

face of the rock. There are also many parts on the hills where we find the exposed rock surfaces finely rounded and smoothed on the side exposed towards the north. An interesting example of the boulder clay, with its smoothed and striated stones and blocks, may be seen at low water opposite Pointhouse Crescent. The clay is of a reddish colour and very tenacious. On removing any of the stones still embedded in it we find them finely smoothed with, in some cases, well marked striæ. Scattered over the shore there are many boulders of varying sizes. Some of these have smoothed surfaces, whilst a number of the large flat stones lying about are finely striated. The study of the phenomena of the glacial period is one which may be readily carried out by anyone interested, the evidences being well marked and quite noticeable. As we walk or drive through the country, or by the shore, or even as we sail up some of the various sea lochs of the Firth of Clyde, we frequently find the rock surfaces smoothed and rounded by the action of the glaciers, which at a far back period had filled the valleys.

NOTES ON THE FRESH WATER FLORA OF BUTE.

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True Waterplants—technically known as Hydrophytes—live always in water. They take carbonic acid from the water and die if exposed to air for any time. But there are many plants which we popularly call Water plants, as they usually grow in watery places, Lochs or Streams. The upper stem and leaves of these plants are exposed to the air, they draw carbonic acid from the air, and while they prefer to live in water they may live on moist earth and are really marsh plants. In popular language, water flora includes both kinds of plants and I propose to deal with the water flora of Bute in the purely popular sense.

Lochsides, generally speaking, show a succession of plants in something like the following order:—(1) Wet Meadow Plants; (2) Rushes; (3) Flag or Iris; (4) Reeds; (5) Water Lily; (6) Pondweed; (7) and then the open water teeming with free swimming Algae. Lochs Fad, Quien and Greenan show a similar succession of water plants.

The Buttercup family is represented over the entire area from the beginning of the marshy ground into the water. The Lesser Spearwort (*Ranunculus flammula*) grows in marshy ground, ditches and lochsides, and is generally distributed throughout Bute. The flowers are yellow and the leaves are always entire, that is not cut up into segments. In muddy pools the Ivy-Leaved Crowfoot (*R. Hederaceus*) is very common—a small plant often creeping over the mud, with a little white flower. Then there is the very variable variety—The Water Crowfoot—the appearance of which depends to a large extent on its place of growth. The common form (*R.*

peltatus) which grows in the Kirk Dam and in Loch Greenan has two quite distinct kinds of leaves. Floating on the surface of the water is a leaf in general shape not unlike that of the Ivy-Leaved Crowfoot, but it has also submerged leaves and these are cut up into many segments. Another variety (*R. Trichophyllus*) grows in the Upper Reservoir at Kilchattan Bay. It has rarely floating leaves and its submerged leaves have short rigid segments. But the chief difference between the varieties are the shapes of the stigma and the achenes, or fruits. Another variety is recorded in Henedy (*R. Heterophyllus*) but I have not been able to locate it. I shall deal with the leaves later on.

The Rushes like the Crowfoots, grow from the boggy Meadows to the waterside. The Common Rush generally keeps to marshy ground and undrained meadows. *Juncus acutiflorus* is also a bog plant while *J. Lampocarpus* grows from the bog to the waterside. The Lesser Bog Jointed Rush (*J. Supinus*) is a very variable plant. Sometimes it grows creeping along moist ground, while it is often found floating in water. This is a plant which is found with flowers and fruits, but in situations unfavourable to the development of flowers and fruit—e.g. Alpine and Arctic regions—it very frequently produces vegetative buds or bulbils which become detached from the parent plant and give rise to new individuals. These bulbils are little leafy shoots which have been produced instead of flowers or fruit.

The Iris is a common plant growing in marshy Meadows and into the water usually where the water is less than eighteen inches deep. The rizome, or underground stem, grows horizontally underground for a short distance and then turns up into the air to produce its leaves and flowering stocks; another branch, starting from the buried part of the first, grows still further forward and also sends up its leaves. By this means it spreads rapidly in suitable soil as can be seen at the Upper Reservoir at Kilchattan Bay.

Various other plants have a similar method of growth. The Marsh Cinquefoil (*Potentilla palustris*) has tough hori-

zontal stems, sometimes three feet long, often submerged in the water. Its leaves are generally in the air but as they are liable to be accidentally plunged below the water there is a development of wax on the leaves which prevents them being permanently wetted.

Another plant belonging to the Rosaceae is the Water Avens (*Geum rivale*). It grows in some of the ditches about Loch Fad and elsewhere throughout the Island. It is a much handsomer flower than *Potentilla palustris*, has not the long creeping stock and its leaves are carried well above the water.

The Marsh Arrow Grass (*Triglochin palustre*) grows in several of the Marshes throughout the Island and by the side of Greenan Loch. The leaves are slender and the flower stem, from six to twelve inches high, bears a slender spike of small yellowish green flowers.

One of our rarest plants is the Marsh St. John's Wort (*Hypericum elodes*) which grows at the side of Loch Quien. It is recorded in Henedy as being found in "Bute near Loch Fad, Lesser Cumbræ, King's Cove, and Lochranza, Arran." Its station in Bute was somewhat a mystery till a few years ago, when Mr Ballantyne, Mr William Cuthbertson and myself were collecting wild flowers for an exhibit at the local Flower Show, Mr Ballantyne accidentally came upon the plant at Loch Quien.

All the above plants are more or less variable as to their habitat and (with the exception of the Water Crowfoot which grows on mud and in water) they usually grow in marshy watery ground. Before I come to the plants which grow in the deeper waters of our Lochs I may just note a few which are more commonly found in ditches than in Lochs.

The Common Water Cress (*Nasturtium officinale*) is well distributed over the Island.

The Branched Bur Reed (*Sprangium ramosum*) grows in stagnant ditches and streams, this specimen being from a burn running into Stravannan Bay.

The Brookline (*Veronica beccabunga*) not infrequently fills up ditches.

The Water blinks (*Montia fontana*) usually frequents shallow ditches or pools. A near relation of this plant is *Claytonia sibirica*, a plant introduced from North America which is very plentiful in the ditches in the Skipper's Wood.

The above mentioned plants belong, generally speaking, to the first three lines of succession of lochside flora. The next line includes the reeds and plants growing in water to a depth up to about four feet six inches, that is round the outer edge of the loch. There are quite a number of plants found in our lochs growing up to this line. The Starwort (*Callitriche*) is found in almost every ditch and in probably all the lochs and when growing in water its common name is quite appropriate. In Loch Quien the variety *Autumnalis* grows and this is one of or probably our rarest local plant. It was discovered by Rev. Mr Marshall, who was visiting the loch with Mr Ballantyne in 1900, and Mr Marshall then informed Mr Ballantyne that it was the only record for Scotland. The water plantain (*Alisma Plantago* and *Ranunculoides*) grow in several ditches and in Lochs Greenan, Fad and Quien (where the specimen of *A. Ranunculoides* came from). This plant belongs to the same family as *Triglochin*. The larger one grows in the water while *Ranunculoides* grows in turf bogs or in water.

The Maretail (*Hippuris vulgaris*) grows in Greenan and I think the Kirk Dam. The plant bears some resemblance to the Horsetail although it belongs to an entirely different family. It has very minute white flowers growing in the axils of the leaves. The stem is crowded by whorls of narrow entire leaves, the submerged leaves being larger than the aerial ones.

The Water Milfoil (*Myriophyllum*) belongs to the same family, but it grows in deeper water. It is common in all our lochs. The stem is wholly submerged, and from the summit of the branches a slender spike bearing the flowers

protrudes from the water. Its leaves are whorled along the whole length of the stem and are divided into capillary segments.

Another plant with finely divided leaves is the Least Marsh Wort (*Apium inudatum*). The habitat of this plant is given as "swamps, shallow ponds and pools, and half dried mud," but it is usually mostly submerged. The specimen is from the upper reservoir at Kilchattan Bay, where it was growing at the water's edge, and it is found in the Vineries Pond and elsewhere in the Island. At the first sight it looks like one of the Water Crowfoots, but a careful examination shows it to be one of the Umbelliferæ—the umbells being small and the flowers very minute.

One of the prettiest little water plants when seen growing in its natural habitat is the Water Lobelia (*Lobelia Dortmanna*), which grows in Loch Quien and the Bull Loch. It formerly grew in Loch Ascog, but it has been drowned out there.

The Amphibious Persicaria (*Polygonum amphibium*), as indicated by its name, is equally at home on dry land and in water. When growing in water the leaves are smooth, without hairs, but when growing in dried up ponds or muddy ditches the leaves have hairs and the stem is creeping.

One of the commonest water plants, and one that has given considerable trouble in Rothesay, is the Water Thyme (*Elodea Canadensis*). This plant was introduced into Great Britain from North America about 1847, and has since spread very rapidly. It is always submerged, having numerous leaves, while the perianth tube of the female flower is very long so that it may reach to the surface of the water. The raising of Loch Ascog has not killed this weed, for it is still in great quantities round the margins, and the specimens which are in flower, were gathered there last September. I shall have more to say about this plant later on.

The Sedge Family generally grow in wet, boggy places or in water. An example of plants growing in bogs is the well-

known Cotton Grass. Two representatives of this family grow in two of our Lochs—the Bulrush (*Scirpus lacustris*) in Loch Quien and the Prickly Fen Sedge (*Cladium jawaicense*) in the Bull Loch. It is said that the stems of the first named are used for the bottoms of chairs, for mats, hassocks and thatching; also by coopers for placing between the staves of casks; and that in hot weather the Tartars lie upon mattresses made of these rushes.

The other plant (*Cladium*) is one of the most interesting of all our local plants. It was discovered by Mr Ballantyne in 1894 growing in the Bull Loch amongst the common reed. The eighth edition of Bentham and Hooker's Flora states that it grows in "deep bogs and marshy places, in most temperate and some tropical regions of the Globe extending northward in Europe to southern Scandinavia. In Britain thinly scattered over England, frequent in the west of Ireland and very rare in Scotland." In the third edition of Hooker's "Students' Flora" it is recorded as being found in Sutherland, Berwick and Wigtown Shires and I think it has also been recorded for one of the Hebrides. According to Johns' "Flowers of the Field," "this plant used to be so common in undrained fens near Cambridge that it was used in that town for lighting fires; it was also used for thatching. It forms floating islands in pools and is still cut as a crop in the fens." In the Bull Loch it is growing in from two to three feet of water. From its wide distribution it would almost seem as if the plant had at one time been plentiful and was now becoming extinct in Scotland. On the other hand it may have been carried to the Bull Loch by water fowl. Be that as it may it is one of our rarest plants and it is still holding its own in the Loch.

Some of the Grasses take up their abode in water. Such grasses for example as the Floating Meadow Cress (*Glyceria fluitans*) the Floating Foxtail (*Alopecurus geniculatus*) and the Common Reed (*Phragmites Communis*). This latter is a handsome plant growing in Lochs Quien, Greenan and Bull. The Reed has extremely long runners growing out towards

the water. From the runners a series of branches are given off at close intervals, and these latter curve upwards and develop their leaves above water. This plant is an example of a class of plants which have moderately stiff leaf blades which can turn like weathercocks on the stem from which they project. It has lofty slender haulms which bear numerous leaves with a fairly broad and tapering blade. It has also a sheath in the form of a hollow cylinder surrounding the haulm, and from which the portion of the haulm in question proceeds as from a tube. As long as the haulms and leaves are not fully developed, the leaf blades are directed in a line parallel to the haulm; later they decline, project horizontally, and finally become even somewhat depressed so that their apices are directed groundwards. They then remain flat and are so stiff that they cannot be bent by light winds. If a stronger gust occurs, they do not bend but twist round like a weathercock in the direction of the wind.

Beyond the Reeds and Horsetail, the Water Lily grows, and growing even beyond the depth of the Water Lily we find the Pondweeds. These are very variable plants, depending largely on their situation. They are found growing in water under very varying conditions. Twenty-eight species of this plant are recorded in the London Catalogue, but they are very difficult of identification and can only be accurately named by an expert. Mr Ballantyne records only two species, but it is quite possible that there are more to be found in our waters.

The open water is full of floating Algae while underneath there is in a subaqueous meadow such plants as the Quillwort (*Isoetes lacustris*) and forms of *Chara*. Dr Wallace in 1885 reported that there was a "kind of *Chara*" growing in Loch Ascog at a depth of 18 feet six inches. In Loch Fad last September we found a plant belonging to the same class of plants as the *Chara*—probably one of the *Nitellas*—but it was not in a state to have it properly identified.

All the plants of which I have shown specimens are attached to the ground. The Duckweed (*Lemna minor*)—

usually found in stagnant water or little pools in ditches—floats on the surface of the water and draws its food from the water by its little rootlets. It has no distinct stem or real leaves, but consists of small leaflike fronds, three or four usually cohering together by their edges. The little fibrous roots grow from their under surface into the water. It is chiefly propagated by offsets, but sometimes produces flowers which appear from a fissure in the edge or on the upper surface of the frond.

Another plant which floats on the surface of the water without its roots being attached to the soil is the Bladderwort, one variety of which *Utricularia minor* is recorded by Mr Ballantyne for Loch Quein. This is one of the insectivorous plants. Other insectivorous plants which grow in Bute are the Butterwort and Sundew. The Bladderwort has little bladders which are really traps, among its leaves. The insect is carefully guided into the trap, but when in the trap is closed and little spines inside the bladder prevent the insect's escape. Inside the bladder are absorption cells which exude the acid which dissolves the unfortunate insect. It is recorded that in one bladder no less than twenty-four little crustaceans have been found.

Water plants have necessarily to be adapted to their surroundings, and they have accordingly distinct characteristics. The Hydrophytes absorb the food salts from the water through the whole of their surface, consequently they do not require the complicated adaptations of land plants to absorb food salts from the earth. So also the plant growing in water does not require such adaptations for defence as land plants, consequently there is very little woody tissue or cork in submerged stems. To illustrate the difference in the stem of an aquatic plant I show first a section of a stem of a Dicotyledon or Exogen. From the outside, towards the inside, the succession is (1) Epidermis, (2) Cortex or bark layer, while the wood bundles are formed towards the pointed ends of the bundles, and the pith is in the centre. In succulent tissues particularly, there are often intercellular spaces which are filled with air, but these do not occupy much of the stem. The next two

sections are woody stems (Lime and Holly) showing the annular rings.

In Monocotyledons the arrangement of cells is quite different. Beginning at the outer margin we have the epidermal cells; close to those we see the bark cells; then loose cellular tissue with air passages. All the remaining portion consists of cellular tissue containing at intervals the fibro-vascular bundles. The cells at the centre are the new growth.

Water plants have quite characteristic stems. They contain many air cavities which fulfil the double purpose of supplying the oxygen required by the living cells for respiration and the presence of these cells makes the plant buoyant and able to float freely. The Rush stem shows these air cavities but they are more marked in the stem of the Marestalk. Beginning at the centre of the section we see the pith surrounded by a cylinder of fibro-vascular tissue. Outside this cylinder and close to it are cellular tissues and air passages. Next we have large intercellular spaces, their walls consisting of cellular tissue. At the margin immediately on the inside is cellular tissue while the external part consists of thick epidermal cells.

Leaves of water plants also differ in several respects from those of land plants. Through the outer skin of plants—technically known as the epidermis—are numerous openings or pores called stomata. These stomata provide for the emission of aqueous vapour and of gases from within the plant, and for the absorption of other gases from without. Stomata are found in all parts of plants above ground and are most numerous on the leaves, particularly on the under surface. These stomata are usually wanting in the parts of plants submerged in water, and in floating leaves they are confined to the upper surface. The leaf structure, like the stem, often contains large air cavities. The sheath or leaf of the rush shows cavities similar to the stem of that plant. The white water lily is found in the Bull, Greenan, and Quien Lochs, the small variety growing in the latter, while

the yellow water lily grows in Greenan. The rhizomes of these plants are sometimes at a depth of nine feet six inches, while their leaves float on the surface of the water. A section of the peduncle of the water lily shows large intercellular spaces filled with air, bounded by simple layers of cells. The section of the petiole shows similar air cavities. The section of the petiole shows cells projecting into the air cavities. These cells (sometimes called internal hairs) are without protoplasm, and have their walls thickened. These fibrous cells give firmness to the parts of the plant in which they are present.

The leaf of the Water Lily is free to expand in any direction and as a result it becomes nearly a circle. But the submerged leaves of many water plants are very much cut up—for example the Water Crowfoots. The submerged leaves of the Marestail are very much longer than the aerial leaves and much narrower—Kerner states that the submerged leaves are thirty times as long as broad, the aerial leaves being only seven to nine times their width. The explanation given by Kerner is that submerged leaves are usually elongated and narrow adapting themselves to the current while this elongation of leaves and division of leaf lamina is associated with diminution undergone by the light in passing through the water. Professor Henslow, on the other hand, states that the general characteristic of all water plants is degeneracy. The reduction in size of the fibro vascular bundles and the filling of the space by air cavities, the want of a true epidermis or skin in submerged stems and leaves and the want of stomata are all cited as examples of this degeneracy. According to Henslow the division of the submerged leaves is due to the supersaturation of the protoplasm and the consequent inability of the plant to produce entire leaves. He gives the result of an experiment carried out in America on a plant of the same order as our Marestail. The plant experimented on has lanceolate leaves above water and pectinate submerged leaves. It was placed in a food solution with the result that the submerged leaves assumed the same shape as the aerial leaves,

Plants adopt various methods to secure the dispersal of their seeds and the seeds of most water plants are able to float in the water. In the White Water Lily each seed has a small envelope which is full of air cavities so that the seed can float for a short time. The seeds of the Brooklime are covered with a fine gummy layer. The capsules only open in water and the seeds drop into the mud. They are in all probability carried off on the feet or feathers of marsh birds. The mud of ponds is very heavily charged with seeds. Darwin tells in his "Origin of Species," how he took three tablespoonfuls of mud from three different points beneath water, on the edge of a little pond. This mud when dried weighed only six and three quarter ounces, yet from this small quantity of mud five hundred and thirty-seven plants of various kinds sprung up. But one of our commonest water plants—*Elodea canadensis*—never produces seed in this country. The time and method of the introduction of this plant into this country is not quite known, but the first record for this country seems to have been in 1847. The flower of the female plant has a long perianth tube so as to reach to the surface of the water, but there are no male flowers (the only record for the male being near Edinburgh) and so seed cannot form. Yet this plant has spread all over Great Britain in a comparatively short time, and no doubt water fowl have largely aided in this distribution. Some of the Pondweeds have a peculiar method of increase. As autumn approached buds are developed which become detached from the old stems and sink to the bottom of the pond. In the following summer they remain sticking in the mud at the spot where they fell and do not rise again to the surface. They send out roots and develop much branched leafy stocks which rapidly grow to the surface of the water. These Pondweeds also multiply by means of long stolons which creep along the mud and send up shoots.