

great cliffs above the shore of Agglomerate, the site of volcanic activity in lower Carboniferous times.

Looking down upon the top of the Columnar structure on the shore we see a smoothed and fairly even surface well marked by the significant forms of the columns when thus seen end on. In other words, we have what is called a tessellated structure. Now, curiously enough, not far from where these Columnar Rocks appear, I noticed in a shallow patch of muddy water which had dried up that cracks appeared, giving various sided figures, just like the surface of the smoothed Columnar deposit. Again, in a paper contributed by the late Professor James Thomson, of Glasgow University, to, I think, the Philosophical Society of Glasgow, he describes a tessellated structure observed by him in certain liquids, and not only was the surface of the fluid marked out in these many sided forms (mostly five irregular sides), but these appeared to be more or less extended downwards into the fluid in column like forms. He says:—"The water viewed from above presented a tessellated appearance, considerably resembling such patterns as are exhibited by vertical basaltic columns when exposed to view in a horizontal section—such, for instance, as may be seen at the Giant's Causeway or at Staffa."

In the British Museum Report on the "Study of Minerals" we find the following:—"The graphite from New Cumnock in Ayrshire shows a Columnar structure, probably caused by the heat which came from a neighbouring dyke," and again the following:—"While the Columnar character of Gypsum, Marl, and Sandstone is due to shrinkage consequent on the loss of moisture, that of basalt is held to be due to shrinkage consequent on the cooling of the molten mass."

These Columnar Sandstones are so unique that their forms impress the beholder much more than the similar structure, more or less perfect, in many of the basaltic rocks of our island.

SEAWEEDS AND THE FORESHORE.

By JOHN N. MARSHALL, M.D.

[Read 24th January, 1911.]

Seaweeds belong to the class of plants called *Algae*—a class which stands at the very bottom of the scale in the Botanical Kingdom. Their structure is comparatively simple, consisting of layers of cells only slightly differentiated from each other, there being no parts like root, stem and leaf, such as we have in our ordinary flowering plants. Externally, no doubt, there is an appearance of what looks like a leaf and a stem, but these do not in structure correspond to the leaves and stems of flowering plants. The environment of these plants, viz., the sea, makes less demand upon them than does the environment of land plants. The buoyancy of the element in which they live enables them to dispense with a rigid stem, and their nourishment is effected more easily by the all-pervading and supporting sea water. They are therefore members of the great family of plants who have never really grown to man's estate. They have had fewer difficulties to contend with and they have retained simplicity of structure and plasticity of growth.

There is little mention of seaweeds in ancient times. Horace calls them "*Algae inutilis*," useless things cast up by the sea. In Scripture there is only one mention of them and that is when Jonah, during his immersion says that the weeds encompassed his head.

Their near relations on land are to be found in the green covering seen on any old wooden fence, and in fresh water, in the green stuff found in a stagnant pool.

Like most other plants, seaweeds obtain their nourishment by means of the green substance called Chlorophyll. This is easily recognised in the green seaweeds. In the olive brown and in the red ones it is obscured by the deposition of red or brown pigment, but it is there all the same. The action of Chlorophyll depends upon sunlight, and sunlight is one of the things necessary for existence, which seaweeds do not always get easily. Sea water intercepts light and especially that part of light, viz.—the red rays on which the action of Chlorophyll depends. The blue rays at the other end of the spectrum are actually harmful to the action of Chlorophyll and so the seaweeds protect themselves by a deposit of red or brown pigment from those harmful blue rays.

It thus comes about that different coloured seaweeds are found at various depth of water and also that the difference in colour in seaweeds becomes one of the main characteristics in their classification.

Green seaweeds are found inshore near high water mark; olive brown ones between tide mark, and red and brown ones in deeper water, small red ones often sheltering in dark pools or under the large fronds of the brown tangle weed. There are few seaweeds beyond a depth of 20 fathoms, although total darkness in the sea is not found until a depth of 700 fathoms is reached, but it is only the blue and green rays which penetrate so far, and they, as has been said, are useless, or worse than useless, for the purposes of plant life.

Besides the plants which we know as seaweeds and which do not do much more than fringe our shores, there is a vast bulk of minute *Algae* floating in the ocean. These *Algae* are mostly microscopic, but put together, their bulk would greatly exceed that of the shore plants, and they form an important part of the food of small animal organisms upon which fish feed. Their presence or absence then becomes an important economical factor in the Fisheries question. Some of these minute *Algae* have the property of emitting light—they are phosphorescent. Others possess red colouring matter and colour

the sea red for miles. At the other extreme, from these minute *Algae*, we have in the Southern Hemisphere seaweeds which attain a length of from 200 to 700 feet, and whose trunks drifted ashore on the Falkland Islands are about the thickness of the human body.

We have on the shores of the Firth of Clyde about 395 species recorded, and of these I have mounted and arranged for exhibition in the Bute Museum a few of the common ones.

Our commonest representatives of the green seaweeds are *Ulva*, or sea lettuce, and *Enteromorpha*. These are to be seen near high water mark all round our shores, especially where fresh water or where drains enter the sea. Water containing Nitrites and Nitrates in solution, suits their existence best, consequently they love drain and foul water, and when they get uprooted and die and rot, they cause a stench quite similar to drains. Their presence, however, does not always denote foul water, as they are invariably found at the mouths of fresh water streams.

In making use of free Ammonia and giving out Oxygen, they perform a useful function in purifying foul water, but *Ulva* is easily torn from its attachment and when it is cast upon the beach and allowed to rot, it sometimes becomes a serious nuisance. In Belfast Lough the accumulation of this seaweed became so great and the nuisance from its decomposition so serious that a departmental Commission had to consider the question and devise means for its remedy. In 1906 some 70,000 tons of decaying seaweed were carted away. Containing so much available Nitrogen, it ought of course to be valuable to the farmers, but I am not aware that much use has been made of it. On our own shores the accumulation of *Ulva* on the beach is never very great. *Enteromorpha* is the commoner green seaweed here. It is smaller and is also less liable to be torn from its attachment.

Coming to the next great division of the seaweeds, viz.—the olive green ones, or *Melanophyceae*, we find them growing mainly between tide marks. To this division belong the

various species of *Fucus* which cover our shores. There are four of these very commonly found. *Fucus canaliculatus*, the shortest one, grows quite near high water mark. It is said to be greedily eaten by sheep who sometimes endanger their lives by going after it. Lower down between tide marks are found the bladder wrack and knot wrack, or *Fucus vesiculosus*, and *Fucus nodosus*. These often grow to a considerable length and in the days of Kelp making they were cut from the rocks and made the bulk of what was known as cut weed. They contain less Iodine than the seaweeds which grow in deeper water, but their value from an agricultural point of view is considerable, as I shall shew you by and bye, and in some places they are still cut from the rocks and used as manure. Dr Landsborough in 1851 narrates that the Minister of Cumbræ had his man go down to the shore every morning and cut this seaweed and give it to his cows who took it readily and thrive upon it.

These two species of *Fucus* are each provided with air bladders which serve the purpose of keeping them afloat in the water, and so enabling them to present a greater surface to the sea water which nourishes them.

The fourth species of *Fucus* (*F. Serratus*) is found nearer low tide mark, or even below it. It is darker in colour, and contains more Iodine than the others. On the surface of the fronds one can see little bundles of what look like white hairs. These mark the orifices of the reproductive organs in the female plant. Some interesting points in the life history of the *Fucaceae* may here be noted. In ordinary flowering plants you are aware that the ovule is attached to the plant, and is fertilised by the pollen grains which are carried to the ovule in various ways. In this group of seaweeds, however, the part which corresponds to the ovule, and the part which corresponds to the pollen grain are borne on different individual plants. They separate themselves from the parent plant and swim freely in the sea, meeting there, the ooblast, becomes surrounded by the spermatozooids which are supposed to be attracted by the exudation of some organic acid, and fertilisation takes place. The round body called the ooblast

may now be regarded as a fruit, but as such it has a separate existence from the parent plant. It rests for a time and then sends out shoots which anchor it to a rock, and there it develops into a plant of seaweed like its parent.

The orifices on the frond of *Fucus Serratus* on microscopical examination are found to lead down to little cyst-like cavities, which are full of a hair-like growth. Among the hairs large round cells are found, each having a cell wall which encloses eight smaller cells. Soon the cell wall bursts and the eight small cells or ooblasts are extruded from the cyst and swim freely in the sea. On other plants—the male plants—similar cysts are found which contain oblong bodies, and these again contain the spermatozooids or male fertilising element. These are free swimming bodies possessing cilia, which endow them with the power of locomotion, and much more like an animal than a plant organism. They are attracted to the ooblast which they surround in large numbers and fertilise.

Growing on the rocks also between tide marks, but rather nearer low water, there is a short, dark purple seaweed called *Gigartina mammosa*. It is nearly allied to Carageen moss or *Chondrus crispus*, and is in fact used as an article of food in the same way as Carageen moss is. It grows abundantly on the rocks from Battery Place to Ascog, and may be easily recognised from a distance, giving as it does a beautiful dark purple colour to the rocks at other places covered by the olive green seaweed.

It is highly esteemed as a food for invalids, first bleached and then boiled in milk, and in its dry state it fetches as much as 1/6 per pound. I am not aware that it is ever gathered on the shores of Bute, though I see no reason why it should not be, at any rate when we get the shores of Rothesay Bay a little cleaner than they are at present. It is, I know, gathered on the shores of Loch Striven.

Another red seaweed growing abundantly on the rocks is Dulse, or *Rhodomenia palmata*. It has also been used as an

article of food, though it cannot be said that its nutritive value is high. Other red seaweeds found commonly on our shores are *Phylota* and *Delesseria*, the latter usually washed ashore. It is conspicuous by its vivid colouring.

The coralline seaweeds, of which we have quite a number in Bute, are interesting from the fact that the deposit of Carbonate of Lime on them may be so great as to make it of commercial value. I am told that a material called Arisaig sand is largely composed of this coralline, and that it is used by farmers to spread on their fields instead of lime. There are considerable deposits of this coralline on the west shores of Inchmarnock, extending well up towards the land. Another calcareous seaweed is found in the fossil condition near Vienna, and forms the beautiful white sandstone from which the large public buildings in the Ringstrasse in Vienna are built. Nulliporous sandstone it is called.

Quite at low water mark and from four to five fathoms depth of water beyond it there is what is called the *Laminaria* zone. Here grows the great tangle or *Laminaria*, an important plant. There are two common species on our shores—*Laminaria digitata* which is smooth, and *Laminaria saccharina* which is rough on the surface and sinuous at the margin. These seaweeds form what is called wrack, or wreck—or in the Channel Islands, vraick—the French word for seaweed being varec. Growing in comparatively shallow water they give shelter to an enormous number of plant and animal organisms. They form a kind of forest with a whole world of beings living in its shelter.

When a storm comes these *Laminaria* are torn from their roots and cast upon the shore, and form what the kelp makers called Drift weed.

It may be interesting here to record one or two facts about the Kelp industry. About the beginning of the 19th Century, kelp, the product of those seaweeds, burned in a kiln, fetched about £20 per ton. Its chief use then was in the

manufacture of Soda, and the revenue from the making of kelp in the Hebrides was estimated to be as much as £120,000 a year. At the end of the Peninsular War the duty was taken off Barilla Ash, and the price at once dropped. At a later date Iodine was manufactured from kelp, and, indeed, is still obtained from it though it is not now the only source. It is said, however, that a fair price may still be had for kelp for the manufacture of Iodine, if only the proper kinds of seaweed were gathered, the species which contain most Iodine, being the *Laminarias* and *Fucus Serratus*.

These seaweeds, however, are valuable in a still more important industry, viz.: Agriculture. The literature upon this subject seems to be rather scanty, but there is an article by Mr Hendrick, in the 1898 Volume of the Highland Society's Transactions, from which I shall take the liberty of quoting some interesting facts. Mr Hendrick remarks in the first place upon the remarkable diversity of opinions as to the agricultural value of seaweeds. On the East Coast of Scotland it is little esteemed. On the West Coast in many places it is much prized. He attributes this diversity in part to differences in soil. The soils of Aberdeenshire, for instance, derived from granite and metamorphic rocks, do not stand so much in need of Potash as the sandy and gravelly soils of the West Coast. He gives tables shewing the chemical composition both of *Fucus* and of *Laminaria*—they are not very dissimilar—and comes to the conclusion that seaweed forms a good all-round manure, about equal in value, weight for weight, to farmyard manure.

Taking the three most valuable constituents of manure as Nitrogen, Phosphoric Acid and Potash, seaweed is found to contain about the same quantity of Nitrogen as farmyard manure—the Nitrogen is in the form of organic Nitrogen, and only becomes available when the seaweed has rotted. It contains much more Potash, but much less Phosphoric Acid. The Potash is in the form of soluble Chloride of Potash and so is soon washed out by fresh water. Hence the value of seaweed soon deteriorates if it is left long on the shore.

Phosphoric Acid is found in very small quantity in seaweed, and if the best results are to be obtained, some kind of artificial Phosphate should be added to it.

Mr Hendrick also made experiments at Helensburgh and at Turnberry in growing potatoes with seaweed and with farm-yard manure in separate plots. The result shewed that the weight of potato was about the same for both, but the quality was not so good with seaweed as with dung, but on the other hand, if Phosphate was added to the seaweed, the weight of potato was very much increased.

The foregoing investigation and experiments were made entirely from a chemical standpoint. Quite recently, however, some important work has been done which shews that there is another factor determining the fertility of soil and that is the presence of bacteria.

In Science Progress for January 1910, Dr Russell, working at the Rothamsted Experimental Station, reports some interesting experiments which go to prove that the fertility of any particular soil depends largely upon the number of bacteria which are present in it. These bacteria have the faculty of being able to fix Nitrogen from the atmosphere and make it available for plant life as well as of bringing about the decomposition of organic matter in the soil. Dr Russell's experiments consisted in heating soil to a temperature of 100°C and then letting it cool. He found that this process more than doubled the fertility of a pot of soil. On the other hand if the temperature was raised to as high as 130°C. the fertility of the soil was reduced. The conclusions he came to from those experiments were that heating the soil to 100°C. killed off the *Protozoa*, small organisms which live in the soil and which feed on bacteria, and then the bacteria were allowed to multiply and fertility was increased. On the other hand when the soil was heated to 130°C. both *Protozoa* and Bacteria were killed and fertility was diminished. A volatile antiseptic applied to the soil was found to have the same effect as heat.

A still more recent article by two Americans called Hoffmann and Hammer, published in the *Central Blatt für*

Bacteriologie, deals with the cultivation of certain forms of those bacteria and the most suitable food for them. They found that a substance called Mannite, somewhat similar in its composition to sugar, formed a very suitable food for them.

Now a possible bearing which this work has upon the agricultural value of seaweeds is this, that it is well known that seaweeds, especially tangle, contain a small percentage of Iodine, which is a powerful germicide, and which might play the same part as the heat did in partially sterilising the soil. Salt, too, of which fresh seaweeds contain a considerable quantity, is well known to kill various organisms in the soil.

The other point is that one species of tangle, viz.—*Laminaria Saccharina*, is known to contain mannite, the substance which Hoffmann and Hammer shewed to be so useful to the growth of the bacteria which increased the fertility of soil.

It would seem likely that further study of these facts and further experimentation might help us to a better understanding of the use of seaweeds as a manure and also help to explain the extraordinary difference in the views as to their value.

Mr Hendrick, in the article to which I have already referred, says, "It should pay to go to some little expense and trouble to save the large quantities of wrack, both cut weed and drift weed, which are allowed to go to waste round some parts of our Coasts." In Bute the Tangle, or drift weed, seems to be largely made use of where access can be obtained to the shore by carts. There is little or no effort made, however, to utilise the cut weed by cutting it from the rocks or to expend extra labour in collecting seaweed in creels, as is done in some parts of Ireland. Is there not an opportunity here for organising and using some unskilled labour, some of the many unemployed whom we have in Rothesay in the Winter time? There can be no doubt that there are quantities of drift weed lying ungathered round our shores and still larger quantities of weed growing on the rocks which it would be worth while

cutting, for there are farms, market gardens, and villa gardens which might be much benefited by their use. It is true, however, that what we do not pay for we do not value, and there being no one to sell seaweed, there is no one to advertise its claims, and so it often goes unregarded.

In the interesting paper which Mr Whyte gave us a few weeks ago, he told us that the sale of seaweed made one of the items of the Income of the the Burgh 200 years ago and further that it was roused once a year. Might not the Municipal Authorities, or at any rate the Civic Guild (a body closely associated with them) resume some interest in the collection of this valuable asset? There would be the additional advantage also that the systematic removal of decaying seaweed would improve the sanitary condition of our shores.

In the Channel Islands the value of seaweed is highly appreciated. Rugulations are in force which permit the cutting of weed only twice a year, in March and in July, and at those times all the inhabitants turn out and engage in the work and it is well known that in those islands market gardening has reached a high state of perfection.

Rothsay is what is called a seaside resort and there can be no doubt that after all, its most valuable asset, as an attraction, is its seashore. At all times and at all places not absolutely spoiled by the effects of our civilization the margin of the sea is of fascinating interest, at any rate to those whose powers of observation have not been dulled by a too exclusive devotion to the printed book. Here we may still "read what is still unread in the manuscripts of God." It behoves the Authorities therefore to do their best to keep the margin of the sea clean, and I am glad there is a likelihood of our soon having a new drainage scheme. Even a cursory examination of the water of Rothsay Bay shows that it is much needed.

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OLD AND REMARKABLE TREES IN BUTE.

By JAMES KAY.

[Read 28th February, 1911.]

The subject before us this evening is the old and remarkable trees in Bute.

The Island of Bute being divided into three Parishes, viz.:—Kingarth, Rothesay, and North Bute, we shall take up each Parish separately and enumerate the most noteworthy trees as arrived at. First—

PARISH OF KINGARTH.

The Policy Woods of Mountstuart are in this Parish.

The north portion from Kerrycroy Lodge to Lime Tree Avenue was planted in 1811. That to the south of the Lime Tree Avenue dates back to the building of Mountstuart, which was begun by James Stuart, 2nd Earl of Bute, who died in 1722 at the age of 32, and four years after the work was begun.

The planting of the woods in the immediate vicinity of Mountstuart was latterly carried out under the personal supervision of John, 3rd Earl of Bute, a most enthusiastic arboriculturist, and, as showing the interest manifested by his Lordship, it may be mentioned that there is in the Bute Library a minute diary with an account of the various trees planted and the improvements carried out at the time.

The Policy Woods of Mountstuart originally possessed great natural beauty, but the devastating storms of the past