two in the potency of their anti-calcifying effect, in order, other preparations of oats, rye, barley, maize, the germ of wheat and maize, wholemeal flour and rice; bran has no influence, whilst rye germ exerts a positive calcifying effect. Examination of the various constituents of oatmeal showed that the anti-calcifying factor was not the fat or the protein, although it might in part accompany these constituents when extracted; nor was it related to the carbohydrate, nucleic acid, or calcium and phosphorus content, or to the acid-base ratio of the cereal. Rye germ, as well as ergot of rye, were shown to contain small quantities of vitamin D; after the fat had been extracted from the former, and with it the vitamin, the residue had a definite anti-calcifying influence. Destruction of this factor occurred on heating the cereal with 1 per cent hydrochloric acid or caustic soda for 1½ hours; heating alone had little effect. Malting also resulted in some destruction, provided the germinated cereal was allowed to stand for a few days before consumption.

Since the cereal forms the chief energy producing constituent of the diet, varying its amount in the diet varies also the number of calories available, and within limits, the growth rate of the puppy. On the same diet more rapidly growing animals have worse calcified teeth than those growing more slowly; hence, to obtain comparable results, it is necessary to limit the food consumption of a series of animals to that of the one with the smallest appetite.

Experiments on the influence of environment on tooth calcification indicated that confinement played no part; the important factor in this connexion is exposure to sunshine. Similarly, irradiation of the animal by a mercury-vapour lamp resulted in improved calcification, but under the conditions used was not so effective as adding cod-liver oil to the diet; irradiation of various food materials also improved their calcifying action: for example, olive oil, butterfat, oatmeal, and maize germ, due to the production of vitamin D from the ergosterol present in them; as was to be expected, even small amounts of irradiated ergosterol can give nearly perfect calcification.

Vitamin D can be stored in the body; hence offspring from a mother well supplied with it show greater resistance to an imperfect diet than young from a mother kept herself on this diet; evidence was obtained that the mother supplies the young from her own stores when her intake is deficient. The structure of a tooth is permanent, so that variations in the diet at different periods will be reflected in variations in its structure; in contradistinction, imperfectly calcified bone will be reabsorbed when the diet is improved. Improvement of a bad diet will be reflected immediately in improved calcification of the later-formed dentine; but a change from a good to a bad diet will have little immediate effect, owing to the availability of the body's stores of vitamin D.

The work here presented proves convincingly that the structure of the teeth of puppies depends almost entirely upon the intake of vitamin D. Even although the diet given was soft and pappy, perfectly formed teeth and well-developed jaws were produced, provided a sufficiency of the vitamin was given. Exercise of the jaws appears to depend upon the general health; giving an animal something hard to gnaw will not produce well-developed jaws when the vitamin intake is low.

The application of these results to man and the relationship of structure to dental disease will form the subjects of Parts II. and III. of Mrs. Mellanby's reports. Considering that rickets occurs in both man and the dog, it might be expected that diet would have an influence upon the structure of human teeth. Caries of the teeth, however, does not occur in the latter, so that a relationship between this disease and structure must be determined in other animals or in man himself. Some evidence of such a relationship has already been published (see, for example, the *British Dental Journal*, 1928; July 15); the final reports will be awaited with interest, owing to the importance of such a conclusion for the prevention of human dental disease.

Obituary.

PROF. AUGUSTINE HENRY.

AUGUSTINE HENRY was born on July 2, 1857, coming of an old Derry family, and possessing to the full the delightful characteristics of the Irish race. He was educated at Queen's College, Galway and Belfast, and was trained as a medical man, being L.R.C.P., Edinburgh. He began his career as an attached medical officer of the Chinese Imperial Customs at Shanghai. In 1882 he was appointed in this capacity to the Customs Station at Ichang on the Yangtze, where he remained for seven years. Here he commenced to interest himself in the flora, following in the footsteps of earlier medical officers in India, such as Wallich, Falconer, Cleghorn, Hooker, etc. As with these officers, it was doubtless the medicinal possibilities of the many unknown plants which aroused Henry's interest at the outset. Even more than in India, China is the home of the *materia medica*, the great therapeutic value of many bulbs, roots, and leaves of common plants being known to the Chinese. The legendary Emperor, Chennung, was, so tradition has it, a great exponent of the medicinal values of plants. So keen was this interest that it is said that Chennung had a glass window fitted into the wall of his stomach in order to study the reactions of different plants on the alimentary system! Henry will be remembered in horticultural circles as the introducer of the beautiful *Lilium Henryi* and many other Chinese plants.

It was during his sojourn at Ichang that Henry commenced his explorations and investigations into the flora, and thus became the first of a select band of adventurous spirits who investigated the flora of central and western China. One predecessor there had been, Robert Fortune, who first went to China in 1842 to collect plants for the Royal Horticultural Society, and afterwards, in 1848, on behalf of the East India Company, introduced the tea plant into India. But Fortune's work was carried on in other parts of China. Henry's collections were chiefly of dried plants, and he wisely sent those first made to Kew, where they were received by Thiselton-Dyer with high appreciation: for their examination soon showed that a new flora was being tapped. For example, the collections from Hupeh (made in 1888), a botanically unexplored country, were found to contain 500 new species of plants and 20 new genera. It was here that Henry came across the flowering tree *Davidia*. This is now well known in Great Britain, but the seed was not sent home by Henry. Veitch, of Chelsea, sent out E. H. Wilson, who afterwards became famous for his collecting work, and the latter obtained the seed.

After a year's leave at home, where Henry found himself eagerly welcomed in botanical circles, he returned to Shanghai, and was soon transferred to Formosa (which had not then been made over to Japan). During three years spent there he collected assiduously and greatly enriched our knowledge of Formosan plants, publishing later a first account of the flora of Formosa. Henry had for some time previously ceased to practise medicine. In 1896, Sir Robert Hart transferred him to Mengtse in southern Yunnan. In this region he collected extensively, and sent home large collections containing many new species. He discovered the wild tea plant whilst exploring the virgin forests in the mountains south of the Red River in south-east Yunnan. This plant had not previously been discovered out of Assam. He was afterwards stationed at Szemao, where his