

Bradshaw Lecture

ON

SUBTROPICAL ESCULENTS.

Delivered before the Royal College of Physicians of London.

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THE purpose of this lecture is to bring before the College knowledge acquired during a long experience of the esculents, both animal and vegetable, produced where winter does not forbid—esculents which increasing communication, rapid transit, and modern methods of preservation have made available for us in their first freshness, when the short cold days of the north have restricted the profusion of our home-grown supplies.

In the limits of one brief lecture I can only hope to touch the fringe of so great a subject, although I also hope to justify a transgression beyond the limits which have hitherto confined the subject-matter of our annual Bradshaw Commemoration.

VEGETABLE FOODS.

I propose first to deal with vegetable esculents, selecting such examples as may best illustrate the growing importance of the food, vital and accessory, with which we can supplement home production.

Custard Apples, Smooth and Reticular.—The common custard apple, *Anona cherimolia*, grows abundantly in Madeira up to 1000 ft. above sea-level, and is exported to England in ever-increasing quantities. It matures in October and is available until April; the fruit is gathered when fully developed and ripens perfectly during the three days' voyage to Europe. There are many varieties; the best are scantily reticulated and bear few seeds. The typical fruit is not met with in perfection south of Madeira, though other species, such as the squamose, are common in the Cape Verde Islands. It will not bear a long journey and the specific delicacy of flavour is completely lost by cold storage. The stony, hard, black seeds of this delicious fruit survive beneath our feet in the Trafalgar-square district of the London clay, and indicate to some extent the nature of the flora of this latitude in Eocene times.

Cruciferae.

The principal edible species of the cruciferae abound in all the Atlantic islands, but are not exported.

Water-cress.—Among the cruciferae *Nasturtium officinale*, the common water-cress, occurs in every mountain stream, and is largely used as an ingredient in Spanish and Portuguese soups. A spinach of water-cress into which fragments of the fungus *Boletus edulis* have been crumbled makes a dainty and agreeable nutriment. It is held in high repute as a remedy in pulmonary disorders and in the treatment of gout and rheumatism, and I have seen marked advantage derived from its use in the latter maladies. I was informed by a Scottish landowner that the cattle feeding in meadows which were traversed by a meandering stream stocked with water-cress were entirely exempt from the rheumatism and swollen joints affecting the rest of his flocks and herds, and that they retained the immunity thus acquired when they had migrated and mixed with other stocks.

The cruciferae are pre-eminent in the natural orders for their antiscorbutic qualities; *Cochlearia officinalis* must not escape notice in this respect.

The Mango: the Genus Citrus.

Anacardiaceae: Mangifera Indica.—The mango, though comparatively rare in the Canary and Cape Verde Islands, is very common in Madeira, fruiting abundantly when 10 years old. The oval yellow and pink-flushed fruit, stringy in substance, abounds with a rich nectarine-tasting juice not free from a resinous or carrot-like suggestion. Though distinctly smaller and less luscious than the more highly matured West Indian fruit, the Madeira mangoes carry well and find a ready sale in London during October and November. An attractive variety of the Bombay mango has recently been imported into Madeira, which is beginning to yield abundantly a somewhat larger fruit, free from fibre, but with a flavour slightly inferior to that of the wilder sorts.

The orange, *Citrus aurantium*, is found in all the Atlantic islands, varying in quality with local circumstances and environment. As it bears transport from distant regions and

is not hurt by cold storage, there is here never any lack of the orange; the importance now ascribed to its juice in averting deficiency disease and its value in the diet of quite young children have enormously increased the perennial demand and consumption of this important fruit. At one time the Argentine ant, in association with several species of coccus and lecanium, completely destroyed the orange plantations in Madeira; but a means of dealing with this terrible pest has now been established, and once more both *Citrus aurantium* and *Citrus nobiliss* (the tangerine) flourish unrestrained in the valleys of Madeira.

Lemon.—*Citrus limonium* in several varieties, common lemon, matchless in size and flavour, is found in all the Atlantic islands, but the lime is neglected.

Citron.—The Madeira citron, *Citrus medica*, has world-wide commercial importance, and is grown almost exclusively in a deep steamy valley 2000 ft. above the sea-level; it is, perhaps, the only satisfactory fruit of its kind imported into this country.

Plant Lice and Ants.

Many forms of aphids and coccus attack the Aurantiaceae; they are mostly apterous, the males appearing for a short season; but in one species of lecanium, yearly more and more common, the female is also winged, and thus able to spread her progeny far and wide. They are all singularly dependent on the fostering care of the small Argentine ant, and are no longer formidable when this nursing is withdrawn. In a British Association paper on the life-history of this ant last year I showed that 40,500 ants in association with their fostered plant lice were engaged in draining a single lemon tree of its vitality. The female ant of the Argentine species undertakes none of the cares of motherhood, but after impregnation sheds her wings, issues forth with the workers, and in her apterous state continually founds new colonies. There seems to be an ebb and flow in the prevalence and fecundity of many species, both animal and vegetable, and the ebb phase has for some years limited the activity or propagation of the apterous *Aphis phylloxera vastatrix*, which, when first introduced, practically swept the vineyards of Madeira out of existence, but which is now almost negligible. So, also, some of the testacea, *Helix aspersa* and *Stenogyra decollata*, for example, are sometimes swarming and at other times hardly met with. Among plants the useful *Physalis peruviana*, the so-called Cape gooseberry, has its waxing and waning periods, and other solaceous examples are similarly liable to the same oscillation of activity.

The Vine.

The vine—commercially negligible further south in the North Atlantic—is now resuming its proper place in Madeira, being cultivated from the sea-level to 2000 ft. above; the ravages both of the *Oidium* leaf fungus and of the root-sucking *Phylloxera vastatrix* are well under control. I have no space to describe the methods of Madeira vine cultivation; and I have only a word to say of the wine itself. Before me are two specimens, one to illustrate the keeping qualities of this specific wine and the other carrying interesting associations. The wine of the vintage of 1792 is still in perfect order and is typical of a slowly matured Madeira wine. The second specimen is a wine which, when about 10 years old, was tasted at my table by Sir Wyville Thompson and some other members of the *Challenger* Expedition of 1878. I sent a cask of the wine in that famous ship for the specific development a sea voyage is suppose to impart.

Need for Further Deep-sea Exploration.

But the name of the *Challenger* has other references in this College, and I should be neglecting an opportunity if I failed to emphasise the need of further deep-sea and similar explorations. Another *Challenger* expedition is long overdue; knowledge has increased, methods of investigation have improved, great food-supplying areas await investigation; the fruitful results of the first expedition—for instance, the national value of the Christmas Island phosphates discovery and the disclosing of the now famous fishery near Wyville Thompson Ridge in the Faroe Channel—should suffice to stimulate the Government to permit the insignificant outlay necessary for this aspect of the public welfare. It may not be generally realised that the result of the *Challenger* Expedition of 1878 has been published in 43 huge quarto volumes, composed mainly of new matter, and that the record is yet incomplete; but it is well known that the knowledge acquired merely touches the fringe of the wealth awaiting investigation, and it is impossible to watch the course of the Danish vessel recently sent forth on deep-sea investigation without a sense of disappointment at our national lethargy.

Leguminosae.

The better sorts of bean and pea degenerate both in size and flavour and require fresh seed after a year or two; and even then there is lacking, as in many subtropical fruits and vegetables, the full flavour of our English productions in their proper seasons after winter rest. There are under cultivation in Madeira alone probably not less than 40

well-marked varieties of the common French or kidney bean, *Phaseolus vulgaris*. The climbing sorts flourish in the summer season, but the dwarf kinds produce crop after crop perennially and contribute largely to British and continental markets for green vegetable food in the winter months.

The Soya bean was unknown in these regions until, in 1910, I introduced an important variety of *Glycine hispida* from Portugal. The plants have yielded their small almost round bean copiously and can be relied upon for both as a spring and autumn crop; but the species is not fully acclimatised and has suffered from some degree of hybridisation which, in spite of the power of self-fertilisation the plant possesses, the bees of Madeira have managed to effect.

The American estimate of the exceptional position held by the Soya bean is thus stated by Osborne and Mendel: "The Soya bean is probably the only seed yet investigated which contains both the water-soluble, and in a limited quantity, the fat-soluble, unidentified dietetic essentials known as vitamins: and this fact, taken in conjunction with the high physiological value of their protein, lends an unique significance to the use of this esculent as food."

The practical application of the Soya bean in a variety of cooking is very extensive and the sustaining quality is very great, whether the bean is used alone or as an adjunct. At my own table I have used the bean either as a soup purée or as a most agreeable mush to serve with fish or meat of any kind with much satisfaction. The so-called Soya milk has too much of its own specific taste for use in tea, but is excellent and creamy in coffee, and to replace milk in pastry. As human or cattle food, fertiliser, or source of vegetable oil, the Soya bean plant is an esculent of the highest economic value, and I hope to establish it shortly in the rich and extensive lands around Lake Tsana in Abyssinia, where, 7000 ft. above the sea, in true subtropical environment and in the absence of allied species and liability to hybridisation, it will become a food resource of first-rate importance. Records show that the Soya bean was cultivated and esteemed in China 5000 years ago, but only in modern times has exact knowledge of its worth been obtained.

I cannot leave the leguminosæ without a reference to the two aspects of their estimated value met with in accessible literature. Burton, in his fascinating treatise on diet and melancholy, dismisses the entire tribe with one laconic comment, "All pulse are naught." But in the charming legend of the Jewish captives who were to be fed and fattened for presentation to the king, but were allowed 10 days' experience on pulse and water alone, the probationers in that short period appeared "fairer and . . . fatter in flesh than all the youths which did eat of the king's meat." The pulse and water diet seems to have been continued for three years without, in those primitive times, developing any of the deficiency diseases we now dread from such restrictions. I always thought that the potent pulse of Nebuchadnezzar might have referred to *Ervum lens*—the widely distributed lentil, the favourite pulse of super-equatorial regions—but there is conflict of opinion on the matter; and my learned friend who presides over the Royal Gardens at Kew considers that the prevalent *Phaseolus radiatus*, found everywhere in the East, may with greater probability be regarded as the food of the Jewish captives.

Amygdalaceæ, Rosaceæ, and Pomaceæ.

The peach, *Amygdalus persica*, may be said to flourish too well in Madeira, for its cultivation by the propagation of good sorts and eradication of the self-sown, worthless, hard-fleshed seedlings, is thus sadly neglected. Perennially green, in all cases it is grown in the standard form, coming into flower about Christmas or earlier, and ripening from July to September. The same remarks apply both to the nectarine and apricot, several kinds of which produce enormous crops of hard, poor fruit in the absence of selection or cultivation. The almond flourishes especially well in the island La Palma of the Canaries, where whole deep valleys are devoted to it. The plum, *Prunus domestica*, and the cherry, *Cerasus avium*, provide abundant crops.

The strawberry, *Fragaria vesca*, occurs in every variety, both wild and cultivated, in Madeira, though not further south. It begins to be abundant in April and yields heavily until September, never being entirely absent.

Of the Pomaceæ, *Pyrus communis*, the common pear, is abundant, but the fruit, even of the best sorts, is inferior. *Pyrus malus*, the apple, is grown in many kinds in Madeira and the Canaries, but further south rarely seen. Quince, the common cydonia, thrives in all the islands and is preserved by the Portuguese as an excellent marmalade. *Mespilus germanica*, the common medlar, is found only in Madeira, and yields excellent fruit, which, however, is not greatly esteemed. *Eriobotrya japonica*, the loquat or Japanese medlar, a more important fruit, has become extremely common in Madeira, but not further south; its acidulous amber-coloured fruit, which is produced from February to May in great quantities, should be available as a cheap and agreeable comestible in the fruit-vacant months of the early English spring.

Among the Myrtaceæ, the guava (*Psidium*) is found principally in Madeira. The fruit is largely used like apples for culinary purposes and for dessert, but does not now exist in sufficient quantity for export on account of the ravages of the Argentine ant. The white fruit is far superior to the red and smaller variety. *P. littorale* and *P. cattlejana* flourish everywhere and yield an agreeable little fruit, sometimes twice a year.

Passifloraceæ.

Among all the gorgeous varieties of passion flower which adorn the Madeira gardens two only need here be mentioned. The abundant *Passiflora edulis* has purple fruit the size of a small hen's egg with orange-coloured pulp and an agreeable raspberry-like flavour; it was hardly known in the Canaries a few years ago. *Passiflora lowei* is the best of all passion fruits, being as large as a duck's egg and of an orange-yellow colour; this species was originally brought to Madeira—probably in transit—from the Canaries, but was unknown a few years ago in any of the islands beyond these. The entrancing beauty of the flower alone would entitle the plant to a conspicuous place in any garden, but the fruit is in request beyond these limits and is hence exported in increasing quantities. I have sent the seed to almost all our dependencies, and have excellent reports of its establishment and appreciated value.

Cucurbitaceæ.

The cucumber, *Cucumis sativus*, uncommon in the Canary and Cape Verde Islands, abounds in Madeira, where a stunted-looking variety grown on the hot rocks in a few inches of soil acquires an excellence of taste and quality hard to equal elsewhere. A cucumber or two, with a little salt and a loaf of bread, makes a satisfying breakfast for many a labourer. Of the gourds, *Cucurbita melanosperma* is a watery constituent of an agreeable Portuguese soup, and is supplied in bulk as a table vegetable to passing ships. This gourd is well known in the Canaries, but no further south. *Cucurbita moschata* is largely cultivated in all the islands, though attaining in no other place the excellence it possesses in Madeira, where for at least six months in the year it provides perhaps one-third of the daily nourishment of the people. The importance of this esculent in the Atlantic islands can hardly be overrated, and its value is quite comparable to the importance of the potato in Ireland; with its large supply of saccharine and farinaceous material and its facility of combination by boiling with fatty substances it makes a most nutritious food, as is shown by the surprising muscular power and endurance of the Portuguese peasantry, who so greatly depend on it. I have sent seeds of this truly desirable food far and wide.

Sechium edule chocho, the pepinella, seems to have come to Madeira about 100 years ago. A full description of the species and its attributes would occupy the entire time allotted to this lecture. Besides the charm of its cultivation, its surprising growth, and the peach-like fragrance of its creamy flowers, the plant yields now a copious and unflinching supply of an esculent of the first order in food value. I have sent this wonderful vegetable to many countries—selecting the green and more tasty variety, though Sir Daniel Morris tells me that the white sorts do better in the tropics, and it is now established in many regions formerly devoid of cucurbitaceous produce. The sechium is propagated by planting the one-seeded fruit entire, the whole gourd enlarging into a persistent subperennial rhizome a foot or more in diameter and sending up annually, when well-established, 100 or more shoots to cover a trellis of enormous extent from whence hangs the small fruit in myriads. I know of no other such transmutation of the nutrient surrounding matter of a seed into the permanent tissue growth of the new plant. The pepinella is boiled as a favourite vegetable in the winter months and has an agreeable nutty flavour, together with a greater power of combining with fats than I have observed in any other gourds. It is, moreover, free from fibre and very digestible; I have employed it to great advantage boiled with cream and other fats as a non-irritant food in gastric ulceration, enteric fever, and other intestinal disorders.

Coffee.—*Rubiaceæ coffea arabica*, the Madeira coffee tree, once cultivated with great success with respect to the excellence of produce, was entirely destroyed before we learned how to restrain the depredations of the Argentine ant; it is now slowly re-appearing. The plant grows freely in the Western Islands, and the principal valleys of the Portuguese Cape Verde Islands are jungles or thickets of coffee growth yielding in great abundance a small berry of excellent quality. Apart from the Liberian species, with which I have not succeeded in Madeira, several new varieties of this important esculent have recently been found in the development of our Central African dependencies. One of these—*Coffea robusta*—is being distributed from Northern Nigeria and yields a fairly large berry of excellent flavour; the leader of the present Grabham Mission to Lake Tsana in Abyssinia (whence the coffee tree is believed to have first

come) reports the presence of the tree in abundance and vigorous condition 7000 ft. above sea-level in those scarcely explored regions. To those who do not habitually drink it coffee may prove an effective medicine; it is a valuable adjunct in the treatment of intermittent fevers, it relieves asthma, and it assists in overcoming the effects of alcohol or opium.

Compositæ.

The Jerusalem artichoke, *Helianthus tuberosus*, grows in Madeira with the same weedy profusion as in England and will profitably occupy waste ground with little care or cultivation. Artichokes (originally Brazilian) yield a heavy crop, and the interest just now attaching to the tubers has reference to the presence in their abundant tubercles of 12 or 14 per cent. of inulin, a substance akin to starch, but convertible by appropriate treatment into fructose—the sweetest of all sugars. I learned the nutritive and sustaining value of the artichoke in the second year of the war, when our reserves of food were exhausted and we had to devise or improvise new methods of sustaining life. I soon found out the value of the artichoke, then growing in small plots of waste land in my mountain home. Three or four of the tubercles were boiled into an imperfect purée, to which I added a handful of the succulent roots of *Oxalis purpurea* and a little salt. Meanwhile some strips of pumpkin food were boiled with three or four ounces of fat until the latter was emulsified or saponified; during the process chopped cabbage leaf, water-cress, or a few chestnuts were mixed in. When the cooking was nearly finished I crumbled into the mixture small pieces of half a dozen large boletus fungi. Three famished men were then fed sparingly on this potent food and regaled after two hours more copiously; and on the strength of this meal they worked nearly all day with well-sustained energy. During the stress of threatened starvation we discovered the unsuspected value of many a neglected esculent, and we also became conscious of the excesses of our diet in normal times. I made a point sometimes of interrupting a hungry man in his voracious consumption of a bulky meal to find, after half an hour, that appetite had been completely satisfied and that the remaining portion of his food would merely have taxed his gastric powers for purposes of elimination and rejection.

Convolvulaceæ.

Batatas edulis is cultivated in all the Atlantic islands in great profusion. The sweet potato is the foundation food of the Madeira peasantry and yields crop after crop freely with no restriction of season; but there is no storage or overplus for exportation either in Madeira or the Canaries. The tubers vary in weight from three or four ounces upwards, and their size relates in a great measure to the space allotted to the trailing or climbing growth of the stem, which, when unrestrained, will yield 25 to 30 lb. weight of potatoes. A man will do a heavy day's work on a sufficiency of plain boiled "batatas," but owing to their high percentage of starch the latter require to be supplemented occasionally with food of greater nitrogenous value. In the Azores the sweet potato is grown on a larger scale and is found capable of yielding a high percentage of alcohol; it has been estimated that tubers having 25 per cent. starch will yield 38 gallons of spirit per ton. The spirit thus extracted is largely used in the treatment of the wines of Portugal. A reliable analysis of sweet potatoes shows the main constituents as albumin 8.7, fatty oils 0.7, starch 80.3 per cent. from material dried at 212°F., and it has been found that three tons of starch possessing a high commercial value can be made from 12 tons of sweet potatoes, leaving a rich residue suitable for cattle food. It would thus be difficult in many respects to overrate the esculent value of this interesting convolvulus.

Solanaceæ.

Tomato (*Lycopersicum*) farming has now become an important industry, and it is difficult to cope with the growing demand of the European markets. Forty years ago the British supply was limited to the summer produce of our own gardens and tomato houses, and no general or perennial demand had developed. Several forms have long been naturalised in all the Atlantic islands and are to be found semi-wild in every district. This is especially the case with the wild tomato, *L. cerasiforme*, an excellent culinary example growing in every waste place perennially. In St. Jago (Cape Verde Islands) whole mountain tracts are covered for miles with matted beds of this variety laden with its brilliant fruit, a potential wealth yet to be turned to account. Quite recently the Italians have succeeded in extracting from tomato seeds an oil suitable for soap-making. The Portuguese preserve the tomato for months in perfect freshness entire in brine or coarse salt; preserved in this manner it must have been at my suggestion of priceless benefit as an antiscorbutic to Nares in his long and adventurous southern expedition.

Potato.—The potato, *Solanum tuberosum*, is cultivated at all seasons both in Madeira and the Canaries at all elevations, and forms an important portion of the food of the whole

population, besides yielding an overplus to northern markets as new potatoes in the early spring months. The potato, though not a perfect nutrient, is believed to yield a greater bulk of sustenance per acre than any other cultivated vegetable; no other vegetable esculent is considered so essential an accompaniment to our daily meals.

Melon Pear.—The interesting *Solanum guatemelense* was brought to Madeira 30 years ago; it became well established under the fanciful name of melon pear. It bears pallid, yellow, somewhat insipid fruit as large as that of the cyphomandra, and has become the prey of the Argentine ant, in association with the *Coccus hemisphericus* of the Azores.

Cape Gooseberry.—*Physalis peruviana* is found as a weed in every garden from the sea-level to 3000 ft. above. Of the abundant fruit not one-tenth is collected, though there is an unfailing demand abroad for the Cape gooseberry jam yielded by these wholesome berries.

Lauraceæ.

Alligator Pear.—*Persea gratissima*, the avocado or alligator pear, with its thick butyraceous substance (the midshipman's butter of other days) is an excellent fruit, creamy, rich and nutty in flavour, largely eaten also as a vegetable in many forms. The pear softens in ripening four or five days after picking, and thus arrives in perfection for sale in London during the late autumn. I have sent abundant seed of our wild indigenous *Persea indica* far and wide with the view of increasing by grafting the range of the alligator pear in climates with temperature variations greater than those of Madeira. The protein content of the fruit is 2 per cent. and the fat 15 per cent.

Cannaceæ.

The famous Madeira arrowroot is grown chiefly from *Curcuma leucorhiza* and has a high commercial value. The yield is important and the quality of first-rate excellence. There is no other starch comparable in specific gravity or nutrient value to this sort when well cleaned and prepared.

Musaceæ.

Banana.—Of the many varieties of banana the Atlantic islands mainly cultivate *Musa cavendishii* both for export and home use. This fruit is brought to all the European markets, both from Madeira and from the Canary islands, and is greatly superior in taste and quality to the larger, coarser, and more insipid fruit imported from Costa Rica and the West Indies and sold in every London street on costermongers' barrows.

A far superior fruit is yielded by another species, *M. sapientum*, much cultivated in Madeira for home use but taking quite two years to mature, and known elsewhere as the silver banana or, as Sir D. Morris tells me, the apple banana. The tree grows quite 30 ft. high and is liable to destruction by high winds; the fruit requires tender handling in packing if exported. During the war the entire crop was needed locally, and in any case there were no steamers available to convey supplies away, but normally both Madeira and the Canaries yield a heavy overplus, mainly of *M. cavendishii*, which has a well-recognised value in London. Though the banana flowers are apparently perfect and their pollen abundant no seed has been known to develop through dissemination by bees. A recent analysis gives the food value of the average banana as protein 1.3 per cent., fat 0.6 per cent., total carbohydrates 22, and the tremendous importance of the fruit in our national feeding is now fully recognised, the better sorts preserving a very exquisite flavour.

The banana has spread to the masses of our people while retaining its place on the dessert table of the rich. In my early days bananas were only known in London as a curiosity with no suspicion of their great nutrient value; and for some years later they were quite unsaleable while our English summer fruits lasted. Fifty years ago the total value of fruit of all kinds exported from Jamaica was only £720; this small sum was the commencement of a banana trade which to-day is valued at a million and a half pounds sterling and is constantly expanding as the demand grows. The substantial volumes which have been written on the banana have by no means exhausted the description of the attributes and uses of the plant apart from the food value of its fruit.

Bromeliaceæ.

Pineapple.—*Ananassa sativa* will grow wild in most of the Atlantic islands, but needs all the care, selection, and treatment which have brought the fruit to perfection in the western islands; there, sun-ripened with scientific precision and methods of stifling and retarding, its appearance is made to coincide with the season of greatest demand in London and elsewhere.

Liliaceæ.

Onion.—*Allium cepa*, the common onion, is cultivated in all the islands and exported in fabulous quantity. The size and quality obtained in Madeira can hardly be surpassed; I once had a dozen bulbs presented to me, of which one weighed 4 lb., three others more than 3 lb., and the whole

dozen 40 lb. From Madeira the onion is chiefly exported to Brazil. As an essential in our food and as a condiment, I need say nothing except to point out the delicacy of flavour in these subtropical forms, and the superiority of southern methods of serving. Long before the physiologists began to speak about vitamins the general public had shown an instinctive greediness for the onion which, though poor in caloric value, abounds in accessory food value. Before the war in 1914, imported onions, mainly from Spain, Portugal, and the Atlantic islands into this country, were valued at over one million sterling—a sound investment, providing a distinct mitigation to the people of this country of the poverty of their winter diet. Nelson, 130 years ago, had also learnt the value of the onion at Naples, and I heard in early life from the daughter of the Captain Codrington who fought under him at Trafalgar, that every ship in a blockading squadron had to be copiously supplied with this valuable antiscorbutic.

Sugar.

The sugar cane, *Saccharum officinarum*, is a general object of cultivation in all the islands, and in Madeira covers every available space with a sunny exposure from the sea-level to 1000 ft. above. The juice is devoted partly to the distillation of alcohol, but mainly to the manufacture of excellent sugar. The presence of the sugar cane in Madeira, occupying ground which could be devoted more profitably to the production of the custard apple and a variety of fruits and vegetables which Madeira only can supply in their first freshness to the London markets, is a reproach to the fiscal administration of the Government of Portugal.

Fungi.

All the well-known fungi of the British islands are well represented in the super-equatorial regions of the East Atlantic. Some are very poisonous, and these so nearly approach the edible varieties in appearance that, notwithstanding the admirable coloured charts now published, I have confined my commendation of them to two unmistakable forms—viz., our common agaricus and the *Boletus edulis* which abounds in the pine woods of Madeira in the autumn months. The boletus is a substantial esculent having a tangible protein value, and when properly prepared forms a valuable and agreeable contribution to our dietetics, though Ambroise Paré contemptuously dismisses the entire order as “an excrescence of the earth’s superfluity not void of a venomous quality.”

Absence of Deficiency Diseases in the East Atlantic.

It will be readily understood in the sketch I have now given of the wealth and variety of our vegetable food-supplies, perennially fresh and plentiful, that the native races in these regions do not suffer from the so-called deficiency diseases associated with the absence of vitamin substances. Open-air life and freedom from excessive changes of temperature must also contribute to this immunity. In the great war we, at Madeira, were taken by surprise; to a great extent we exhausted our local resources before we realised that normal importations of wheat and maize would completely cease. In those days we were insufficiently fed; we lost weight, and you could see among the people the vacancy of expression, apathy, and depression so well known in association with incipient starvation, and it was then that I reaped the full benefit of the botanical knowledge—built on the meagre foundation laid in the remote times of my early medical curriculum—which I have since acquired and which has enabled me as a referee in these regions to minister to the constant requirements of new provinces of the Empire.

Botanical Education.

I remember the dismay at the British Association for the Advancement of Science with which the announcement that botany would probably have to disappear from the overlaid curriculum of essential requirements of medical education was received, and the strongly expressed opinions that a place should be allotted to some instruction at least in this science, however elementary. About that time Sir George Nares, whose crews had suffered terribly from scurvy in his then recent Polar expedition, and in whose ships the superior antiscorbutic value of lemon juice over lime juice had been demonstrated, called to confer with me, on his way to Patagonia, as to the material which might be available in Madeira to ferment into the sort of beer which our splendid

navigator, Captain Cook, found effective in those days of miserable equipment 140 years before. Cook, doubtless under the guidance of Banks and Solander, seems to have fermented just anything, and the resulting nauseous liquid amply confirms the scathing criticism of Burton on the beer in vogue 100 years before Cook’s time: “*Nil spissius illa dum bibitur, nil clarius est dum mingitur, unde constat quod multas faeces in corpore linquat.*”

Nares, with my help, concocted something at least less nauseous, and I also supplied him with a quantity of sprouting sweet potatoes which, kept moist with a fertilising fluid, gave a copious yield of green shoots and for many weeks were very serviceable; further, I gave him that information respecting tomatoes and onions, already spoken of, while we sat under the shadow of a gigantic tulip tree which Cook and Solander had planted on one of my terraces 120 years before. We spoke much that evening—probably after dinner—of the customary excesses of our diet beyond the requirements of energy and repair, and of the waste of effort exerted in eliminating at least half of the protein taken in excess of bodily needs; true physiological economy is the judicious application of scientific truth to the art of living.

ANIMAL FOODS.

The animal foods of the Atlantic islands I can pass over with the general remark that cattle of every well-known breed abound in proportion to their means of sustenance, and that we have at all seasons poultry, eggs, milk, and butter in abundance, both for local use and exportation. Several breeds of goats are met with in all our mountains; some have run wild and subsist in plenty in inaccessible places. We rely, too, on our goats’ milk, which is excellent and happily free from the infection which Sir David and Lady Bruce investigated at Malta.

SEA FOODS.

I will now mention very briefly the salient points relating to the latent, almost unexplored sources of food which the surface water and abysmal depths of the seas in these regions invite us to explore. The surface plankton, or floating life, and the condition of the sea bottom with its deposits and deep-sea organisms, present general problems full of economic, biological, and geological interest. I can only hope to illustrate by a few examples the scientific importance and practical utility attaching to the study of these surface and abysmal conditions.

Tunny.—From the economic point of view the thynnus or tunny is our most important fish. Known everywhere, it is never long absent from our island markets, and scattered examples of enormous size appear throughout the year; this fish is gregarious in habit, visiting Madeira in vast numbers in the early spring, driving inshore frightened shoals of its own and other smaller species. In Atlantic regions it is captured with a stout hook baited with a living mackerel or herring, and a full-grown example 10 ft. long generally weighs about 400 lb., reaching in occasional instances the extreme weight of twice this ponderous bulk. The life-history of the tunny is imperfectly known; the rate of growth to maturity, the locality it haunts, and its means of sustenance in early life all need investigation, but its esculent value may be gathered from the fact that when eviscerated and prepared for market quite 85 per cent. of the substantial fish-meat is available for human food. A certain amount of tunny flesh is now canned and exported, but further investigation and improved methods of fishing will presently show what huge reserves of this valuable food at present escape us. The tiny scales entirely surrounding the body give the skin a smooth appearance, and excellent leather is now being manufactured from this and other sea monsters.

The flesh of the tunny fish, like that of many other Scombridae, seems to carry with it a liability to a mild and evanescent form of urticaria. I was once present at a dinner where 7 out of 12 guests were victims of some noxious substance thus conveyed in eating. The chef had served up an appetising course of “veal” cutlets made of the pallid portion of tunny with a taste suggestive of anything but fish, and two hours later the recipients were comparing notes of their symptoms and highly-coloured countenances. I advised the hostess on future occasions to have her “veal” served up with fennel sauce, which by some beneficent instinct people have learned to eat with mackerel and the like, thereby gaining immunity from nettle-rash. Funchal,

the chief town of Madeira, is named from the prevalence in the neighbourhood of this potent herb.

Many other species of Scombridæ also abound in East Atlantic waters. Among them is *Lepidopus caudatus*, now classed among the Trichiuridæ—a truly subtropical fish of wide distribution—known occasionally even as far north as our own southern coasts, and here called the scabbard-fish. In New Zealand it is known and esteemed as the frost-fish. The lepidopus has a band-like body, black, without scales; taken at Madeira at all seasons, it is with the tunny the mainstay of our market supplies. It grows to a length of about 6 ft. and rarely exceeds 7 or 8 lb. in weight. Though found at all depths, the lepidopus in the slender structure of its bones and other respects must be considered a deep-sea fish; its rapacious character is indicated by its formidable dentition. The flesh of no other fish is so serviceable for the table as regards variety of cooking.

Shermy.—I select the *Polyprion cernium* as typical of the highly important food-yielding order of Serranidæ. This species is known as the wreck fish, from its habit of accompanying floating wood, attracted thus by the small marine food species generally associated with such objects. Known as the shern or sherny, the fish has a great geographical range, and without following it into the Pacific we find it throughout the Atlantic Ocean, and even also in the Mediterranean at the present day, though there is no trace of the species in that sea in the writings of the ancient Greek and Roman naturalists. It abounds in subtropical waters and in Madeira, where it seems to occupy the place of the familiar Mediterranean *Sciæna aguilæ*, it is one of the commonest and best known fishes in the market, esteemed for its white flesh and substantial nutriment, though lacking any particular excellence of flavour. Possessing a high degree of muscular irritability, this fish is better for being kept quite 24 hours before boiling. The pulsation of the sherny's heart is maintained for some hours after every other sign of life has ceased—quite six hours, in my experience, when the organ has been laid open to view—and the fishermen affirm that cardiac movements sometimes continue for two days, though you cannot revive them when once they have ceased. Some of the sharks show the same apparent survival of cardiac life or motion, for I have held in my hand the beating heart of *Zygæna malleus* for some minutes after the organ had been severed from a recently captured fish. The sherny of these latitudes is only captured by the hook, and though shoals of small fishes weighing from 5 to 20 lb. are often to be taken near the surface, the proper home of the full-grown adult is in the deep open abyss where, weighing from 30 to 100 lb. or more, it is taken at the enormous depth of 2000 to 2500 ft. or even deeper. Coming up from a depth so stupendous the fish becomes so distended with gas, expanding upon the removal of the vast pressure below, that it rises to the surface, not indeed dead, but wholly powerless, in a sort of rigid cataleptic spasm. The stomach is usually inverted and protruded into or through the mouth, and its eyes forced far out of their sockets. Its life-history, rate of growth, food, and the circumstances which determine its descent from the warm surface water into the cold depths, and the means necessary for securing and utilising this great source of valuable food, are problems awaiting solution. In general character and appearance the sherny is a plain, dull-coloured unshapely fish, with a capacious gape and enormous head, showing a clear generic affinity to Serranus, but its fascinating anatomical details are beside the province of this lecture.

Market Varieties.

Distinguished ichthyologists have wondered at the variety, abundance, and colouring of the southern fish markets. There are no flat fish, and the common members of the cod-fish tribe, which so largely fill our stalls in England, are usually represented only by one subordinate species of the tribe, the Mediterranean phycis. Many of the most useful of the fish esculents are present throughout the year, though more abundant in spring and early summer; among them two species of Clupea, the *Caranx trachurus*, the familiar Zeus or John Dory, and the appreciated red mullet; but the seasons are marked by the prevalence and predominance of successive forms, which month by month vary the perennial supply. The red mullet is taken abundantly at all seasons in shallow water, in traps made of cane or wicker-work without any bait, into which the fish aimlessly wander. I once tried to augment their capture by suspending a few luminously painted shells in the traps to entice them, but these experiments were entirely vitiated by the intrusion of unwelcome visitors—octopus and conger—which, attracted by the unusual phosphorescent glow, entered and devoured the rightful occupants of my cages.

An Unexplored Food Reserve.

The impression left after contemplating our fish markets and noting the patient and primitive methods employed in capture is that we have in these southern

waters a reserve and wealth of food which, in the progress of investigation, will eventually be made to minister to the needs of many regions now beyond the narrow limits of its application. And when we remember the great depth of the oceans and that plants may live and function three or four thousand feet below the surface, and moreover that animals are found at every depth, we may truly conclude that the total quantity of living matter in the sea greatly exceeds that on the land surface of the earth. The whole subject of these super-equatorial marine food resources abounds with both economic and biological interest. The surface plankton has yet to be explored; we have in these abundant surface foods a key to the welfare and maintenance of life in the depths; and it is not unusual to meet in their early stages crustacean and other species which, bred and born on the surface, disappear and are not afterwards known in their maturity in these waters. The globigerinuous ooze on the surface below also bears evidence of the perpetual rain of food descending from above. Much of this surface organic matter is, doubtless, intercepted and consumed in its fall, but far more either reaches the bottom or is actually dissolved in the sea water and becomes thus a tangible source of deep-sea food. Nevertheless, the fat robust condition in which our large deep-sea fish arrive at the surface when captured, and the numbers in which we know them to abound, suggest the nutriment available in these abysses.

With the desire of knowing something more of deep-sea life and nutriment I have recently been sinking some large, closely woven wicker-work traps a couple of miles out at sea S.E. of Madeira in water about 1000 ft. deep. The traps are let down with stout cords buoyed all the way down at intervals with large cork floats which ease the labour of hauling in. Barnacles and other creatures soon attach themselves to the cork floats, and thus show that life is not absent in any stage of this sea depth. The traps are baited with some highly pungent decomposing animal matter, and are drawn up every 6 or 12 hours for examination. If the trap has rested on the smooth Atlantic globigerinuous ooze, where—as they would be exposed to the vigilant monsters in search of food—the smaller creatures do not venture, the take is negligible; whereas, if the bottom is rocky or near some stony ledge, there seems to be an unfailing supply of well-nourished and tempting prawns (*Pandalus*) and Amphionidæ. The prawns, like some of the larger deep-sea fish I have been describing, do not survive their transference to the surface, but arrive dazed or dead. Some of them escape from the traps in the process of hauling in, but float to the surface dazed and helpless with the destructive expansion already noticed.

The Sea Bottom.

The condition of the sea bottom is not less mysterious than the life-history and food of its occupants, and occasionally we know it to be subject to change and disruptive commotion. It was my good fortune to observe the occurrence of one such commotion. I was observing at that time the strength and variations of the electrical so-called earth-currents which affect our deep-sea cables, and which, sometimes weak and sometimes active, are never entirely absent. My hope was to establish a definite relation between these submarine indications and the earth tremors registered by seismographic observation, and thus render it possible not merely to record but to predict an earthquake or a threat of earthquake in a given locality. On this occasion an earthquake of moderate intensity actually happened, shaking down great masses of rock and generating a surface wave of sea water of considerable magnitude. But the cable currents were present in great excitement quite three days before any sign of coming commotion could have effected an instrument of vibration. The cable under observation happened to lie in the path of commotion and was destroyed by the submarine disruption. It was the accident of the earthquake locality coinciding with the path of the

cable which revealed the occurrence of a volcanic outbreak in this oceanic depth, and showed what may often happen on the ocean floor with little or no evidence at the surface. The cable itself beneath was destroyed for several miles, and the extent of the disturbance was only revealed when, in laying the cable afresh, it was found necessary to travel 15 miles away before a smooth bed could be found beyond the jagged rocks into which the placid ocean bed had been torn.

CONCLUSION.

I confess to a sense of disappointment in view of the status and repute of this College, and of the pride every Fellow feels in our traditions and equipment, that the coöperation sought by the Government of this country during the recent war as to food, dietetics, hygiene, and cognate matters was not required of us in corporate capacity. The work I am indicating was truly accomplished in association with us; neither could the Royal Society have furnished the advice and information needed by the Government and nation in such matters without the able and disinterested coöperation of our distinguished colleagues. We are largely engaged in meeting the provision of our country's need of competent medical practitioners. We are an examining and licensing body truly, but much more. We are the custodians and exponents of science far beyond the narrow definition of medicine itself, and it will be found that in any committee appointed to report on a matter of collateral science—and what science is not collateral to ours?—the effective output has been largely and perhaps mainly due to some guiding influence issuing from within these walls.

THE USE OF LÆVULOSE AS A TEST FOR HEPATIC INEFFICIENCY.*

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LÆVULOSE as a test for liver function has been extensively used in the past by Strauss and various others, but for reasons which will be fully described later the results obtained were unreliable. All the observers based their conclusions on the absence or presence of glycosuria after the patient had received a large dose of lævulose by the mouth. Recent observations on the increase in blood-sugar concentration, brought about by the ingestion of carbohydrate, point to the conclusion that the degree of hyperglycæmia produced is more important than the presence or absence of glycosuria in indicating liver inefficiency. Hopkins,¹ Hammam,² Maclean and de Wesselow³ and others have shown that if 50 g. of glucose be given to a normal adult individual after he has fasted for three or four hours an immediate rise in the sugar content of the blood can be demonstrated. If blood-sugar estimations be made immediately before and at half hourly intervals after the ingestion of the glucose, it will be found that this rise is from an original basal level near 0.100 per cent. to about 0.170 to 0.180 per cent. at the end of the first half hour. At this point a rapid subsidence takes place, and the sugar content of the blood falls to or below the original level within an hour or an hour and a half. When plotted graphically the result represents the normal "blood-sugar curve" for 50 g. of glucose. Alterations in sugar tolerance will affect the shape of this blood-sugar curve. In conditions of decreased sugar tolerance the rise is abnormally high and prolonged. If the blood-sugar

has not returned to its original level within one and a half or two hours, a diminution in the sugar tolerance is considered to be present. All the available evidence suggests that the nature of this curve is chiefly dependent on the power of the liver to store sugar in the form of glycogen. Maclean and de Wesselow³ pointed out that the only sugar in ordinary use which did not produce a rise in blood-sugar concentration was lævulose. They showed that in the normal healthy adult 50 g. of lævulose could be taken without producing any appreciable increase in the blood-sugar; this observation they made use of in testing for liver efficiency in various cases, on the supposition that a defective liver mechanism would result in the production of lævulose hyperglycæmia.

That lævulose in the amounts used by Maclean and de Wesselow produces no definite increase of blood-sugar we have confirmed. In some cases a very slight rise of from 5 to 10 mgm. per 100 c.cm. was observed, a rise almost within the bounds of experimental error. The normal blood-sugar curve after 50 g. of lævulose can thus be represented by a continuous straight line from the original blood-sugar level, or a line showing slight oscillatory deviations of 5 to 10 mgm. per 100 c.cm. from the original level. A definite rise in the blood-sugar of even 20 mgm. per 100 c.cm. after 50 g. lævulose indicates a diminution of sugar tolerance.

Liver Function and Lævulose and Glucose.

The only explanation of the difference in the blood-sugar curves following the ingestion of these two sugars that can be put forward in the present state of our knowledge is, that in the case of lævulose, the sugar, after absorption from the alimentary tract, is so readily taken up by the liver and stored as glycogen that it does not appear in the systemic circulation. If the functional capacity of the liver be diminished in any way—e.g., in the degeneration of hepatic parenchyma seen in salvarsan poisoning—it will not be able to deal with the 50 g. of lævulose presented to it. The lævulose will then pass to the systemic circulation, where a rise in the blood-sugar content will result. The greater the degree of liver damage the more lævulose will pass through, and the greater will be the rise in the blood-sugar curve.

Glucose is not assimilated and stored as rapidly as lævulose. Even in the healthy individual it passes readily through the liver to circulate for half an hour or more in the systemic circulation, producing there, as we have seen, a definite rise in the blood-sugar. It appears to be abstracted from the blood stream by the intervention of a carbohydrate storage mechanism, which does not, however, come into play effectively until half an hour or more after the ingestion of the sugar. In the presence of an inefficient liver this abstraction and storage of the glucose is delayed. A high and prolonged blood-sugar curve results. But the variation from the normal is not so marked as it is in the case of the altered lævulose curve of liver inefficiency.

A Theory Tracing Rise of Blood-Sugar to Absorption of Salts.

We are aware that Cammidge, Forsyth and Howard⁴ have recently advanced a theory which opposes this explanation. They argue that the rise of the blood-sugar following the ingestion of food results from changes in the reaction of the blood produced by absorption of salts formed from the digestive secretions; and that the rise results from the breaking down of preformed glycogen—an increased glycogenolysis—in the liver. Their theory explains this increase in glycogenolysis as being caused by the active stimulation of the diastatic ferment of the liver, which in its turn is brought about by three factors: an actual change in the hydrogen-ion concentration of the blood, an increased permeability of the liver cells to sodium chloride, and a release of the inhibitory action of the pancreas. Their argument is based, however, on experimental work in which certain results were quite different from the results which we, and many other workers, have reached in covering the same ground;

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