PROCEEDINGS

OF THE

ROYAL IRISH ACADEMY

VOLUME XXXI

SECTION 1

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1911–1915

A BIOLOGICAL SURVEY
OF
CLARE ISLAND
IN THE COUNTY OF MAYO, IRELAND
AND OF THE ADJOINING DISTRICT

SECTION 1

(COMPRISING PARTS 1 TO 16)

INTRODUCTION. ARCHAEOLOGY. IRISH NAMES.
AGRICULTURE. CLIMATOLOGY. GEOLOGY.
BOTANY.

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CONTENTS

OF SECTION 1.

Note.—Part 8, which was to have dealt with the Peat deposits, will not be published.

ADDENDA AND CORRIGENDA TO SECTION 1.

2.—HISTORY AND ARCHAEOLOGY.

Page 2, line 6, *add* where they now appear, vol. xlii, pp. 51, 101, 185; vol xliv, pp. 67, 297, 317.

Page 6, line 11, *for* one *read* two exceptions.

Page 13, correct confusion between Ui Mhaille and Umail.

Page 17, line 20, *for* Mr. Lloyd *read* Professor Mac Neill.

Page 17, line 27, *for* month of the flat moor *read* mouth of the cave, and correct name to Ooghgubanoomeen.

Page 18, several names should be revised from Professor Mac Neill's list, Part 3.

Page 20, *add* DUNTRAGHA as alternative to Duntraneen. It is "Doontraue" on Bald's map, 1813, which gives the other forts as Doonalla, Doon-cloak, and Doon Oughenska.

Page 31, line 32, *add* paintings and diapers in red and green still remain well preserved in the sedilia of the Franciscan Church, Adare.

Page 57, *for* Rooduff *read* Roonduff.

Page 59, line 16, *for* Ferguson *read* Wilde.

T. J. WESTROPP.

4.—GAELIC PLANT AND ANIMAL NAMES.

Through the kindness of Professor John MacNeill I am enabled to supplement here the confessedly incomplete lists of Gaelic Plant and Animal Names given in Part **4** of this Survey by the results of inquiries carried on by him in Clare Island subsequent to the date of my visits in 1909 and 1910. It will be seen that the additions here made refer chiefly to the birds of the island. Almost all of these additional bird-names were supplied by Patrick Toole, an Irish-speaking islander aged seventy-one years, and in their collection Professor MacNeill was assisted by the late Mr. R. J. Ussher, then engaged in working out the ornithology of the district. In publishing this supplement I take the opportunity of embodying some material collected by myself in September, 1911, at Louisburgh and in its neighbourhood, or the mainland opposite to Clare Island, these additions being distinguished by the initials N.C. Where no station is mentioned the name is to be taken as current in Clare Island.

Bird Names.

Caillеaċ ḋuḃ, *Phalacrocorax carbo* Linn., Cormorant.

Cairlín, *Saxicola oenanthe* (Linn.), Wheatear.

Cairlín ceanu duḃ, *Pratincola rubicola* (Linn.), Stonechat.

Cánóg, *Puffinus anglorum* (Temm.), Manx Shearwater.

Cearc fhraoiġ, *Lagopus scoticus* (Latham), Grouse.

Colum, *Columba livia*, J. F. Gmel., Rock Dove.

Corr ġrréaċóg, *Ardea cinerea* Linn., Heron.

Creabhar caoċ, *Scolopax rusticula* Linn., Woodcock.

Croirán, *Alca torda* Linn., Razorbill.

Crotaċ, *Numenius arquata* (Linn.), Curlew.

Cuilthreaċán, *Fratercula arctica* (Linn.), Puffin.

Dreóilín an earbuig, *Regulus cristatus* R. L. Koch, Gold-crested Wren.

Druid, Druideóg, } *Sturnus vulgaris* Linn., Starling.

Faoile mór, *Larus marinus* Linn., Great Black-backed Gull.

Faoiṫeaċ,, *Phalacrocorax carbo* (Linn.), Cormorant.

Feadóg, *Charadrius pluvialis* (Linn.), Plover.

Filbín, *Vanellus vulgaris* Bechst., Lapwing. Also round Louisburgh. In the town of Louisburgh it occurs as a personal name over two shop fronts.—N.C.

Foraċa, *Uria troile* (Linn.), Guillemot.

Fuireóg, *Alauda arvensis* Linn., Sky-Lark.

Gallún, *Emberiza miliaria* Linn., Corn Bunting.

Iolra, *Aquila chrysaëtus* (Linn.), Golden Eagle.

Lonḋuḃ, *Turdus merula* Linn., Blackbird.

Meanntán, *Anthus pratensis* (Linn.), Meadow Pipit.

Muiréad, *Lagopus scoticus* (Latham), Grouse.

Naoṁ, *Gallinago coelestis* (Frenzel), Snipe.

Fraċán duḃ, P. Muirrce, } *Corvus frugilegus* Linn., Rook. The second name is suggested by the fact that the rooks usually come to Clare Island from Murrisk on the coast of the opposite mainland.

Roilleaċ, *Haematopus ostralegus* Linn., Oyster-catcher.

Ruaḋán, R. aille, } *Falco tinnunculus* Linn., Kestrel.

Seabac, *Falco peregrinus* Tunstall, Peregrine Falcon.

Ugaróin, *Sula bassana* (Linn.), Gannet.

Plant Names.

Bainne bó bliocán, *Primula vulgaris* Huds., Primrose. At Roonah: *N.C.*

Baiġ, *Alnus glutinosa* Gaertn., Alder. General round Louisburgh, where the bark of the tree is mixed with Airgead Luaċra (Meadow Sweet) to make a black dye: *N.C.*

Biolra, *Nasturtium officinale* Br., Water Cress.

Buaċallán bán, *Chrysanthemum Leucanthemum* (Linn.) (Dog Daisy) and *Matricaria inodora* Linn. (Sea Chamomile). Also applied to *Artemisia vulgaris*. See Part **4**.

Carraiġín, *Chondrus crispus* Linn., Carrageen, or Irish Moss.

Ceannaban, *Eriophorum polystachion* Linn., Cotton Sedge.

Coiġeal na mban Sióe, The Banshee's Distaff, *Typha latifolia* Linn., Reed Mace. Round Louisburgh, where I was told the fruiting head was a "grand strop for a razor." The same name, transposed to Bean ríóe coiġeal, is applied to this plant in Co. Dublin: *N.C.*

Cora carróiġe, *Vicia Cracca* Linn., Wild Vetch.

Creaċnaċ, *Rhodymenia palmata* Linn., Dillisk. Also at Roonith on the mainland. This name is applied only to the young plant growing amongst dwarf mussels (Dublicín), on rocks near low-water mark: *N.C.*

Earboġ béa, *Chrysanthemum Leucanthemum* Linn., Dog Daisy.

Fairḟ na madaióe, Dogs' Fifes, *Heracleum Sphondylium* Linn., Cow Parsnip.

Feaṁbán, *Potentilla Anserina* Linn., Silver Weed. Also used in parts of Co. Dublin, but in West Ireland commonly applied to *Ranunculus repens*: *N.C.*

Foċannan mín, Soft Thistle, *Sonchus oleraceus* Linn., Sowthistle. Clare Island and round Louisburgh. So called, as a Louisburgh man told me, "because it's a kind thistle": *N.C.*

Ġaġáine, Gaudy Spear. Applied to the Yellow Iris, or Sellirtiġ, when in flower. The word ġáine was thus explained by Pat Toole: Ruo ar bit oeiġ feiceála, tá ré ina ġáine.

Mucoiṁ, Hips, or fruit, of the Wild Rose, *Rosa canina*. Commonly used round Louisburgh. In East Ireland, in Dublin and Louth, it appears in the form Johnny McGorey: *N.C.*

Erratum.

Part 4, p. 15. *For* Ténaġarainti *read* Té na nġarraintí.

Nathaniel Colgan.

10.—PHANEROGAMIA AND PTERIDOPHYTA.

The observations of the ornithologists, carried out and published since the date of this report, throw light on the question of bird migration into Clare Island. They show that in hard weather large influxes of birds take place (see Part **20**, p. 3). The remarks on this point on pp. 85, 86 of my report therefore need modification. It is clear that the influence of birds in bringing seeds into Clare Island is greater than I had assumed on the evidence available at the time.

As regards the question of the dispersal of seeds by water (Part **10**, pp. 60-62), a body of detailed evidence regarding the power of floating in water of seeds will be found in my paper "On the Buoyancy of the Seeds of some Britannic Plants," Sci. Proc. R. Dublin Soc., N.S. xiv, No. 3 (1913). Here are given the results of experiments on the floating power of the seeds of some 800 species, undertaken as a continuation of the Clare Island study of dispersal. The result confirms the estimate originally made by Darwin, that about 10 per cent of a flora have seeds capable of floating.

R. LLOYD PRAEGER.

15.—MARINE ALGAE.

ERRATA.

p. 95 *Myriactis stellata*, Batt., should read *Myriactis stellulata*, Batt.

p. 124 *Aerothrix mirabilis*, Kylin, should read *Aerothrix gracilis*, Kylin (as listed on p. 96), throughout the paragraph.

ADDENDA.

There are no additions or corrections to be made to the list of species published, but two recent papers bearing on the Clare Island flora may be noted.

LEMOINE, P. "Mélobésiées de l'Ouest de l'Irlande" (Nouv. Arch. Mus. Hist. Nat. v. 1913, pp. 121-145). Here the authoress deals in further detail with the Clare Island Melobesieae reported on by her in 1912 (see Part **15**, pp. 145-151), the anotomical structure of the more interesting species being described at length and illustrated.

COTTON, A. D. "The distribution of certain British Algae" (Journ. Bot. lii. 1914, pp. 35-40). With the help of this note, which deals with the coast-line of the West of England and Wales, a more accurate statement can be made than was possible in 1912 with regard to the distribution in the British Isles of the interesting algae *Ptilota plumosa*, *Callithamnion arbuscula*, and *Codium mucronatum* var. *atlanticum*. There is still no evidence that the last-named occurs in England or Wales.

A. D. COTTON.

R. Welch, photo. London Stereoscopic Co.

CLARE ISLAND SURVEY—CROAGHMORE FROM THE NORTH-EAST.

1

GENERAL INTRODUCTION AND NARRATIVE.

By R. LLOYD PRAEGER.

Plates I–IX.

Read June 22, 1914. Published April 15, 1915.

Islands and their animal and plant inhabitants have a special interest for the naturalist. The study of their fauna and flora raises at once questions of fundamental biological importance, especially with regard to the sources from which their population has been derived, the means by which that population reached its present habitat, and the effects of isolation upon the flora and fauna in their island home. Thus it comes about that the problem of insular populations has attracted the attention of the most eminent biologists, many of whom have given close attention to this study—for instance, Alphonse de Candolle, Edward Forbes, Charles Darwin, Alfred Russel Wallace, Sir J. D. Hooker. Thus, also, we find that in recent years many notable works on the flora and fauna of islands have been published, narrating, in most cases, the results of special expeditions sent out for the purpose of studying the animals and plants of selected insular areas, and inquiring into their relationships and origin. Places so far apart as Christmas Island,[1] Anticosti,[2] Krakatau,[3] Funafuti,[4] the Faeröes,[5] and the subantarctic islands of New Zealand,[6] have been monographed thus in recent years.

Most of these islands are far removed from any other land, thus accentuating the interest which centres round the question of the arrival of the organisms which colonize them, and their subsequent behaviour. But even in the case of islands which are separated by but a narrow barrier of sea from adjoining areas, similar important problems arise. A study of the dispersal of animals and plants across comparatively narrow stretches of sea must undoubtedly throw much light on the problem of their passage

[1] A Monograph of Christmas Island (Indian Ocean). London: British Museum, 1900.
[2] Joseph Schmitt: Monographie de l'Ile Anticosti (Golfe Saint-Laurent). Paris, 1904.
[3] A. Ernst: The New Flora of the Volcanic Island of Krakatau. Cambridge, 1908.
[4] The Atoll of Funafuti, Ellice Group. Sydney: Australian Museum, 1896–7.
[5] Botany of the Faeröes, based upon Danish investigations. Copenhagen, &c., 1901–8.
[6] C. Chilton: The Subantarctic Islands of New Zealand, vols. i-ii. Wellington, N. Z., 1909.

across wider barriers; and in islands which may have been joined with adjoining areas in comparatively recent times, we may hope to find some beginnings of that differentiation and specialization which are so remarkable a feature of the natural history of oceanic islands. Besides, the close examination of any island is sure to yield important contributions to the biology of the larger region of which it forms a part; especially since, on account of the limitation of area, an intensive study results which is often specially productive among those more obscure and difficult groups which are apt to be neglected when, on a larger area, a rich fauna and flora prevail.

It was considerations such as these, as well as the interest attending the exploration, a few years earlier, of the island of Lambay, off the coast of county Dublin,[1] which led to the suggestion early in 1908 that an organized natural history survey should be carried out on one of the islands lying off the west coast of Ireland. Following on this, a meeting of Irish naturalists, summoned by circular sent to persons likely to be interested, was held in the National Museum in Dublin, on April 13, 1908. At this meeting Clare Island was selected as the scene of operations, and the following were appointed a committee to carry out the work:—Dr. R. F. Scharff (Chairman), R. M. Barrington, N. Colgan, Prof. G. A. J. Cole, Rev. Canon Lett, and R. Lloyd Praeger (Secretary). The selection of Clare Island was influenced by its suitable size, position, and unusual elevation as compared with most of the western islands; it lay sufficiently far off the coast to raise interesting problems as to the immigration of its fauna and flora, but not so far as to introduce delay and expense to the working parties owing to precarious communication with the mainland; also it was possible on Clare Island to procure accommodation for working parties without outlay on building. With the kind permission of the Congested Districts Board, a large shed close to the harbour and little hotel was fitted up as a laboratory.

Owing to the British Association meeting in Dublin in the autumn of 1908, work on the island was not commenced until the following spring. After the latter date, parties of workers, numbering from six to sixteen, were sent down at about monthly intervals between April and September. In addition, a large number of workers visited the island separately, and there was no month of the year during which observations of some kind were not carried out. It had been agreed to work the adjoining mainland and islands so far as time and opportunity permitted, and also to include in the scope of

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[1] Contributions to the Natural History of Lambay, County Dublin. "Irish Naturalist," xvi, pp. 1–112, plates i–xxv, 1907.

the survey the marine area surrounding Clare Island; this led to a frequent wide dispersal of workers over the district stretching from Achill to Killary, and from Clare Island to Castlebar. The limit of the district was extended as far eastward as Castlebar, in order to bring in, for comparative purposes, a piece of the limestone country of the Central Plain of Ireland. The chief centres used for work on the mainland were Achill Sound, Westport, Belclare, and Louisburgh. Achill Island was worked for many groups. Inishturk, Caher Island, and Inishbofin were worked for Mollusca, Phanerogamia, Archaeology, &c.; and some outlying rocks difficult to approach, such as The Bills and Mweelaun, were also visited. In the marine area much shore-collecting was carried out on Clare Island and round Clew Bay and Achill Sound; and dredging operations, otherwise carried on from open boats, were much advanced by several visits of the Fisheries steamer "Helga."

It is worthy of mention that the authors of the whole series of reports have themselves visited and worked in the district—a fact which adds materially to the value of their remarks on the distributional and ecological problems involved.

The best thanks of the Committee are due to various public bodies who in practical ways assisted the researches both on the island and on the mainland; they would like in this connexion to mention especially the Congested Districts Board, the Fisheries Branch of the Department of Agriculture and Technical Instruction, and the Irish Lights Commissioners. By arranging for a detailed examination of the island as regards both its solid and surface geology, during the period of our survey, the Director of the Geological Survey of Ireland supplied us with a mass of important evidence bearing on questions related to local biology, and furnished the materials for the geological description of the island which forms part of the present series. Thanks are also due to the Director of the Royal Gardens, Kew, and the Keeper of the Botanical Collections in the British Museum, for facilitating visits by members of their staffs who took part in our work; and to the Director of the National Museum in Dublin for help in the way of apparatus and material. To a large number of private persons, also, the Committee's thanks are due for facilitating in one way or another the work of the last six years; and they would also thank the numerous scientific men who, on their invitation, threw themselves so energetically into the work of the Survey; the reports which they have furnished are themselves the best proof of the success of their efforts.

Generous grants of money made to the Committee at various times by the Royal Irish Academy, the British Association (administered by a committee consisting of Professor T. Johnson (Chairman), Professor G. A. J. Cole,

Dr. R. F. Scharff, A. G. Tansley, and R. Lloyd Praeger (Secretary)), the Royal Society of London, and the Royal Dublin Society, helped materially to defray the cost of the Survey, and, in the case of the Royal Society, the cost of publication.

A brief account of the field-work is now given.

Narrative of the Field-work.

1909.[1]

The field-work opened at Easter, when a party of seven, namely Major Barrett-Hamilton (Mammals), J. Bayley Butler (Protozoa), A. D. Cotton (Marine Algae), Arthur Skinner (Photography, &c.), A. W. Stelfox (Mollusca), Isaac Swain (Geology), and R. Ll. Praeger (Phanerogams), spent five to eight days upon the island. In the groups of Seaweeds and Terrestrial Mollusks especially good progress was made not only on the island, but subsequently on the mainland adjoining. H. Bassett and W. L. Hicks, both of Liverpool University, members of a cave-exploring party who had been working at Cong, joined the party before the week was out, and reinforced the photographic detachment.

The May party was small, consisting of Nevin H. Foster (Birds), Rev. Canon Lett (Mosses and Liverworts), R. Southern (Worms), and the writer. In all the groups mentioned good lists and collections were made on the island, and subsequently in the surrounding district, where Canon Lett worked Achill and Curraun, and Mr. Foster the Louisburgh area; while the welcome arrival of the Fisheries steamer "Helga" gave Mr. Southern an opportunity of dredging in the local waters in company with G. P. Farran, S. W. Kemp, and W. M. Tattersall, who were on board; the result being considerable collections of marine animals. Great progress was made during May with the Mosses and Liverworts, as Canon Lett was reinforced by W. H. Pearson from Manchester and the Rev. C. H. Waddell from Co. Down, and among them much exploration was carried out.

Early in June a party of ten went to the island, including J. N. Halbert (Insects, &c.), W. F. de V. Kane (Lepidoptera, &c.), C. F. Rousselet (Rotifera), D. J. Scourfield (Entomostraca), R. F. Scharff (Mollusca, Woodlice, &c.), and R. Ll. Praeger. As regards insects, the prevalence of cloud and wind during the visit caused very little to be on the wing, Lepidoptera being especially few; but good collections of beetles, &c., were made. On leaving the island after a five days' sojourn, the majority of the party worked the Achill Sound district.

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[1] Portion of a Report laid before the Royal Irish Academy, 8th November, 1909, and published in the "Irish Naturalist," December, 1909.

On June 19 Miss Knowles went west to collect Lichens and Flowering Plants, and spent a fortnight in the Louisburgh and Westport districts, and on the island.

Two parties were organized in July. The first one, crossing on July 8, included D. R. Pack-Beresford, who worked the Spiders, first of the island, and subsequently of the Mulranny neighbourhood; Prof. J. Wilson, who studied the agricultural conditions of the island, past and present; and the writer, who pushed on with a vegetation map. The second party, crossing on July 16, included F. Balfour-Browne (Water-beetles), A. D. Cotton (Sea-weeds), N. Colgan (Marine Mollusca), J. de W. Hinch (Glacial Geology), A. W. Hill (Botany), W. F. de V. Kane (Lepidoptera), A. R. Nichols (Polyzoa, &c.), and Miss J. Stephens (Sponges, &c.).

The marine fauna and flora received much attention during this trip; considerable collections were made, and some inshore dredging was carried out by N. Colgan and R. Ll. Praeger. Messrs. Balfour-Browne, Kane, Cotton, and Colgan subsequently carried out further work around Louisburgh and Westport; and Miss Stephens, revisiting the district almost immediately explored the shores of Achill, Belclare, and Louisburgh.

At the end of July we were fortunate in securing the assistance of Dr. Eugene Penard, of Geneva, the well-known authority on the Rhizopoda. He spent a week in the district, collecting on the island, and in the Louisburgh and Achill neighbourhoods.

On August 20 a strong party went to the island for a week's work, chiefly at the flora. It included Sir H. C. Hawley (Fungi), J. Adams (Marine Algae), Rev. Canon Lett (Mosses and Hepatics); also Dr. Otto Stapf of Kew and Miss Saunders of Newnham College; the late Dr. G. Fogerty and T. J. Westropp (Archaeology), W. Rankin (Crustacea), and the writer. The "Helga" came in on August 23, with G. P. Farran and S. W. Kemp on board, and, joined by Messrs. Rankin, Adams, and Praeger, three days were devoted to dredging. Messrs. Westropp and Fogerty were successful in their antiquarian work, and their results form an interesting chapter of the Report. A preliminary survey of the fungus flora was made, and dredging added some important species to the list of Algae already made by A. D. Cotton. Sir Henry Hawley subsequently worked the Westport district for Fungi.

Early in September the last expedition of the year was sent down. The late G. W. Chaster, Edward Collier, A. W. Stelfox, R. Welch, and J. N. Milne worked Achill Sound, Clare Island (especially), Louisburgh, Westport, and thence to Castlebar. Land and fresh-water Mollusca particularly engaged their attention, but many insects, &c., were also collected, and Mr. Welch secured a fine series of photographs on the island. D. M'Ardle, who went

down with them, spent ten days working the Mosses and Hepatics of the island and of the Louisburgh district.

During the season the geology of the island engaged the attention of the staff of the Geological Survey. J. R. Kilroe, R. Clark, and T. Hallissy were all at work, and the revision of the "solid" map, as well as new drift and soil maps, was pushed forward.

1910.[1]

The first working party of 1910 took the field at Easter, which fell in the last week of March. F. Balfour-Browne and A. W. Stelfox worked for Water-beetles and Mollusca respectively in the Louisburgh, Westport, and Achill districts, the latter subsequently proceeding to Belmullet. On the island W. J. Lyons set up meteorological instruments, Prof. C. J. Patten studied the Birds, and R. Ll. Praeger completed his vegetation map. All returned in about a week. On March 31 F. J. Lewis commenced his work on the peats of the district, and spent ten days on the north side of Clew Bay, camping out in very severe weather.

A special Clew Bay marine party took up their quarters at Belclare from May 6 until May 12, and devoted a tempestuous and bitterly cold week to shore-collecting and dredging. N. Colgan added considerably to his list of Marine Mollusca; Miss Stephens collected Sponges; A. R. Nichols, Polyzoa; W. Rankin, Decapoda; and Miss M'Nab and R. Ll. Praeger rendered general assistance. In addition to the groups mentioned, a good deal of collecting was done in a number of other groups.

The Fresh-water Algae of the island were worked on May 14-22 by the late William West, who also made valuable collections of Lichens and Bryophytes.

On June 6, Rev. W. F. Johnson and Mrs. Johnson went west, and carried out nearly four weeks' insect-collecting in the Achill and Mulranny districts. They were joined two days later by W. F. de V. Kane and T. Greer, who did a week's work at Lepidoptera at Achill Sound before crossing to the island.

Prof. Cole and T. Hallissy examined the geology, and especially the glacial features, of the district between Westport and Achill, on June 14-15, when, after a day's work on the island, they visited the Louisburgh district.

On June 16 a large party crossed to the island, comprising A. D. Cotton (Marine Algae), A. C. Forbes (Forestry), T. Greer and W. F. de V. Kane (Lepidoptera), H. Wallis Kew (Pseudoscorpiones, &c.), Paul Kuckuck (Marine

[1] Portion of a Report laid before the Royal Irish Academy, 17th February, 1911, and published in the "Irish Naturalist," April, 1911.

Algae), Pastor Carl Lindner and the late R. J. Ussher (Birds), W. J. Lyons (Meteorology), R. Welch (Photography), and R. Ll. Praeger. Much collecting and observing were done. Mr. Kane left on June 20 for a fortnight's collecting round Louisburgh and Belclare, and Mr. Ussher and Herr Lindner on the same day sailed to Belclare to join N. H. Foster, who had arrived there three days previously, in studying the breeding birds of the Clew Bay islands and Belclare district. The majority of the rest of the party returned from the island at the end of a week, A. D. Cotton remaining there until June 24, when he proceeded to Louisburgh for a week's work in company with J. Adams, who had arrived there on the 22nd. Indeed, during June our workers pervaded the whole district.

In July also much work was done, especially in the domain of entomology. J. N. Halbert went to Louisburgh on July 1 for a fortnight's insect-collecting. He was joined on the 12th by Claude Morley, who worked there at Hymenoptera until the 20th, when he crossed to the island in order to join Percy E. Grimshaw (Diptera), N. Colgan (Marine Mollusca), Miss Stephens (Sponges), Miss Knowles (Lichens, &c.), Rev. Canon Lett (Mosses and Hepatics), F. J. Lewis (Peat deposits), and R. Ll. Praeger. At the close of a busy week the party broke up. P. E. Grimshaw collected at Achill, Mulranny, and Westport for some days longer, and N. Colgan examined the Mulranny shores. Miss Stephens and Miss Knowles worked southwards into Connemara. During this month also Prof. C. J. Patten spent a fortnight investigating the local birds.

On August 15, in very tempestuous weather, a small party took the field:—T. J. Westropp (Archaeology), N. Colgan (Marine Mollusca), W. J. Lyons (Meteorology), and R. Ll. Praeger. It was two days before they succeeded in crossing to the island, but the time was not wasted. Achillbeg and the coast east and west of it were explored, some interesting and hitherto unknown cliff-forts and kitchen-middens being discovered. The Fisheries steamer "Helga" arrived at the island on the 16th, with G. P. Farran, L. E. Smith, and R. Southern on board, and, joined by Colgan and Praeger, several days' dredging and trawling were accomplished, in spite of loss of gear owing to rough weather.

Meanwhile W. A. Wattam arrived from Huddersfield on August 20, and in a fortnight's work made large collections of Lichens, with Achill Sound and Dugort as headquarters. Rev. W. F. Johnson and Mrs. Johnson paid a second visit to the district in September, collecting insects on the island for a fortnight, and at Achill Sound for a week. Rev. Canon Lett also revisited Achill Sound, and finished his collecting there. Prof. Patten revisited the island from September 9 to 29, and studied the autumnal migration of birds.

On October 2 a strong Cryptogamic party crossed to the island, comprising Sir H. C. Hawley (Fungi), A. D. Cotton (Marine Algae), Miss A. Lorrain Smith (Lichens and Fungi), Miss Beatrice Taylor (Lichens), and Miss Knowles (Lichens); the party also included Miss Stephens (Sponges) and R. Ll. Praeger. Four to six days' collecting was done on the island by the various members, after which they scattered; and the Achill Sound, Louisburgh, Belclare, Westport, and Castlebar districts all received attention.

A late fungus foray was carried out during the third week in November by Carleton Rea, accompanied for two days by R. Ll. Praeger. Operations were hampered at the beginning by snow lying on the ground, but this soon passed away, and a good list of the later kinds was made, including no less than thirty species new to the Irish flora.

The last visit of the season was made by Prof. Patten, who crossed to the island on December 27 to spend a week in studying the winter avifauna.

1911.[1]

The third season's field-work began early. A. D. Cotton went west on February 13 to study the winter Alga flora at Louisburgh and Achill Sound. He was followed on March 7 by G. H. Wailes and the late James Murray. The latter spent a week in collecting Bdelloid Rotifera and Arctiscoida in Achill, Clare Island, and the Louisburgh district. Mr. Wailes took up his residence on Clare Island, and remained there till June 3 working at the Rhizopoda, and collecting not only on Clare Island, but in Achill, at Roonah, and on Caher Island, Inishturk, and Inishbofin, the result being one of the most complete lists of Rhizopods ever formed for a single district. He was joined for a few days in March by R. M. Barrington, who studied the Birds of the island.

On April 13 J. S. Dunkerly and G. O. Sherrard went down for a week, and, using Belclare as headquarters, collected Infusoria and Nematodes respectively.

The first combined party of the season left Dublin for the island on April 27. It included Sir H. C. Hawley (Fungi), A. D. Cotton and Dr. F. Börgesen of Copenhagen (Marine Algae), F. J. Lewis (Peat deposits), R. Ll. Praeger, and several others. While most of the party returned at the end of a week, A. D. Cotton worked on at Louisburgh and Achill till May 15.

On May 29 Rev. W. F. Johnson and Mrs. Johnson went down, and spent a month, mainly on the island, collecting insects. In connexion with the

[1] Portion of a Report laid before the Royal Irish Academy, 13th November, 1911, and published in the "Irish Naturalist," February, 1912.

geological survey of the area, Newell Arber spent several days in June collecting Carboniferous fossils from the sandstones of the north-eastern part of the island. During the same month C. J. Patten again visited Clare Island in pursuance of his study of the Birds; and W. West paid a second visit of ten days' duration to complete his work on the fresh-water Algae.

A double party was arranged in July. On the 12th of that month Miss Stephens (Sponges), J. de W. Hinch (Glacial fossils), R. Ll. Praeger, and others went to the island. Advantage was taken of exceptionally calm weather to land and collect on Mweelaun, an isolated rock lying two miles south of Clare Island. This first party was followed five days later by a larger contingent, including R. J. Ussher and Pastor Lindner (Birds), W. F. de V. Kane (Lepidoptera), T. J. Westropp and the late Dr. G. Fogerty (Archaeology) Professor G. H. Carpenter (Aptera), J. S. Dunkerly (Infusoria and Flagellata), A. W. Stelfox (Land and Fresh-water Mollusca), G. O. Sherrard (Nematodes), and Professor Gwynne Vaughan (Botany); several of these had previously done some days' work on Achill. The break-up of the party was gradual, and while Kane, Dunkerly, Hinch, and Gwynne Vaughan subsequently worked at Louisburgh or Achill, Westropp, Fogerty, Stelfox, and Praeger sailed on to Caher Island, Inishturk, and Inishbofin (and Ussher and Lindner to the latter two), for the purpose of completing their survey by studying the insular areas adjoining the immediate scene of the main work; results of very considerable interest were obtained. In the meantime J. N. Halbert was collecting insects at Louisburgh, where he was joined by P. H. Grimshaw (Diptera), and a very good fortnight's work was carried out in that area.

On August 11 E. Heron-Allen and Arthur Earland arrived at Mulranny for the purpose of collecting Foraminifera. A. D. Cotton at the same time paid his final visit for Marine Algae, working first at Achill Sound, and subsequently on the island. The SS. "Helga," with G. P. Farran and R. Southern on board, came in, and dredging was carried on for some days. After the departure of the steamer further work was done, and the search for Foraminifera was extended as far south as the famous deposit of Dog's Bay near Roundstone.

The especially low spring tides of September were utilized by A. R. Nichols (Polyzoa) and N. Colgan (Mollusca) for collecting at Louisburgh, while Miss Stephens (Sponges) and Miss Knowles (Lichens) worked during the same period with the "Helga" staff at Blacksod; but tempestuous weather interfered to some extent with their researches.

During the same month D. R. Pack-Beresford spent a week working at the Spiders of the district lying between Clew Bay and Killary Harbour.

At the beginning of October Mr. and Mrs. Carleton Rea (Fungi), and

Miss Lister (Mycetozoa), went to Westport, where they were joined for two days by R. Ll. Praeger, and vigorous exploration of the adjoining woods was carried out for a period of ten days. Miss Stephens was at the same time at work at fresh-water Sponges in the Newport area. Later, joined by R. Ll. Praeger, dredging for Sponges, &c., was carried out in lakes in the Louisburgh and Westport areas; owing partly to stormy weather, and partly to the nature of the lake-bottoms, which generally consisted either of boulders or deep peat-mud, this work proved difficult and not productive of much material. The last visit paid to the district during the year was on November 11, when A. W. Stelfox and R. Ll. Praeger worked at Manulla, investigating the lake-marls, and making sections of them in order to throw light on the past history of the Fresh-water Mollusca of the district. This formed the conclusion of the three years' field-work.

Although only six years have now elapsed since the commencement of the Survey work, the death of six of our workers has to be recorded, four of them being authors of reports in the series which follows. Two of these perished, one in the Arctic and one in the Antarctic, while engaged on the biological studies to which their lives had been devoted. Major Gerald E. H. Barrett-Hamilton died in South Georgia in January, 1914, while carrying out an investigation, on behalf of the Government, of the whale fisheries of the southern ocean, and Mr. James Murray was lost, along with the majority of the scientific staff of the ill-fated Canadian Arctic expedition, after their ship the "Karluk" was crushed by the ice near Wrangel Island. We have also to deplore the loss of Dr. G. W. Chaster of Southport, who assisted with the Mollusca, &c.; Mr. R. J. Ussher of Cappagh, Co. Waterford, author of the report on Birds; Mr. William West of Bradford, who reported on the Fresh-water Algae; and Dr. George Fogerty of Limerick, who assisted Mr. Westropp in the archaeological report.

General Description of the Area.

In the series of reports which follow the various authors have included as much descriptive matter relating to the nature of the area as they deemed necessary in connexion with the particular group or subject with which they deal. In this Introduction a brief general description of the area will suffice.

Clare Island lies at about the middle of the great projecting buttress of ancient rocks which forms west Galway and west Mayo, and which occupies a position about half-way along the western coast of Ireland. This area is very mountainous and varied, presenting a wide range of volcanic, metamorphic, and sedimentary rocks (all of Palaeozoic age, save for small volcanic

intrusions), a great variety of scenery, and an extremely broken coast-line with deep bays, bold headlands, and many outlying islands.[1] The highest hill is Mweelrea (2688 feet), and summits of over 2000 feet are scattered widely over the district, separated by great tracts of peat-bog and areas of cultivated land. Heather is the prevailing formation over large areas, and the region is singularly devoid of trees—the effect of exposure to the westerly winds which sweep in from the Atlantic. The rivers of the area are small, on account of the proximity of the watershed to the coast; lakelets, mostly occupying rock-basins, are numerous.

From Castlebar to the sea at Westport a tongue of limestone occupies the continuation of the trough which forms Clew Bay. Elsewhere slates, sandstones, quartzites, mica-schists, &c., occupy the ground. The district has been heavily glaciated, and in places cliffs of drift up to 100 feet in height, facing the sea, attest the former wide extension of thick Glacial deposits. The limestone-filled depression which runs down westward to Clew Bay is choked with drift-mounds of drumlin type. As these dip below the sea they produce the archipelago which fills the head of Clew Bay, and further seaward they continue as a series of shoals. This interesting topography is shown in detail on Plate VI of Part 7. The seaward edge of this archipelago has been denuded by wave-action under the influence of westerly gales, and the islets show every gradation from perfect whale-backed drumlins, through truncated drumlins facing the sea with high drift-cliffs subtended by great boulder beaches, to submerged banks of great stones. Plate III of Part 7 and Plate II of the present part show some stages in this process of decay.

As regards climate, thoroughly insular conditions prevail. The mean temperature of the coldest month (January) is 42·8° F., and of the warmest (August) 58·2° F. The mean annual rainfall is about 50 inches (much more in certain places among the mountains), distributed over the unusually high number of 266 rain-days. These figures refer to Blacksod, at the north end of the district, where there is a meteorological station.

Clare Island itself lies across the entrance to Clew Bay, with channels each of a minimum width of about three miles separating it from the mainland on the north and the north-east. There is no need to describe the topography of the island, since that is dealt with from various aspects in several of the reports. In the illustrations accompanying the present notes the appearance of the island from several directions is shown, and these photographs convey a good idea of its topography. Towards the eastern end

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[1] A map of the district surrounding Clare Island is included in the present part, and others will be found in Part 64 (Plate I), and Part 67 (Plate I).

is found most of the cultivated land, and here alone stunted trees, both native and introduced, can grow. Plate I of Part 7 illustrates the general appearance of the island viewed from the north-eastern shore. The western end is exceedingly bare and storm-swept. A good idea of its appearance is given by Plate VIII, which is a view looking south-west, showing the neighbouring island of Inishturk in the background. Almost everywhere the coast is cliff-bound, the cliffs varying in height from 50–100 feet in the east and south (see Plate II of Part 7) to 1000 feet in the north-west (see Plate II of Part 20). The dominating feature of the island is the high ridge of Croaghmore (1520 feet) on the north-western shore. On the inland (southern) side Croaghmore presents a steep, heathery slope, and on the seaward face plunges down in a magnificent precipice into the Atlantic (see Plate I of the present part; also Part 10, Plate I, and Part 23, Plate I). This scarp is the home of a very interesting alpine flora, and proved a productive collecting-ground in several other groups, such as Land Mollusca. The islands of western Ireland are all so closely grazed that it is often only on such ground as this that the less aggressive members of the fauna and flora can find a sanctuary.

The adjoining islands of Inishturk and Inishbofin, which are included in the present Survey so far as certain groups are concerned, have no such lofty elevations as Clare Island, but in the general character of their surface they are similar.

It is not necessary to enlarge here on the nature of the marine area, as this is dealt with fully in Part 67. It may be stated that mud, sand, gravel, stones, and rock are all well represented in the district, and that in the deeper waters gravel and rock form the bottom over the greater part of the region. For the purposes of the Survey a depth of 50 fathoms was taken as the seaward limit of the area.

FIG. 1.—Boulder-clay scarp 90 feet high on seaward face of Dorinish More, Clew Bay, with boulder beach derived from the drift. Looking south.

W. Rankine, *photo.*

FIG. 2.—Dorinish Beg from the boulder beach of Dorinish More, Clew Bay, showing whale-backed island truncated by wave-action from the west. Looking south.

W. Rankine, *photo.*

FIG. 3.—Low water in Westport Bay. The "Scotch Bonnet," the last remnant of a denuded islet. At high water the sea washes the base of the scarp. Typical whale-backed islands in the background. Looking N.W.

W. Rankine, *photo.*

FIG. 1.—Croaghmore from the entrance of Achill Sound. North end of island with lighthouse in front. The Bills are visible on the horizon in the extreme right.

A. W. Stelfox, *photo.*

FIG. 2.—The island from E.N.E. Croaghmore in centre. Lighthouse on extreme right. Harbour on extreme left.

G. P. Farran, *photo.*

FIG. 3.—The island from Inishturk. Mweelaun is seen on the extreme right, and Achill Island on the extreme left.

G. Fogerty, *photo.*

FIG. 4.—The island from Roonah Quay. Croaghmore to left of kelp-ship. Knocknaveen to right.

R. Welch, *photo.*

R. Welch, *photo.*

Clare Island from the Bills.
Croaghmore in centre. Lighthouse on extreme left. Beetle Head on extreme right.

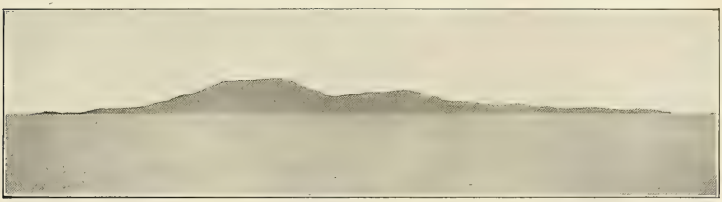

FIG. 1.—Clare Island from Roonah. Kinnacorra on extreme right. Beetle Head on extreme left.
R. Welch, *photo.*

FIG. 2.—Croaghpatrick from Clare Island harbour. Old Head is seen below and to the left of the summit.
R. Welch, *photo.*

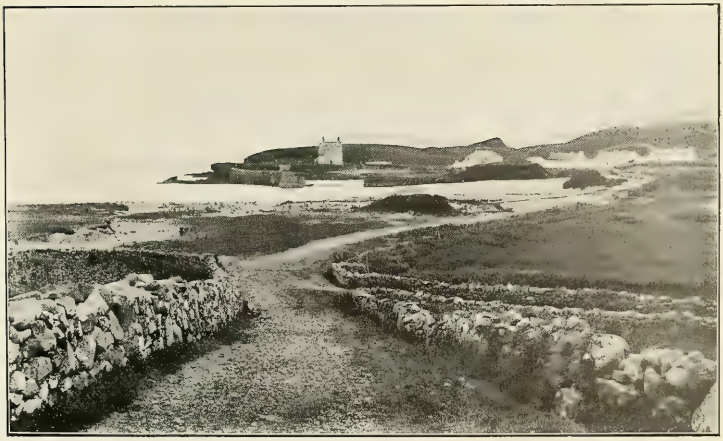

FIG. 3.—Clare Island harbour and bay from the north. The old castle on the left, the hotel in the centre.
G. Fogerty, *photo.*

FIG. 1.—Budawanny, a stack of Upper Silurian slate about 80 feet high, at west end of island. Achill (Croaghaun) is seen faintly behind. Looking N.W.

R. Welch, *Photo.*

FIG. 2.—Clare Island lighthouse, on cliff 400 feet high. Looking N.E. In the distance, Achill Beg in centre, Achill Island on left, Curraun on right (over the lighthouse).

R. Welch, *Photo.*

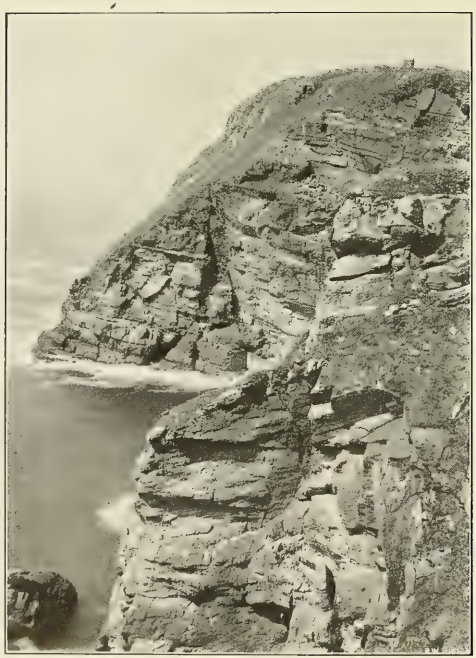

Fig. 1.—Signal Tower Head, Clare Island. Silurian cliffs, 700 feet high. Looking north.

R. Welch, *photo.*

Fig. 2.—Gully (one of several) cut across vertical Silurian slates on S.W. shore of island. In middle distance Inishturk, with Inishbofin on right and Caher Island on left.

R. Welch, *photo.*

West end of Clare Island.

Taken looking S.W. In the foreground small local moraines, clothed with Plantago sward. Running out towards the right Kinatevdilla or Beetle Head. In the middle distance Inishturk. Inishbofin is barely visible on the horizon to the right of Inishturk.

CLARE ISLAND SURVEY.—PRAEGER: INTRODUCTION.

2

HISTORY AND ARCHAEOLOGY.

By T. J. WESTROPP, M.A.

Plates I–X.

Read November 13. Published December 21, 1911.

CONTENTS.

1. INTRODUCTION.

When the Clare Island Committee prepared for the survey of that area, and the subject of Archaeology fell to my lot, the subject at first seemed to me to be a field likely to yield but little result. The islands were supposed to be well known and to have been examined by careful workers; the remains on Clare Island had been visited by several antiquaries, and yet the results were scanty. Engaged on the rich fields of north Kerry, north-west County Clare, and the Aran Isles, the task of recording the scanty remains seemed a light one, but became very different in its aspect after three visits. Despite every care, besides help from the observations of Mr. R. Lloyd Praeger, Dr. George Fogerty, R.N., and others, I fear even now that individual remains, though probably none of any size or importance, may have escaped my search, especially in the network of low crags and hollows in Inishbofin. Our survey did not extend to Inishark; but, for completeness, I include what I can gather about that islet. It is hoped that the present survey may at least preserve a careful account of the ancient remains in these islands, Clare, Turk, Caher, and Bofin, so little known and so inaccurately described by my predecessors. Coming, as it does, before these places have been modernized by travelling facilities and the consequent influx of visitors, it may have a record value outside its present use. Besides the actual survey of the islands, I made a careful

examination of the Mayo coasts from Ballina to the Mullet and of Achill Island and Achillbeg to try by a wider study of the local archaeology to throw light on the remains here described.

It seemed, at first, well to give these coast results here *in extenso*; but, as I hope to publish them fully in the *Journal* of the Royal Society of Antiquaries of Ireland, to which I have already given my survey of north Mayo, and as I have described the chief cliff forts fully in these Proceedings last year, 1910, I will not further lengthen an already full section of the Survey.[1]

Rude Stone Monuments.

The present survey has had rarely to record any remains more primitive in character than the forts and huts. The coast of Mayo (especially near Ballycastle, Duncarton, and Binghamstown) presents examples of circles and alignments of low stones, rounded and weathered out of all shape, evidently of the remotest antiquity, some perhaps even Neolithic. Dolmens are scarce; an interesting type (spectacle-like in plan), with two small circles or ovals, and a large cist between, occurs on Slievemore in Achill, and another (a long somewhat oval enclosure with a smaller one at each end) lies between Ballycastle and Dunfeeny. Mr. Bald, when designing the road through Glencastle, would not divert it even for a few feet to spare a fine dolmen in that valley. One of the stones of another monument there—the reputed grave of the giant Domnall dual buidh—was destroyed about 1839. The monuments on the sandhills of the Mullet I reserve for the succeeding section. Small circles of standing stones occur near Porteen (5 feet across) and Glengad, on Broadhaven (17 feet across). The spectacle-dolmen on Slievemore had two ancient tracks leading to it at right angles, now called "Cladh Lochlannach" or Danes' Ditch.[2] At the end of the western, 380 feet away from the eastern, is a curious monument called a "cromlech-tumulus" or chambered mound, but really a multiple *clochán* or hut. The "Pagan cemetery," 500 feet from the cathair near the border of the Bal of Dookinelly, seems to have consisted of two oblong chambers lying north-east and south-east, kerbed by large blocks, now unfortunately in course of removal and nearly all gone; but the sockets (from which they were raised, after so many ages) preserve the plan. The north-western cell is about 6 feet wide, and about 23 feet 6 inches long. It has two compartments—the northern 5 feet 6 inches, the southern 12 feet 9 inches, divided by a row of three thin slabs which hardly rise over the sward. The eastern cell is 6 feet inside and

[1] For a list of antiquities in West Murrisk, see note at the end.

[2] They appear to be old tracks in the hollows of which richer soil settled and brighter herbage sprang up. Many occur on these islands without the name being attached to them.

8 feet wide outside and undivided, 25 feet long; 3 feet eastward is a trace of another line of slabs. The northern end described by Col. Wood-Martin in "Rude Stone Monuments of Ireland," has nearly vanished, and the whole must shortly disappear, as there is no enlightened public opinion to prevent the destruction of these important monuments for the mere profit of road-contractors and builders of labourers' cottages. Up the great mountain, and so better preserved because less accessible, not far below the "spectacle-dolmen" and the "tumulus cromlech," in Keel East, I find, in Doogort West, a wrecked but noble dolmen, its standing slabs, 9 feet 3 inches by 6 feet, and 7 feet 4 inches, by 4 feet 6 inches, usually about a foot thick. The fragment of its broken cover is 7 feet 4 inches by 7 feet 10 inches, but perhaps only half remains; the rest of this huge slab was used for an old cottage near its site. Down the slope, beside the ancient bohereen or laneway, and near the west border of Keel, is a very large chambered cairn called (like the Doogort dolmen) the "Giant's Grave" with several chambers, divided by great set slabs, one 6 feet 6 inches long, 6 inches thick, and nearly 5 feet over the debris. Another block, a roof-lintel, is 10 feet 4 inches, by 3 feet, by 10 inches—so far from my notes.

Colonel Wood-Martin[1] describes, before its partial demolition, "Clochán na stooka," "Pagan Cemetery," an elaborate monument lying a little east of north. It had a circle at its northern end 8 feet across; then parallel rows 10 feet apart for 52 feet; then a square enclosure 26 feet 6 inches by 25 feet 6 inches. From the south-west corner a long, slightly curved row of blocks extended; a corresponding row from the south-east corner was destroyed in human memory. A grave, "Tonalorcha," had a circle 80 feet across; but only parts to the north-west and south-west remained, with a long row of slabs running southward for 80 feet. About a quarter of a mile westward was a dilapidated cist; its south-west angle remained, and nine scattered slabs. Another monument had four small cups like the "Elf Mills" in Swedish dolmens or the basins in the slabs of the dolmens of Ballyganner Hill, Cappaghkenny, and Newgrove in Co. Clare, and the Clochtogle near Lisbellaw in Fermanagh; the Achill cups diminish from left to right like at the Clochtogle. There are also a Labba, or bed, adjoining the last, and a cairn, 25 feet by 17 feet, with a ruined cist embedded. Down the hill near the road was a defaced tumulus or cairn 96 feet across, in which a series of cists formed a cross, the shorter (north and south) arms of which ended in rings, 10 feet and 21 feet across. It is called "Giant's Grave"; the circles have disappeared. On Clew Bay to the west

[1] "Rude Stone Monuments," chapter viii, p. 238: Extra Volume, 1888, of the Roy. Hist. and Archaeol. Assoc. (Roy. Soc. Antiq. Ir.) Journal for same period, vol. xviii, pp. 367–378.

of Murrisk, I noted a remnant of an alignment of blocks, 4 to 5 feet high, running east and west; only a few remain. At a marshy point between Murrisk Abbey and Westport is a very remarkable monument. It consists of an alignment of stones (now separated from the rest by a little creek), leading eastward to a large slight ring oval in plan. In the enclosure stand six stones in a line, W.S.W. and E.N.E., about 20 feet long; they are about 3 feet high and long, the fourth being 4 feet long; there is a fallen stone to the east, making seven in all. The enclosure is 4 to 5 feet thick, and rarely 3 feet high, with a shallow fosse and ten large blocks to the south. The whole site is barely higher than the high water; and I noticed to the west, at lowest tide, the long line of a seaweed-grown causeway cut through by a deep channel. I incline to the conclusion (but prefer not to assert) that the land has sunk since the erection of the monument, which, from its worn condition, seems to be of vast antiquity. The question depends much on scientific considerations; whether a presumable temple of perhaps the Stone Age in Ireland is so early as to have been nearly submerged by the undoubted subsidence of the coast. If so, the wonderful inroads of the sea on the evidently far later cliff-forts sink down to almost modern events. I therefore give no *decision*, but state the facts as to the Gortbraud monument.

Middens and Sand-hill Monuments.

Near Kilgalligan, on the east of Broad Haven, a fine cairn, 13 feet high, 50 feet on base, and a number of well-preserved hut-circles, small cairns, and middens of shells remain. They had been uncovered by the wind about seventy years ago; but the sand and vegetation hid them till a few years since. In them Dr. G. Fogerty found a polished stone implement of which Miss Knowles most kindly made a sketch. The great sandhills near Binghamstown[1] abound in middens and monuments. Chief of these is the Lacht air Iorruis, the tomb of the slaughter of Erris. It was hidden in a sandhill till a great storm blew away nearly 20 feet of sand in one night, and disclosed the cairn. Near it lay Lug na fulla,[2] the hollow of blood. It rests on the rock, and is about 12 feet high and 35 feet across. On the west is a platform girt by a fosse and outer ring about 111 feet by 60 feet over all. A small cist or circle is on the platform with traces of a second. Another larger cist lies to the north about 63 feet from the cairn; the ground was found to be strewn with thousands of human bones all around when the sand was first removed.

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[1] For accounts of the Binghamstown group see Rev. Caesar Otway, "Erris and Tyrawley," 1841, pp. 89–95; W. Chambers Borlase, "Dolmens of Ireland," p. 111: Ordnance Survey Letters, Co. Mayo (ms. R. I. Acad., 14 E 18), pp. 209, 214.

[2] The name seems to have existed before the tombs and bones were disclosed.

Farther to the north-west is the Lacht ree Moonni (leacht righ Mumhain) or tomb of the king of Munster. It also was under a sandhill till nearly 1840; a number of cists (containing scorched bones, steatite beads, and rings) lay not far away near Kilmore graveyard. The Trunk na callighe, in Carn townland, is a square enclosure and cist of upright blocks. A smaller cairn lies in Emlybeg North—a dolmen, 14 feet long, in a circle of stones, 36 yards across. Near Cross, at Bealdorcha, another earthen mound, under the sand, contained a cist and a skeleton. Some said the body had been buried standing upright (like King Laoghaire in the fifth century, and King Eoghan Bel in the sixth); others that it was seated on a stone chair, or cist; its face (all agree) was turned towards the Lacht air Iorruis. This enumeration sufficiently shows the importance of the sandhill settlements of Co. Mayo.

Unfortunately none of equal importance occur south of the Mullet. Middens and hut-sites, hearths and burned stones exist in the sandhills at either end of Achill Sound. Those at the southern end, in the townland of Gubnahardin, on the mainland, when examined by Messrs. Praeger, Lyons, and myself, proved of interest, and are worthy of more methodical examination. At the northern site, opposite Gubnahardin Fort and the coastguard station of Achill Sound, the chief part is about 40 feet long, with charcoal (showing wood fibre and burned twigs) hearths, and blackened stones. The shells are (as so usually) Ostrea, Pecten varius, Buccinum, Littorina (littorea, obtusata, and rudis), Anomia ephippium, Venus lincta, Nassa reticulata, Trochus (umbilicatus and lineatus), Solen siliqua and Carduus; the vast majority are Littorina. The whole heap seems to be 130 feet across.

Farther to the south-east is a lesser one. A third, still farther eastward, has a well-marked layer of black mould and burned slabs and pebbles; it is in two layers with 6 feet of sand between, containing shells, vertebrae and spines of fish; a quartzite hammer was also found here. Then a layer of oysters, green clay, black mould, and charcoal, with a layer of periwinkles on top of it. The upper stratum was directly under the sward. Mr. Praeger found here a large, finely polished bead of blue limestone. The shells were mainly limpets, with only a few periwinkles. Hearth-slabs and pebbles, blackened by fire, abound. On the shore of Keel West, just above highwater-mark, Colonel Wood-Martin found three shell-middens. They also yielded, like those I examined, a hammer stone and steatite beads, also a half-made spindle-whorl, and a later green-glass bead—all of which passed to the collection of Canon Grainger. No metal was found, but bones of deer, swine, and rayfish occurred among the layers of oysters, mussels, limpets, and cockles.

As may be seen, I found no similar settlement till we reached Inishbofin.

The midden at Clare Island seems late, and yielded nothing of interest. It almost seems as if the early settlers, circle-makers, dolmen- and cairn-builders and sandhill-dwellers did not venture across the fierce currents and waves round Clare Island, Turk, and Caher, to those islands; certainly save for pillars in the first two, I found nothing resembling an early monument. The bronze weapon found in Clare Island, like all isolated finds, proves little or nothing, and was certainly imported, whether in early or late times.

Forts.

The forts in the islands specially studied in this Survey are of considerable interest. The six *dúns* in Clare Island are, with one exception, of the walled-rock type, such as we find at Danes' Island in Waterford, Darby's Island in Kerry, and Illaunadoon in Co. Clare. The type recurs in the great wrecked example at Dunnahineena in Bofin. The other two are of the more usual form. Dunnagappul has two curved fosses and stone-faced mounds, and Dun-Ooghbeg had a straight, dry-stone wall. In Turk, Dun Ballyheer had a nearly straight wall along a low rock, forming a revetment. Finest of the true headland forts is Dunmore in Bofin—a massive, curved rampart of dry stone. Of Ring Forts, a thin-walled cathair, Caherpatrick, is found in Caher Island, and two strong Duns at Portadoon in Turk. Two examples of the multiple-celled *clochán* occur in the same townland of Ballyheer; also simpler early hut-circles, usually about 40 feet across.

It is hard to believe that the platform forts are of very great age, unless perhaps Doon-Ooghaniska and Dunnahineena. The rocks are often very friable; and yet it is evident that the whole of the old extent is still covered by (or rather included within) the ambit of the fort. Dunnaglas, however, is earlier than the cutting-away of the great clay bank which once joined Achillbeg to the larger island at the west end of Bealaglas Sound.

As to the general features, I found no steps, upright joints, chambers or passages in the wall in any fort south of the Mullet. Dunmore in Bofin had a well-built gateway, 6 feet 3 inches wide, and nearly 10 feet deep. The east Dun of Portadoon, in Turk, had also a gateway of coursed masonry aslant through its wall, sloping down a crag like that of the central ring of Dun Aengusa in Aran, while the western Dun, in Ballyheer, had a more massive one, its left jamb of a single stone 7 feet 4 inches long. I found no long lintels save at the Cathair of Slievemore in Achill, but doubtless all such gateways were once covered by long stones. The walls, save in the east Dun of Turk, are of a single section with two faces. That Dun has two sections, the outer 4 feet 3 inches, the inner (possibly a terrace) 3 feet. Dunmore has a foundation course of very massive blocks, set as stretchers,

over which, partly resting on the filling of the centre, was a course of long small-ended headers, a fine example of strong bonding. The thicknesses of the wall are:—Doon-Ooghaniska, 6 feet to 9 feet; Dunnagappul, 10 feet to 13 feet; Dun-Ooghbeg, 12 feet; Porteen, 9 feet; Cathair of Bal-Dookinelly, 16 feet; Dun-Kilmore, 18 feet to 19 feet; Dunnaglas, 6 feet to 7 feet; the Dun-Portadoon, 6 feet to 9 feet; Dun-Ballyheer, 6 feet to 7 feet; Dun-Ooghmore, 6 feet; Caherpatrick, 4 feet; and Dunmore-Bofin, 10 feet to 15 feet. The widths of the gateways are:—Dun-Kilmore, 6 feet; Dun-Portadoon, 3 feet 8 inches; Dun-Ballyheer, 3 feet 4 inches; Dunmore-Bofin, 6 feet 3 inches.

The ring-fort becomes very rare in north-west Mayo after we leave the Ballycastle valley at Dunfeeny. The cliff-forts are abundant. Taking them in order, they are found at the fortified headlands of Downpatrick and Dunbriste (the last now broken away from the land, as its name implies). Their walls are of most beautiful masonry, but quite different from the usual types. Port-Conaghra has a long, straight fosse, once stone-faced, with a dry stone wall on top, now nearly all rebuilt. Cashlaunicrobin, near Glenlosseragh, has the typical crescent fosse and mounds of earth protecting the neck (now fallen), which led to a fine conical rock, with huts on its platform now called Goat Island. Horse Island, at Bealdearg, is now only joined to the land by the collapsed neck, beyond which the last remains of its dry-stone wall totter on the edge of the falling bank. Dunmara, now an inaccessible shore rock, before huge cliffs, seems once to have been walled, as heaps of stone are visible. Dunminulla, owing to a vast land-slide at the neck, and the fall of the edges of its lofty platform, now only exhibits two landward trenches, one cut in the rock, and a mound, capped by a dry-stone wall.

The once important Manor-Castle of Dookeeghan (Dumhach ui Caochain) was a fenced platform, on whose narrow neck (now half fallen) a gatehouse was built in the fifteenth century, outside which are faint traces of the crescent-mound, and ditch of the Dun. Duncarton, while better preserved, is of similar design. In the Mullet I have described Dunfiachra, Dunnamo, and Porth.[1] Dunfiachra is a natural platform, its narrow neck fenced by a deep fosse, with a rampart on either side. Dunnamo is a huge dry-stone rampart (with the later features of cells at its gateway, like Dunbeg near Ventry). The wall rests on the earthwork of an earlier cliff-fort. Outside are the faint remains of an abattis, found elsewhere only at Dun Aengusa and Dubh Cathair in Aran, Ballykinvarga, Co. Clare, and a few forts in other countries—Cademuir and Dreva in Scotland, the demolished Castel Coz in

[1] Proc. R.I.A., vol. xxix, (c), p. 11. See also Royal Commission on Coast Erosion, vol. iii, part 2, pp. 231, 237, 241.

France, two hill-forts in Switzerland, and a ring-wall in Möhne Island in the Baltic. Inside are a few huts, round, with square annexes, and a large ring-wall. Porth is a huge dry-stone wall, overthrown in early times, and completed by an earthwork. It has a group of huts and souterrains. In the Mullet is a small entrenched headland, and the great walled platforms of Dunaneanir and Dunadearg. Inland, but not far from Belmullet, is the scarped rock and oval ring-fort of Dundonnell (90 feet by 40 feet) rich in folk-lore. Achill has injured Cathairs in the Sandhills and in the Bal of Dookinelly on Slievemore, an entrenched drift-headland at Porteen, and two rocks so nearly denuded of earth that the best evidence of their character lies in their names, Dunnagappul and Dunmore. Possibly the two groups of "Doonty" rocks were of this character. The name Gubadoon marks another cliff-fort on Dooega Head, near the southern rock of that name.

At Achillbeg are three more cliff-forts. One is already described in our *Proceedings.* The great fort of Dun-Kilmore has a fosse, a stone-faced rampart, and an inner ring-fort of similar design, enclosing an early cemetery, altars, and a basin-stone. Within the fort are two subsidiary headlands, the *Dún* and the *Dangan*, each entrenched. The two neighbouring forts must be described here, if briefly, for they are closely connected with our main subject.

Dunnaglas, Achill (Ordnance Survey Map,[1] No. 65).—Off the shore of Carrowgarve, at the eastern end of the Blind Sound, or Bealachglass, is a fragment of a headland called Doonagloss (Dun na glas) and "the *Dún.*" It is remembered that a "tower" stood on the rock some fifty to sixty years ago. Crossing at low water by a painful and slippery stretch of boulders, and climbing the steep though grassy side, we find a structure closely similar to the Doon of Inishturk. A well-built dry-stone wall of slabs thickly covered with grey lichen carefully conforms to the minutest features of the natural edge,[2] about 50 feet above the base. The rampart is usually about 6 feet high and 7 feet thick, of good, rather open-jointed work, and along the north-west segment, where it is best preserved, has the rare feature (in Co. Mayo) of a terrace inside 3 feet 6 inches high and 2 feet 6 inches to 3 feet wide. The wall at that point rises 4 feet to 4 feet 6 inches higher, and is over 10 feet thick in all. The garth is 74 feet long, east and west, and is still 50 feet wide, for about half has fallen away. In the middle were two large huts, the "Tower," 16 feet 6 inches, inside, with a wall of earth and stones, 7 feet 6 inches to

[1] The references are to the maps of six inches to the mile.

[2] This unnecessary accuracy is well seen at the walled rocks of Dunaneanir in the Mullet and the Cashlaun Gar, Co. Clare.

9 feet thick. It recalls the hermit's "tower" of sods and stones, with walls 11 feet thick, broken by King Dathi with such fatal results to himself, when the lightning slew him in Gaul at the beginning of the fifth century. The second hut adjoins the west of the Tower, and is 15 feet inside, and its wall 6 feet thick. The conjoined huts are 50 feet east and west by 30 feet north and south. Half of the annexe has fallen. To the west of the fort, outside the rampart, and evidently defending the approach, we find a glacis, 14 feet to 15 feet long, sloping steeply to a fosse, now barely 4 feet deep and 9 feet wide. A portion of the outer ring, 4 feet thick, remains. The whole must soon be washed away like the Dugort *duns*, as great waves run up its low rocks at all times of storm.

Dunacurrogh, Achillbeg.—It lies on a headland in a cove near the last. It is called Doonagurroge on the new maps, but locally Dunacurrogh. Outside its fosse, 54 feet to the east, is a double hut, with walls 6 feet to 7 feet thick, and two circular cells, the eastern 15 feet, the western 12 feet inside. The fort had an outer ring, now embodied in a fence, a fosse 4 feet deep and 12 feet wide with a gangway 6 feet wide, at 18 feet from the south cliff and 12 feet from the north. Another fosse, nearly filled by its bank, lies 21 feet westward. It was probably 9 feet wide. At 54 feet westward from the last we reach the level platform, defended by an unusual dry-stone wall, projecting with an angle to flank the entrance, and so presumably late. It is 6 feet thick, with a slab entrance 6 feet wide; thence a low bank of earth and stones fences the platform, 27 feet wide at the gate, 39 feet in the middle, and 48 feet long east and west.

Bal of Dookinelly.—The only ring-fort in Achill calling for notice is the Cathair of Slievemore. In 1888, when the plan published by Col. Wood-Martin was made, its wall was 4 feet to 5 feet high. Now nearly all the stonework has been removed. So recently has this been done that the edges of the soil against the wall are still bare, sharp, and upright, the fort being a now well-marked oval shallow ditch, 15 feet to 15 feet 9 inches wide, and 18 inches deep, from which the very foundations are removed. It enclosed a space 39 feet north and south to 45 feet east and west. A gate-lintel, 6 feet 6 inches long, 28 inches wide, and 10 inches thick, lies to the east. There were two old semicircular enclosures beside the gate (formerly traceable) to the south in 1888. It has been destroyed for road material, though stones are over-abundant.

The Dun of Oileach in the Mullet has vanished. It is supposed to have been on the circular hillock of Elly, south from Binghamstown, on Blacksod Bay, still called An Cathair; locally, "Anaar." There are some small ring-forts between the Bay and Dundonnell—perhaps half a dozen—calling for

no remark. So also I need only mention the occurrence of forts between Murrisk and Westport. A fort at the latter town is named Cahernamart.

The remaining forts I shall describe as on the various islands. The most remarkable are Dun-Ooghaniska on Clare Island, the Duns at Portadoon in Turk, and Dunmore (Dunkeen) and Dunnahineena in Bofin. Owing to the light soil, the removal of the stonework, and the ceaseless inroads of the sea, it is wonderful that so much of interest remains to be recorded. Doubtless numerous forts have vanished altogether, even in the last three centuries, from these powerful causes of destruction.

Later Buildings.—On Achill Sound is the neat, small peel tower of the O'Mailles.[1] It is a typical specimen, and probably dates from between 1460 and 1480, with small window-slits, one with a characteristic ogee-head. The under-story is vaulted, and was so filled with carts and turf-ricks on my visits that I could not get up to the other stories. The tower is neatly battlemented, and has often been illustrated. It forms, with its beautiful surroundings, the broad Sound, the purple hills, and the golden and brown seaweed of its rocky base, a most picturesque object. Kildawnet Church has a simple (and perhaps ancient) oblong slit in its west gable; but the rest was repaired and used for a chapel, so little of its older features is traceable. The south door is lintelled, with a small square recess to either side. The two side-windows are oblong and modern; so is the light of the east window. Over the latter is a relieving arch of thin slabs. There are three plain old ambries—two in the east wall, and one at the east corner of the north wall. I found no old tombstones.

On the other islands are the early church, cashel, and monuments at Caher; the clocháns or religious cells on Inishark; the thirteenth-century abbey, with fifteenth-century repairs, and the curious holy wells on Clare Island. St. Columba's Church has been levelled on Turk. St. Colman's Abbey is to all appearance a very late building, but it has an evidently early basin or font. St. Leo's Church, on Inishark, has been altogether modernized; but a neat window-slit is preserved.

Of the castles south from Achill, that on Clare Island, attributed to Grania Uaille, is evidently of her period, in the latter half of Queen Elizabeth's reign; while "Bosco's Castle" (or "Cromwell's Barracks"), guarding the harbour of Bofin, evidently dates from 1656. The other castle of "Guarhim" has left no trace, nor has any description been preserved.

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[1] The Lords of Umallia recorded in the Annals are—1123, Tadhg Ua Mhaille drowned; 1177, Domnall; 1219, Dubhdara; 1362, Owen; 1401, Domnall; 1415, Aedh; 1421, Maelsechlainn (tanist); 1427, Aedh (tanist); 1560, Tuathal, "pilot of a fleet."

2. CLARE ISLAND (Plates I–VI).

Clare Island, or more properly "Cliara," forms part of Kilgeever Parish and Murrisk Barony in the County of Mayo. It was one of the most conspicuous islands of that beautiful coast, and to all appearance was a suitable and even desirable place for an early settlement. Sheltered to the north by its huge mountain, and abounding in creeks, with a sandy beach, abundant water supply, and, at one time, thick forests,[1] it certainly seemed more likely to have attracted early settlers than the unsheltered Mullet or the bare rocks of Aran; but such was not the case. Inishbofin and the Mullet and its surroundings have sandhill settlements and monuments; Achill abounds in megalithic structures; but so far as I am aware none are found on Clare Island; one Bronze Age spear-head alone attests the presence of man at that period, while nothing, so far, seems to have reached us from the Stone Age. Inishbofin, with its huge cliff-forts, has numerous huts; Inishturk its fine ring-walls; others occur in Achill, but none in Clare Island. The Islands of Torry, Inismurray, Ardoilean, the three Aran Isles, the Magharees, even the great stack of Skellig, were the resort of monks and the scene of piratical attack; nothing similar is recorded of Clare Island. From the historian's standpoint the record of the island is nearly a blank. This is not altogether wonderful when we consider what impenetrable tracts of bogs, mountain, and oak forests lay between it and the ancient kingdoms of inland Mayo. The natural barriers continued in Connemara, and, if the learned monks of the Aras ever recorded anything about the far distant Isles of Mod, Cliara, and Achill, the destructive Norse raids must have swept it away.

The ancient buildings are equally disappointing; no great ring-fort, like Inismurray Cashel, or Dun Aengusa, is found in the group with which we now deal. There were several large cliff-forts: Dun-Kilmore in Achillbeg, Dunnahineena, and Dunkeen, or Dunmore, in Inishbofin; some small but strong ring-walls in Achill; an alleged site at a hillock in Clare Island, and the Doon of Inishturk. The predominant remains are of fortified rock platforms like Dane's Island in Waterford on a smaller scale;[2] these are not very usual on the Irish coast compared to the entrenched or walled headland. Up the west coast I recall only Darby's Island and Ballingarry in Kerry and Illaunadoon in Co. Clare;[3] but here we have Dunallia, Duntraneen, Duncloak,

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[1] The remains of a very extensive forest of large trees lie not far from Oogbeg. "Derry" also occurs more than once in the place-names Derraghyemon, Derraghgarriff (Garbh), and Derreen at the back of Knocknaveen.

[2] Described in Journal Roy. Soc. Ant. Ir., xxxvii, pp. 252–4.

[3] *Ibid.*, xl, p. 17, p. 117, and xxxviii, p. 42.

and Doon-Ooghaniska in Clare Island, Dungrania and Dunnahineena in Bofin, and Duneenapisha in Inishark. Of the more ordinary type are Dunmore on Inishbofin, Dunnagappul in Clare Island, Dunacurrogh and Dunnaglass in Achill; Dun Kilmore stands apart, one of the exceptional cliff-forts of Ireland, and indeed of Europe.[1]

So with medieval buildings; nothing like those on Inismurray, Inisglora, Inishkea, or Ardoilean, is to be found; none of the existing churches is of great age, the bulk are of the late fifteenth century, or even later. The beehive hut is found in Achill, at Dunnaglass, in a fort; how far the foundation of the rude and primitive cell at Toberfelabreed in Clare Island is old I am unable to say. No early crosses or inscribed stones of early age occur in the group of islands save on Caher Island, and with one exception of Templepatrick church and one of a religious house on Cliara, the only remains are the rather late and most disappointing "Abbey" of St. Colman on Inishbofin, the restored church of St. Leo on Inishark, and a graveyard on Inishturk.

History of the Islands.—The history of the whole district down to the twelfth century is nearly a blank. Of places round Clew Bay we only hear that in 848 a lake in Umaile in Connacht suddenly "ran off into the sea," and that in 1113 a thunderbolt fell on Cruachan Aigle on the night of the festival of Patrick, and destroyed thirty of the fasting people. The Chronicon Scotorum adds that Ua Longain, Erenagh of Ardpatrick, was then struck by lightning. After the Norman Invasion "Achill" seems again to take the lead, but the records only begin in the thirteenth century (1235), and it remains a very grave uncertainty whether the Eccuil, or Acuill, is not the district on both sides of Clew Bay called by these names, and the apparently kindred Aigle or Oigle, which gave its name to Cruachan Oigle.[2] This was apparently a place near the foot of Croaghpatrick rather than that great natural pyramid the dwelling-place of Corgen, who slew the Dagda's divine younger son. It is possible that, as in Erris, so here a Damnonian race prevailed;[3] of it (or classed under the very vague name of "Firbolg") a strong tribe called Uathmor or Umoir existed. A Munster bard, Muircheartach Mac Liac, before 1016, represents them as a weak group of

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[1] Described *supra*, vol. xxix, pp. 29–33, with a plan, sections, and view, plate vi.

[2] Cruach Aigle is rendered "Mons Aquilae" by Colgan, but O'Donovan will not bind himself to the similar translation of "Achill," and certainly the place-name for "eagle" in Clare Island and farther north in the County is Illar. Renilra on the seventeenth-century maps, 1620–1683, Glenuilra in Tirawly, &c. (Compare O. S. Letters, vol ii, on Croagh Patrick, and vol. i, on Achill.)

[3] I have condensed our present slight knowledge of the races above in vol. xxix, p. 12; for present-day ethnology and notes on the folk-lore see Dr. Charles R. Browne's paper, *supra*, vol v, ser. iii, p. 40. This, the works of Maxwell, Caesar Otway, Knight, and the Handbooks ii & vi of the Royal Soc. Antiq. Ir. almost exhaust the bibliography of these coasts.

families living in nine raths and soon exterminated by the Tara warriors; but there is much reason for holding the contrary view, for the Clann Uathmor was no mean opponent of the Nemedians, and appears in many early records of Co. Mayo.

Having recently discussed the Munster legend preserved in the Dind Seanchus and the poem on it by Mac Liac, it is enough to give, after passing over the settlements identified as at Galway Bay, those probably intended as dwelling farther north. "They fixed Mod at Moidluin . . . Cing obtained the district of Oigle. At Laidlinni (Laiglinde), I do assert, were Bairnech and Barambel" (or Bairnech, or Bairnde Batanbel),[1] and even of these Irgas (Eeerish of Caherdooneerish) on Ceann Boirne (Black Head) is placed between and not far from Mod's alleged settlement. Petty marks in 1683 a "Moyluin" in Burren near Turlough and its huge hill fort. Were there an Oigle on Galway Bay, it should be preferred as the place meant by Mac Liac. O'Donovan considers the Islands of Mod as in Clew Bay, but he wavers as to Modh's settlement, even suggesting that it lay as far north as Dunnamo, "Dun modh." When, however, we find a Tragh Murbhaigh near Killala, a Tawinlough on Clare Island, Cathair Tamun at Castlehill, and a place-name Dael[2] in North Connacht,[3] we more than suspect the original settlements of the Clann Uathmor (Murbech, Taman, and Dael) to have been there, and not as located by Mac Liac in Co. Clare, Galway, and Aran. We may accordingly pass from this unsatisfactory legend.

In more historic times the islands were joined to the district in which the Ui Mhailles[4] held sway, which, on that account, was called Umail (Ooail), whence in Tudor times the name "the Owles." This from an ignorant confusion with *ubhall* (pomum) led to some overlearned writer giving to its chief the unexpected title of "Omaley de pomo."[5] The last trace of the name is found in Burrishoole or Burgheis umhaill, Ui Mhaille's burgage. Umail covered the barony of Murrisk, and seems to have included Achill and certainly Cliara, Bofin, Inishturk, Shark, and Caher. Bofin and Shark were formerly part of hIar Connacht, but were won by the O'Mailles about 1370.[6] Nothing seems

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[1] Onomasticon Goedelicum, p. 474, but Loch Laiglinne, named after a son of Partholan, was in Ua mac Uais Breagh, i.e. in Moygoish, Westmeath (Keating, book i, sect. vi, Ir. Text ed., p. 165).

[2] Daol. O. S. Letters, vol i, p. 97.

[3] For full text see MacLiac's poem in Ossianic Society, vol. v, p. 287, the prose text in the Dind Seanchus (ed. Whitley Stokes) in Revue Celtique, vol. xv, 1894, pp. 478-480; also Journal Roy. Soc. Antiq. Ir., vol xxvi, p. 142.

[4] They claimed descent from the High King Eochaidh Muighmheadhain through his son Conall Orison. Local legend derived them from the "god" Crom-dubh.

[5] See Customs, Tribes, and Genealogies of Hy Fiachrach, J. O'Donovan, Ir. Archæol. Soc., 1844, p. 499.

[6] Roderick O'Flaherty, "hIar Connaught," p. 115.

recorded of Inishark, while there is much doubt and confusion as to whether some supposed mention of Inishbofin refers to the island here noted or to another of this not unusual name.

The Umail were warlike and fond of the sea. Seaan Mor Ui Dubhagain (O'Dugan), who died in 1372, thus describes them :—

> "Oh Clann Maille of the sea-sent treasure,
> Every land is against thee in this
> Ye inhabit the two Umhalls—"
> "A good man never there was
> Of the Ui Mhaille, but a mariner.
> The prophets of the weather are ye,
> A tribe of affection and brotherly love."[1]

Giolla Iosa Mac Firbis in 1417 sings of them as "The Clann Mailli, valiant the branch." The State papers of the following century describe them as "Omaylle, strong in galleys and seamen" in 1576,[2] and the galley in their arms with the motto, "Terra marique potens," on the walls of Cliara Abbey, shows that the family boasted of its sea-power. The Abbey was a Carmelite cell dedicated to the Blessed Virgin, and in later days attached to the great Cistercian House of Knockmoy or "De Colle Victoriae." It was (it is said) built by the O'Mailles, in 1224, according to Ware. A little later, in 1235, the Four Masters and the Annalist of Loch Cé tell how Felim (son of Cathal Crovdearg) O'Conor resolved upon taking with him to O'Donnell all the cows belonging to those who would take his advice in Conmaicnemara, and Conmaicne Cuile with the son of Manus, and Conor Roe, the son of Murtagh Muimhneach, and leaving the whole country desolate to the English . . . The English then sent from Dun Mugdord a numerous army against the son of Roderick which plundered Ecuill and carried great spoils to Drumimni. Domhnall and Muircheartach sons of Muredach Ui Maille were slain by Domhnall son of Magnus son of Muircheartach Ua Chonchobhair (O'Conor) in Cliara, where they were buried—probably in the newly built monastery.[3] Later in the same century in 1273 Domnall Irrus, son of Manus, who was son of Murtagh Muimhneach O'Conor, was expelled from Umallia and Irros.[4] This comprises all the history at present known earlier than the reign of Elizabeth.

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[1] The Topographical Poems of John O'Dubhugain and Giolla na naemh O'Huidhrin (ed. O'Donovan, 1862), p. 65, "Hy Fiachrach," p. 181; also Hardiman's ed. of "hIar Connaught," p. 301.

[2] Cal. State Papers Ir.; also "hIar Connaught," p. 301.

[3] Mr. Hubert T. Knox has collected the scattered notices in his History of Mayo, pp. 86–94, and 306. I procured but little material in the Public Record Offices; the Inquisition merely names the place, giving no details of the building or its lands.

[4] Annals Four Masters.

The church was entirely restored about 1480, the ceiling painted, an elaborate tomb made in the north wall, and new windows inserted in the chancel. The cell probably shared the fate of Knockmoy, which was dissolved in 1542. Hugh O'Kelly, the last Abbot, made excellent terms with the Crown; he was to furnish the King with sixty horse, a battle of galloglasses, and sixty kerne, whenever the Lord Deputy came to Connacht, and twelve horse and twenty-four kerne for service outside the province, May 24th, 1542. Among the Elizabethan Inquisitions relating to the Abbey we find more than once mention of "the Island of Cleary," containing a quarter of land and tithes worth 13*s.* 4*d.* per annum, besides reprises. The second Exchequer Inquisition of Co. Mayo, June 3rd, 1585, before Thomas Dillon, Chief Justice, 1585, states that "the Island of Clerë contains a quarter of land and divers appurtenances of the Abbey of Knockmoy, and is worth per annum, besides reprises, 13*s.* 4*d.*" No further details are given, and it is probable that the O'Mailles protected the monks, and kept the building in repair. Later monastic writers have little to tell. Downing mentions "Cliera, about 2 leagues from the mainland, a small Abbey of St. Bernard; Dermitius Caladus O'Maly and Morte O'Conor were there buried." One of the Carew MSS. gives a list in March, 1574, of the islands as—"Inysturke, Inyshourke (Shark), Cliera, and Aukilles, held by O'Male—Abbeys—Clyera possessed by friars, or rebels, so as her Majesty has no commodity by the same."[1]

In September, 1588, one of the ships of the Armada was wrecked on the coast of Cliara, with 400 men on board; seventy are said to have been slain or drowned, and the rest were taken off by another ship, but Cliara is devoid of all definite traditions of the wreck. Sir G. Fenton's final list of the Spanish losses in September, 1588, names the following wrecks:—In Tirawley, one ship, 400 men; in Clare Island, one ship, 300 men; in Fynglasse, O'Malley's country, one ship, 400 men; in Erris, two ships, none lost, because the men were taken into other vessels, but the vessels and ordnance remain. This seems to contradict the first account, nor does a third help us to a definite conclusion by telling how the Clare Island wreck was of a ship of Don Pedro de Mendoza, who refused to surrender, upon which Dovdara O'Malley (the father of Grania) slew him and 100 men.[2] Nothing so definite as the fearful accounts of the havoc in Sligo, or the story of the escape of the Zuniga, or of the two wrecks on the coast of Clare, is preserved. The connexion of the famous sea queen, Grania Uaile, with Cliara, is more a matter of tradition than of history, and Burrishoole

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[1] Cal. State Papers, vol. i, p. 473; see the Fiants of Queen Elizabeth (they usually give mere names, or allude to Cliara Abbey), notably Fiant 4844 of 1586.

[2] Cal. of State Papers, Ireland and Spanish; also Knox, History of Mayo, pp. 220, 223.

claimed to be her burial-place against the stories and slab of Cliara. Perrott's composition with the Mayo gentry in 1586 gives us a list of the family and their lands without mentioning Grania. Molaghlyne O'Mayle of Belclare was chief of the name. Teige Roe O'Mayle of Cahairnemart (Westport), gent.; Ouan O'Mayle of the same, Dermot McArte of Clare, gent. (whether Cliara or Claremorris is doubtful). In the Barronie of Burreshowle there are Ackeall and other parcels belonging, it is said, to the Earl of Ormond. The Stowe MS.,[1] a curious document relating to the inauguration of O'Conor, is another proof of Omaille's maritime skill. "The command of the fleet to O'Flahertie and Omali whenever he (O'Conor) goes on sea, or on the high sea." Of the local legend of Grania Uaile and the folk-lore I shall have more to say in connexion with the well of Toberfelabreed, and at the close of this paper.[2] Very little can be gathered about Cliara till late in the last century. Bishop Pococke did not visit it in 1752. Beranger,[3] in July, 1779, "ascended Cro Pat(rick)," and saw "the high Island of Clara," but he did not visit it; it was too remote for even the most enterprising travellers of that century. Rev. Caesar Otway, however, though evidently able to give very little time to it, landed about 1838, and inspected the Abbey; he chiefly noted the reputed skull of Grania Uaile. The Ordnance Survey Letters of the same period are also unsatisfactory. Dr. Charles Browne was limited by the scope of his paper in 1897 from describing the ruins. In 1895 the Royal Society of Antiquaries visited the ruins, and a brief note in its Proceedings[4] tells of the "indications of fresco painting, but nothing can be distinguished of the design"; both visits of the Society (the last in 1904) were very hurried. In the Society's hand-book (No. vi, p. 37) a slightly fuller account and two illustrations of the church and monument are given. So that the Academy is now publishing the first detailed description of the abbey, castle, and forts.

The island consists of two high grounds, between which (so far as I am aware) no antiquities remain, save a green mound, a reputed fort-site, near which a bronze lance was found.[5] The lighthouse is at the north-east corner, the castle nearly at the south-east, and the rocks of Canshindilla (Kinatevdilla on map) at the west. The northern coast is so lofty and steep that it is not surprising that no fortified rocks or headlands are found; such may have once existed, but if so, they have long since been worn away. On the east shore the fortified rock of Dunallia, near it a similar rock isolated at half-

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[1] Codex 111, f. 28.

[2] The Ordnance Survey Letters (MSS. R. I. Acad. 14 E 18), Co. Mayo I, p. 476, give us only the baldest statements about Clare Island, not even explaining its name.

[3] Roy. Soc. Antiq. Ir., vol. xi consec. (1870), p. 151, and vol. xiv (1876), p. 151.

[4] *Ibid.*, xxv, p. 243.

[5] I owe this information to Mr. W. J. Lyons.

tide, but with no apparent artificial defences, is called Duntraneen. Beside the road from the lighthouse is a small unshaped pillar. There are traces that possibly represent a walled headland at Ooghbeg. Southward are the curious well, hut, and altar, the last two in a dry-stone cashel of irregular plan. There are middens, which as yet have yielded no implements, at the north end of the strand, near the harbour. On the southern horn of the same bay is the castle. Going westward along the south shore very slight traces corroborate the name of Duncloak as a fortress. The abbey, with its cross-scribed pillar and well, is in the best position between the shore and the southern ridge; to the east is a graveyard believed to be Christian, but without monuments. Beyond the abbey, to the south-west, is the much-levelled but most interesting of the shore-forts, at Ooghnagappul, called Dunnagappul. Still further westward is the bold, fortified rock of Doon, at Ooghaniska. The only other ancient monument is on the shoulder above Budawanna, an irregular loop of small set stones, the age and purpose alike doubtful. The old marks of cultivation are very curious on the hill-sides with curved and even S drills. (Plate VI.)

Names which give us at times hints on the physical features, plants, and animals, abound on the island. Mr. Lloyd studies them in a separate section, but I may be allowed to note their general bearing. First and most marked is the unusually rich nomenclature of the creeks and caves—Oogh, Oomeen, and Ooan—some merely referring to colour, like the two Ooghduffs, or shape, like Ooghlahan (broad), Oomeemgarve (rough), Ooghkinkeel (narrowhead), Ooghbeg (little); others from natural or artificial features Ooghantur (of the tower) at the castle in Glen; Ooghanloghan (of the little pool); Ooghanwaud (of the boat); Ooghgubamonemeen (of the month of the flat moor); Ooghnamara (of the sea); Ooghaniska (of the water); Ooghganny (of the sand). Others refer to plants, animals, and persons, such as Ooghcappul or Ooghnagappul (of the horse); Ooghnacallyduff (of the cormorant); Ooghnamaddy (of the dog); Oomeenamuckmara (of the porpoise); Ooghnageeragh (of the sheep); Ooghcatharina, Ooghmacnamara, and Ooghmoylanduff. Some thirty such names remain, and show that the life of the people was so much concerned with the shore that every rock and hollow needed a name, unlike the north coast at the mountains, where the vast cliffs discouraged all acquaintance with the shore, save at certain creeks. It is interesting that such *oogh*-names are absent from Achill, but are represented in Bofin, Shark, and Turk: thence they are decidedly rare. Some racial or social fact must account for this.

In other place-names we find the following animals:—The bull, Tonaltatarriff and Porttarriff; the horse, Ooghacappul and Cushacappul; the goat, Capnagower; the porpoise as above; the eagle, Benilra; the cormorant at

Carricknambriol, and possibly at Ooghnacallyduff and the Calliaghcrom rocks[1]; the crab at Carricknapartaun; and the beetle at Kinatevdilla.[2] Of plants little trace is found; Oomeenadrishoge, the vague Lacknacranny, and, perhaps, Ivorabrickhill, and an unexpected occurrence of oak-names, Derreen, in the central valley, Derrygravebeg, or Derrygorobeg, and Derraghyemon,[3] are the principal. Of superstitions and legends I only recall Loughanaphuca, evidently an abode of that mischievous demon goat or horse. Roderick O'Flaherty's interesting list of the animals of West Connacht in 1684 probably applies (at least in the winged and swimming creatures and shell-fish) to Cliara. Seafish—cod, ling, hawk-fish, coalefish, turbet, plaise, hadog, whiting, gurnard, macrells, herrings, and pilchard. Shell-fish—Oysters, scollops, cockles, muscles, rasures, lobsters, crabs, and shromps; also great whales, gramps, porcupisses, and thunies. Birds—The black eagle, ganet, clakes, soland geese, barnacles ("engendered out of timber"); some call them puffins, wild geese, swans . . ., Cornish choughs, with red legs and bills, and cormorants.[4]

I may add the following names, for the most part not found on the Ordnance Survey maps:—Aillmore, Barnabaun, Bundorragh, Ballyloughmore, Ballyhear, Bellavaun, Belloohybeg, Carrownisky, Corrydavit, Cloonlaun, Cloonty, Corrymally, Corryaghny, Cross, Capnagower, Derrygravebeg, or Derrygorobeg, Devlin, Fenuine or Feenone, Glen, Glencullen, Garranty, Gurteen, Kille, Killadoon, Kinnadooley, Lettereavagh, Lecarrow, Roonkeel, Roonagh or Koonagh, Straike, Sallylough, Toreenmore, Teevenabina, Tawnymorane, and Tawinlough or Tawneyenlough. I have failed to get any really old version of the place-names. Wyld's Map of Ireland, just preceding the Survey of 1838, gives Ben Ulra, Ooghanachollu, Ooghaduff, Port Lea, Ardell, Carrignapurtaan, Kannacurra, Kanahouha, Portrucka, Doon Cloak, Gubanoureen, Port Alagaan, Ough Kapul, Killglen, Moahmore, Ton Cabrickill, Doon, Oogh Gavna, Laakuig, Kan na Shindilla, Buda Wanny, Glashillaun, and Knockmore.

Early Remains.

I was told of a supposed dolmen, but found no trace of the "Giant's Grave" at the place indicated. Not far away, however, in a similar position, was a row of large blocks wonderfully like such a monument, but they proved

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[1] On the Munster coast "Calliagh" nearly always means cormorant, but the "hags" or bog stems are so called in Mayo, and snag-like rocks may be named from them.

[2] Canshindilla; there is also a Shindilla islet near Murrisk in Clew Bay.

[3] Oak-names are very common on the mainland under Croaghpatrick. The Annals of Clonmacnois give an interesting note (p. 15, ed. Rev. Denis Murphy, R.S.A.I.). "Many Loughs and Rivers broke out in their (Clann Nevye's) time. Many playnes were made by cutting down the woodes." There were floods from want of trees, and the Clan erected many raths.

[4] A chorographical description of hIar Connaught, Roderick O'Flaherty, 1683, p. 12.

to be a natural formation. At the head of the long valley in which Loughanaphuca lies, I found a cist-like group of flat stones, none more than 3 feet high or long, but they formed no definite chamber. It lies near the junction of the two chief brooks, which flow down the slope through a network of former channels, choked with hill debris, to the beautiful creeks, islets, and natural pillars, under the colossus of Budawanna.

At a turn of the road to the lighthouse, not far from where it is joined by the bohereen through the Maum valley, from the abbey, near the southern border of Ballytoohymore, stands a low, rude pillar-stone. It is probably buried for some feet by the raising of the ground by tillage and banking up behind the fence. It is a fairly regular block of grey conglomerate, coated with moss and lichen, and fairly smooth. It measures from 3 feet to 4 feet 1 inch high, and 36 inches by 31 inches thick, standing at the west fence of the road at a slightly rising ground. I searched in vain for any set stones in the curious series of deep valleys between the lighthouse and Croaghmore, and on the central valley and the southern slopes of Knocknaveen.

Though not sure of its age, I had best note here the circle of moderate-sized stones set in the sward 300 feet inland from the cliff-edge, where the long spur runs down to the curious rock-pillar of Budawanna. It measures 25 feet to 27 feet across, being slightly irregular, with more conspicuous blocks, suggestive of "pointers" set to the north and the south-west. Without excavation it is impossible to assert its age or character, whether a hut-site or a burial-circle. Down the slope to the south, and eastward from the creek at Budawanna, in a little round hollow, are evident remains of a hut of a primitive design, whatever be its actual age. The western and a small portion of the eastern segment, formed of fairly large blocks set in the ground so as to form a smooth, curved face inside, still remain; it was divided into two by a partition-wall, evidently an afterthought, and measures 19 feet to 21 feet across north and south, and 16 feet 6 inches east and west. Very usual dimensions.

Lastly, an apparently natural hillock near the old green road, behind Knocknaveen, is reputed to be a fort, and near it a bronze spear-head was found by Mr. MacCabe and Mr. MacGreal, and sent to the National Museum. When found it was sticking prominently out of the sward.

Cliff Forts. (Plate III.)

There are no forts marked as such by either the old or recent Ordnance Survey. The appearance of suitable headlands and rocks, coupled with the occurrence of the name *Dun*, encouraged me to expect promontory forts, nor

was I disappointed, as the remains of what were probably six forts were found. In Cliara, as in Mayo generally, the rock-platform type is well represented, but two examples of the stone-walled headland, and one of the normal entrenched earthwork, occur. It is, of course, to be expected that others remained till the sea cut them away. Probably, save in a sheltered position, all the oldest forts have long since been so destroyed. Even of those that remain in Co. Mayo, the evidence of sea-cutting in the later ages is everywhere—the stupendous cutting-away of Dun Briste and its buildings from the fortified promontory of Downpatrick Head, the cutting-away of the island and hut at Cashlaunicrobin, of much of the garth and even half the late peel tower at Dookeeghan, of most of Dunminulla, and I think of the neck of Horse Island if (as is apparently certain) the latter was fortified. Even in history we read of the breaking of the neck of Duross peninsula by the sea in 1394 as recorded by Mac Firbis. I have so recently discussed this question of erosion and the general question of promontory forts that I need do no more than refer to the previous papers.[1]

To the south-east of the lighthouse a natural depression and a bold ridge behind it suggest a site, but no trace remains; probably a landslip in very early times broke away the upper part and left no space behind the otherwise most suitable natural fosse.

Dunallia and Duntraneen.—(Ordnance Survey Map, 6 inches to the mile, No. 75). In Ballytoohymore the map shows two islets off the coast called "Doonallia" and "Doontraneen." I expected that they were the remains of promontories the necks of which had been cut through by the sea, and was not a little surprised to find their true nature. For the first and northern is really a peninsula, and the other is accessible when the tide goes out.

The names mean either Cliff fort, or O'Malley's fort, and fort of the withered grass stems.

Dunallia resembles on a very much smaller scale such cliff forts as Danes' Island, in Co. Waterford, Illaunadoon in Co. Clare,[2] Darby's Island near Kilconly in Co. Kerry, and Dunaneanir in the Mullet, all very fine examples. I have never seen any shore forts exhibiting such great ramparts as the fortified rocks inland to which they are akin, such as Cashlaun Gar, in Co. Clare. Such forts usually are only very slightly fenced as a protection against falling over. Dunallia is no exception. The narrow neck and gangway are reached down a watercourse and a

[1] Ancient Forts of Ireland, section 120. Journal Roy. Soc. Antiq. Ir., xxxvii, p. 239, xxxviii, p. 28, xl, pp. 6, 99, 179. Trans. R. I. Acad., xxix, pp. 11, 221, 265.

[2] Where the last traces of the fence (extant in 1875) have recently fallen away.

dangerously steep slope, which brought one to an equally steep and difficult ascent exposed to missiles from above. The ascent was in itself nearly sufficient protection to the inhabitants, and the slight bank of earth and stones round the landward edge made it a very effective stronghold out of range of ordinary missiles, so that close approach and, still more, any blockade was practically impossible. Sheep can reach the platform, which is fairly spacious, with a very slight slope seaward and cut into by a cleft to the south-east. The bank is rarely more than 3 feet high, and little more than a foot at present on the inside. It runs round the landward side, and at same distance from the "corner" the northern bank has been evidently destroyed by a landslip so long ago that the slope is now green and apparently little damage has been done for many years or even generations. The fall half destroyed two circular huts; they were evidently of earth and perhaps wood on a stone foundation like the fence. This "soling" is well seen where the bank has crumbled recently at the north-west corner and along past the eastern hut. The latter shows a low mound over 3 feet above the stone "soling," but much filled up; the rich green of its saucer-like enclosure contrasts with the browner grass and bracken of the rest of the garth. The hut is about 12 feet across with walls as usual 3 feet thick. Over 60 feet to the west is a larger hut; its wall is over 5 feet thick, and it is 15 feet wide inside. It resembles the northern station on the brink of the chasm south of Dunbriste on Downpatrick Head in the same county, having a shallow trench just inside the wall and a flat central mound. It lies about 18 feet back from the western fence. The natural gangway was improved by the fort-makers: a large mass of grey rock, which had fallen to its resting-place from the landward cliff, saved much labour; they raised two steep mounds of earth with much stone worked in, and possibly a stone facing to either side of it, to a height of nearly 12 feet, and so made a fairly level path 2 to 3 feet wide; it and the little gully leading to it were deeply overgrown with Meadow-sweet. The water supply is unusually good and convenient; two runnels unite and fall down the landward cliff close beside the causeway, whence water could always have been procured under cover of the night. Another beautiful fall dashes down in a curtain of spray not far to the north.

Duntraneen lies at no great distance from Dunallia; its platform can be overlooked from the opposite high cliff. Mr. Praeger swam out to it and climbed up to the summit, but found no works upon it; a portion about 30 feet wide is not too steep for residence, but much consists of a roof-like ridge on top. It is quite evident from the appearance that at no distant date the drift on both rocks remained to a much greater extent. At Duntraneen the bulk of the cap fell off to either side, doubtless carrying with it the slight

fences and the hut-sites if such existed. The process has only just commenced at Dun-Ooghaniska, where it has made some progress since 1909 owing to the following very wet summer. At Dunnaglas it has destroyed about half the fort, and at the nearly bare rocks of Dunmore and Dunnagappul near Doogort the forts have vanished, and only their name clings to the rocks. In some cases the destruction is very intermittent; vegetation grows again on the bare surface and preserves it for some, even for many, years; then from some cause the plants are destroyed, and the bare bank again commences to crumble till the grass again establishes itself. So far as I have examined the cliff-forts of western Connaught and Munster, this is the most usual process of destruction. It shows how many dozens or hundreds of entrenched head-lands may have perished in the thousand years since the Norse wars, even where the rock bases survive. The two Duns and the adjoining cliffs enclose a series of beautiful picturesque little creeks looking out to Achill and the hills near Mulranny.

Ooghbeg (O. S. 75).—On a low headland, a mass of drift rapidly falling away on every side, I found the remains of a massive wall. It is at present 66 feet long, but both ends are wasting. At 45 feet from the present west end, is a long set slab suggestive of the jamb of a gateway. The wall, instead of having been built on the surface, was made in a foundation trench over 3 feet deep; it was 12 feet thick, of very large blocks, and save for the foundations, is nearly removed. It is very slightly convex to the land and lies roughly east and west. Its masonry and massive character mark it as ancient. The bank at it is 15 feet to 25 feet high, but it may be remembered that the great fortification of the headland at Porth or Portanalbanach in the Mullet abuts on even lower shores. The garth was once tilled, so no traces of inner buildings remain.

There are no marks of any early entrenchment or wall on the headland at Grania Uaile's castle.

Duncloak (O. S. 85).—This natural fortification lies westward from the castle and bears considerable resemblance to the curious promontory fort of Dunmore or Horse Island, near Loop Head, Co. Clare, and to the Horse Island near Belderg on the north coast of Mayo. It is joined to the mainland, however, by a broad grassy neck, 27 feet wide, with steep slopes at either end, and low precipices on each side, the western at a curving creek with two fine high natural arches; the eastern at a crescent of shingle beyond which are abrupt cliffs sheeted with masses of Osmunda wherever a stream descends their faces. Like Dunallia, and the Clare Horse Island it was only very slightly fenced by a mound of earth and large stones at the summit of the neck, and eastward along the face, but probably it was

once better defended by a dry-stone wall, which, like those at Spinkadoon in the Mullet, Minard in Kerry, Doonaunroe in Co. Clare, and others, was removed, leaving little trace. Part of it has been destroyed long since by a landfall, now grassed over. I found no trace of hut foundations on the platform.

DUNNAGAPPUL (O. S. 85).—To the south-west of the Abbey are the remains of what was probably once the strongest artificial fortification on the island. All (save Ooghbeg) of the other *duns* owe their strength to their natural features, and this is eminently the case with the next we must describe, at Ooghaniska. It is strange that the *Dun* of Ooghnagappul should have been overlooked; it is conspicuous from the road, graveyard, and the Abbey roof, from which its character is unmistakable. It says little for the archaeological qualifications of those who made the great maps of our Ordnance Survey that so many forts, even such complex or well-preserved ones as Dun Kilmore and Port Conaghra in this county, and Dunruadh, Doon Castle, and Brumore in Kerry, have been omitted from the maps.

The fosse is cut across a deep mass of drift, about 50 feet thick, on low rocks protected to the north and west by the narrow creek of Ooghcappul or Ooghnagappul. The grassy slopes along the creek are intact, but the storms and weather rather than the sea are eating away the side to the south-east. The works consist of a nearly straight ditch 13 feet wide, and 75 feet long; there is no trace of an outer mound. Inside the fosse is a rampart reduced to only four and a half or 6 feet high, and 10 feet thick; behind it was a platform or banquette such as we find in the Kerry forts of Doonbinnia and Ferriter's Castle on Doon Head; it is 6 feet wide. Inside this to the west is a curved fosse slightly convex to the landward side as usual. It is 59 feet long, 6 feet wide in the middle, and 9 feet wide at the ends, and is nearly 10 feet deep at the latter points. The inner defence is levelled; it was evidently a stone wall, nearly 50 feet long and 9 feet thick; many large foundation blocks remained firmly set in the sward. The north end of the works are very neatly rounded, curving into the face of the slope, as we see in some of the uninjured Kerry forts. The garth is at present 90 feet long and about 60 feet wide; the gangway and entrances were not central, being about 20 feet from the northern edge; the platform was surrounded by the usual fence of no great thickness, which is now nearly levelled. It is evident that on Cliara dry-stone walls and very slight earthworks were the rule. Inside there is a trace of a small circular mound, while outside, to the east, at the edge of the north slope, is an equally faint trace of a ring, 30 feet north and south by about 24 feet, probably for a hut near which a levelled fence (crossed by the modern one) runs aslant across the headland from 6 feet to 70 feet from the fosse. (Plate III.)

We examined the rest of the coast carefully, but only found one other fort at Doon, and that of considerable interest from the skilful adaptation of natural features. It lies just to the west of the curious outcrop of rock, the upturned edges of which have been channelled into great furrow-like hollows. It ends in a formidable precipice at a little stream gully.

Doon-Ooghaniska (O. S. 84).—From the edge of this channelled rock we look across a deep narrow creek to a high headland, with a surrounding mound, and two hut sites, justifying the name "Doon" attached to it. It lies between two creeks, each with a waterfall at the end, which probably helped to cut back the rock. From this circumstance one is called Ooghaniska, which I adopt to qualify the fort-name. Between these the headland runs southward, falling to a low grassy neck. The clay bank has been cut down in stages 3 feet to 5 feet high, to a slope 21 feet wide, and then we find another terrace 6 feet wide and 3 feet high, rising from a partly formed fosse 9 feet wide. This runs E. N. E. and W. S. W. The next platform, 3 feet to 4 feet high, is mainly natural, and rises into a sharp peak, 8 feet higher. Behind this another fosse, running nearly east and west, now somewhat filled, and only 3 feet deep, has been cut between the rocks, and is 9 feet wide. Thence a tower of rock, partly girt by a thin wall, rises with a narrow and dangerous path (a mere goat-track, but cut in the rock) beside it on the west. This leads up to the platform. The level summit is fenced on all sides by a wall of earth and stones, 9 feet thick next the land, but 5 feet to 6 feet elsewhere, and rarely over 3 feet high. The entrance was evidently at the head of the path. Fifty-seven feet southward from it, or 65 feet from the outer face, is a straight traverse, exactly 57 feet long, across the garth. At this point, if we include the walls, the fort is 71 feet wide. Touching the middle traverse in the inner ward is the foundation of an oval house, 21 feet north and south, and 18 feet to 21 feet east and west; the walls 3 feet to 4 feet thick, of stones and earth. At 15 feet south from the last stood another house, 20 feet north and south by 30 feet east and west, the sides nearly straight, but the corners boldly rounded. The central line meets the rampart at 36 feet south from the hut. There are three terraces, or rather ledges, each a foot high, across the southern end of the platform, about 12 feet apart; the last is 36 feet distant from the end of the garth, which is slightly rounded, and 33 feet across, east and west, at 9 feet from the end. Below a steep slope of clay, about 15 feet high in parts, the bare rock juts out to the precipice and rugged reefs at the southern end of the headland. The east rampart curves round the north-east rock, from the entrance; it then curves slightly outward, and then inward, following the edge. At this second curve the face has fallen away for nearly 25 feet along

the base, showing the stone foundations of the wall, as we see across the creek. The bank is usually a couple of feet high. The whole platform, north and south, is about 210 feet long, sloping at the end. The general arrangement strongly recalls the similar Mayo forts of Dookeeghan and Duncartan, though its site is far bolder and more defensive by nature. (Plate III.)

Ecclesiastical Antiquities. (Plates II–VI.)

As I have already noted, no early church site is known to exist, but it is not impossible that the Abbey usurped one, for a portion of one wall is of a more primitive character than the rest of the building, and there is an early-looking bullaun, or basin-stone, in the graveyard. The cross at its south-west corner, scribed plainly on a great pillar, might well belong to an older church than the late Abbey.

It is better for us to deal first with the two wells Toberfelamurry (Tobar féile Mhuiré), at the abbey, and Toberfelabreed, on the eastern shore, for they, especially the latter, are extremely primitive. It is a very curious circumstance that neither is dedicated directly to its patroness but to her feast, the names being "The Well of Mary's Feast" and "The Well of Brigid's Feast"; also that the observances of the latter fall on August 15th, like those of the other, and not on the real day of St. Brigid.

It has been suggested that both wells were once dedicated to the Virgin, and that the names only showed the feast-days on which rites were observed at each; but this is not believed locally.

Toberfelabreed (O. S. 85).—This is not only the more honoured of the two on the island, but the only one whose repute spreads from Galway and Sligo to America. This is strange from the more exalted patronage of its rival, but it is human. "The god that answers by fire," and the patroness that answers by cures, must override all rivals. Toberfelabreed lies in a bushy hollow, near the extraordinary beach—a natural weir of boulders, two lines meeting in an angle at the point called from it Kinnacurra, "head of the weir," and enclosing a triangle of swamp.

The observances on August 15th (Lady-Day in Harvest) take the form of "rounds," the worshippers walking seven times sunward (*i.e.* with the right hand next the wall), round and just outside the cashel or enclosure. After this they go on their bare knees seven times round the labba and altar, inside it, emerging by a gap in the north wall, and finishing by prayers at the well. Emigrants from Clare Island, even in America, vow to "do a station" at this place, and even if they cannot afford to return get a friend to do it for them.

The well is accredited with many miracles of healing, even in recent years, and to anyone acquainted with the cures arising from devout people performing religious rites at places of healing repute, the tales are credible. We were told how one delicate boy, too feeble to walk without help, was brought by his mother to the place. She put him into the saint's "labba," where he fell asleep, while she did the usual rounds, and when she awoke him he was able to walk home with her. This I heard from two people, with but slight variants, so record it here as a local belief. Later than this was another cure, but more explicable by natural causes. An Irish-American, whose health had broken down in the strenuous life of the Republic, returned invalided to Ballinrobe. Some time afterwards, hearing so much of the fame of the well on Clare Island, he went thither, stayed for a week, drinking of the well and performing the regular rounds. Finding, after his return home, that his health had permanently improved, he determined on another visit later on, which done, he entirely recovered his health and strength. No one can question that the strong faith in the power of the well has played a beneficent part, and wrought not a few cures in many weak and nervous persons.

Toberfelabreed is traditionally connected with the famous Grania Uaile. When she was a girl, she rescued a young man from a shipwreck, and he fell deeply in love with his preserver. They were married by the priest of the station, at the altar near the well, and lived very happily for some years. But evil impended. A feud arose between the O'Mailles of Cliara and the Mac Mahons of Ballycroy. The latter surprised the former at a deer-hunt on Achill, and Grania's husband fell in an ambuscade. The young widow made a solemn vow of vengeance, and bided her time. Hearing from an Erris man that the Mac Mahons were under a curse for killing a young man at Achill, and were going on pilgrimage to Caher Island, she manned all her galleys, and anchored behind the latter. She waited until the Mac Mahons had landed, and then cut off their retreat, slew many and captured her husband's slayer, whom she brought to Cliara and hanged with several of his confederates. Not yet were the victim's *manes* appeased, so she sailed to Ballycroy, surprised Doona Castle, put its occupants to the sword, and made it her chief residence.[1]

The remains, though evidently rebuilt, even in recent times, are very primitive and interesting. They consist of a dry-stone cashel, irregularly quadrilateral, with rounded corners. The interior is 48 feet across the

[1] Collected by Dr. C. R. Browne, Proc. R. I. Acad., vol. v, ser. iii, p. 67. It is probably the foundation of Maxwell's novel "The Dark Lady of Doona." For other legends of Grania see Caesar Otway's "Tour in Connaught," pp. 287–294.

eastern side, and 46 feet up the west. The gateway is 25 feet from the south-east corner, 5 feet wide, and 20 feet from the south-west angle. The north side is short, under 30 feet long. All the wall to the west and south has been much rebuilt; but the foundations and set-slabs are *in situ*, and the northern and eastern parts are mainly ancient. It is usually 5 feet thick, and 4 feet high. The old parts are much overgrown with bushes. In the north-east corner, 2 feet to 4 feet from the wall, is the Labbabreed (Leaba Brighdhe), or St. Brigid's bed. It is a small stone structure, rudely built, like a beehive house, about 4 feet across the west base course and 9 feet in diameter. The walls are 18 feet to 20 feet thick, and the outline irregular, evidently rebuilt, but not so recently as the cashel. The interior is about 5 feet across. It has lines of set blocks, probably its original foundations, 3 feet south of the present face. The interior is sunken, like a shallow well. About 6 feet to the south is the altar, a shapeless heap of uninscribed slabs. On it lie large rounded pebbles from the beach, and a couple of "anchor stones," large blocks, with a groove round them for a rope, doubtless votive from some fishing-boat saved from destruction. The cashel was recently repaired by a neighbouring farmer, who put large white shingle stones on the gate piers. The eastern part of the south wall does not cover the old foundation. (Plate III.)

The well lies about 20 feet from the north-east corner of the cashel, in a marsh. It is a fairly regular structure, roofed with long lintels. It is oblong inside, 3 feet 8 inches long by 1 foot 6 inches wide, and full to the brim. Local tradition says that it harbours a holy fish, a mysterious trout, only to be seen by the most devout visitors. These fish in wells are a venerable custom in Irish history. In the Tripartite Life of St. Patrick the saint "left two salmon in the well, alive, and they will abide there for ever. . . . Angels will abide with them."[1] There were also two salmon in the venerated well at the O'Briens' royal fort of Kincora, Co. Clare, which were cooked and eaten in insult by Aedh O'Conor, King of Connacht, in 1062, when he also filled up the well, and destroyed the fort.[2] In modern days we find two venerated trout in the well of Tober Kieran, near Kells, in Meath;[3] others in the "Pigeon Hole," near Cong, and Tober Tullaghan, in Co. Sligo. These latter have been taken and cooked, and even eaten, without injury, as they always reappear in their well. In Co. Kerry a salmon and an eel are said to occupy Tober Monachan, near Dingle, in Co. Kerry; and, not to multiply further examples of this belief, I will only refer to the holy trout in the well near Louisburgh, in this county (Mayo), which was taken, put on a gridiron,

[1] Tripartite Life (ed. Whitley Stokes), p. 112.
[2] Annals of Tighernach, Annals of Ulster, &c.
[3] Roy. Soc. Ant. Ir., xv consec. (1875) pp. 366, 367.

and partly broiled, till it jumped back to the well, and still showed the mark of the bars, in 1839.[1]

A little south of the well, at the northern end of the bay, on which are the castle and harbour, are traces of an extensive kitchen-midden. It has so far yielded little but shells. It is opposite the laneway, near the ruined house where the low cliffs begin. We found shells of oyster, limpet, and periwinkle; more rarely, teeth and broken bones, with charcoal and blackened stones. It lies about 6 inches under the sward, and is 1 to 2 feet thick, running along the clay bank, where a good section is exposed.

The bay and rocks near it are the scene of another legend which once had a bad effect in giving idlers an excuse for pessimism and apathy in any attempt to improve the island. Once on a time the shore ran out to a great rock in the strand, and on its edge stood a weaver's cottage. One day a man, who had alone escaped from a wreck, landed at the rock. The weaver seized, not his beam, but a heavy stick, and ran out to ask the stranger who he was; the waif, unable to speak Irish, gave no intelligible reply, so the suspicious and angry weaver struck him with all his strength on the forehead, killing him on the spot. Now, the murdered man was brother to the Pope and the Emperor of Rome, and by some unknown means the news reached them. The Pontiff laid a most severe curse, not only on the murderer, but on the whole island for all time.[2]

Toberfelamurry (O. S. 85).—The Well of Mary's Feast lies in a marshy field behind the Abbey, to the north, and is in a state of great neglect. It possibly shared the dedication of the Abbey, which was Carmelite, and then Cistercian, and so naturally dedicated to the Blessed Virgin. Despite its marshy site and the two very wet years on which I visited it, there was no water in it. It is covered by a shapeless heap of slabs; at 15 feet to the east is an equally shapeless and rude altar only a couple of feet high. On the last are three dedicatory slabs. The first has a cross of the Maltese type with expanded arms, and the words "I.H.S. Pray to | God and the B.V.M," with the date 1701. It is most curious to find this in English rather than Latin—or even Irish, though inscriptions in the native tongue are rare. The next is almost illegible, being filled up and coated with rough white lichen. It reads, so far as I can decipher, "Pray to God this day | and to the Bless | ed Virgin Mary | A.D. 47 ○," and, "in 1790 D. M. Philip . . ." A name

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[1] Caesar Otway, "Tour in Connaught," p. 280. I have collected stories of cures in an article on the Clare Holy Wells in Folk-lore, xxii, p. 208 (part 2). Holy fish are not unknown in the Mediterranean countries, *e.g.*, near Tripoli and in Turkey; also in India, Persia, and China.

[2] Told by E. O'Malley to Dr. C. R. Browne. Proc. R. I. Acad., vol. v, ser. iii, p. 66. The interesting folk-lore of Cliara is given there, pp. 63 to 70.

follows resembling "Acciputer," which seems improbable. Neither can I interpret the apparent A.D. 47 ϱ. The third slab is very curious; it has an oblong slit worn rather than cut through the yellow sandstone near the top, then a Latin cross and the letters I.H.S. and B.V. (Plate V.)

The altar stands near a levelled enclosure 15 feet from the well; this measures 40 feet north and south by 36 feet east and west, the walls being 3 feet 6 inches thick, and levelled to the ground. There is a trace of an old ditch at 27 feet distant from the well.

Cliara "Abbey" (O. S., 85). (Plates II–VI.)

The most interesting ancient structure on the island is the little Monastery; despite its simple architecture, it enables us, in a way rarely done by our greater and more ornate monasteries, to realize the appearance of Irish churches before the reign of Henry VIII. Very rarely do we see stucco-work or designs in colour elsewhere; but at Cliara we get abundant material for a general idea of the colouring, and a hint at the way stucco-work was employed to adorn plain stone-work. The illustrations of these designs may, I hope, prove of value to architectural students, as none of them has been published hitherto. They were traced and copied in colours on five days, three of which were spent in tracing them from a platform of barrels and planks—a weary, painful task. I also devoted time to checking them on subsequent visits, and Dr. George Fogerty photographed several, though (for obvious reasons) photography gives a poor and often an imperfect and inaccurate result, through the curve of the roof and the discoloration of the stucco.

The "Abbey" consists of a nave 36 feet 6 inches long, and 18 feet 9 inches wide, a chancel 19 feet long inside, and 13 feet 2 inches wide, over which is a room reached by narrow staircases up the side walls. Beside this, in line with the eastern face, a northern wing of two stories projects with a staircase in its western wall. The north doorways of the church show that another building ran along the north wall of the nave, but I could not trace its foundations. Save in the north wing and part of the nave, I saw little that could be even provisionally assigned to a period before 1450, and much seems nearly half a century later. It must be borne in mind that there was a great outburst of church and castle building and restoration during the very obscure fifteenth century, especially all through the provinces of Munster and Connaught. Hundreds of peel towers, many monasteries and churches date entirely from that period, and the vast majority of the older buildings exhibit insertions of the same date.

The nave calls for but little description. It has a slightly moulded pointed

door in the west end; the south wall has a defaced window near the east end, and a mark of another break or opening of no definite shape now built up at 12 feet 6 inches from the west end, where probably there was once another window, or else the nave must have been very dark. In the north wall is another plain pointed door; its inner face was enriched by mouldings in plaster. I can only recall the plaster mouldings over the beautiful stone-work in the chancel of St. Patrick's Cathedral among Irish examples. High up the wall near it (though now accessible owing to the raising of the soil for several feet) a small stoup with uncouth animals, one on each side and two in front, has been reset by the modern restorers. Another very defaced doorway lies close to the west of the last. The two may have opened from a building outside and to the north of the nave. The top of the walls has a water table, the joints covered by long, narrow stones and projecting flags to throw off the water. There was a thin battlement, now nearly all gone. In the south-east corner is an opening, now closed, and so forming a recess; this led from the lower landing of the south stairs, most probably to a wooden pulpit in the south-east corner of the nave.

The chancel was entered by a large pointed arch of four plain recesses, the stone-work roughly dressed and once smooth plastered, and very probably painted: the sockets for a rood-beam or screen remain in the sides. Just within the chancel is the closed slit of a small ope or "squint" from a curious little cell in the north wall hereafter described. Beside it is the O'Mailles' later monument, a well-cut undated slab and frame of black stone with a greenish sheen like bronze. It is attributed to Grania Uaile, but the general appearance suggests a later date; indeed the foliage (rather than mantling) is very similar to that in dated monuments from 1660 to 1720, and it probably belongs to the latter half of the seventeenth century. The crest is a rearing stallion, with, however, a mule's tail, on a wreath above a helmet and a curious barred ornament. The shield is of strangely irregular design, a wild boar trippant in the middle between three bows bent with arrows pointed at him, while a galley appears at the bottom dexter corner. The mantling ends in large tassels, and below all in large, raised letters is the name, OMAILLE; above this, between the tassels, in smaller raised capitals, are the words of the appropriate motto "TERRA MARIQ' POTENS," the "NS" termination running up the side and not conspicuous. (Plate II.)

To the north, close beside the tablet, is a fine and fairly perfect late perpendicular screen and recess; it possibly fulfilled the double debt of the founder's tomb and the "Easter Sepulchre," and was evidently used for the latter, as the crucifixion appears scribed and with traces of painting at the back of the recess. The interior of the chancel must be now at least 4 feet

above its old level, as the slab of the recess is covered. In other parts the filling is even 5 feet deep, and in the nave usually 3 and 4 feet. The tracery rests on a segmental arch, with bold cuspings, and is enclosed in an ogee frame with side pillars ending in three finials, the innermost being set askew, evidently to show with better effect to persons at the archway of the chancel. A defaced door leads into a vaulted sacristy, also filled for 4 to 5 feet. The east end is recessed, with a small east window which has two trefoil-headed lights, with trefoils in the outer spandrels, under a bold angular frame outside; they had iron frames for the glass held by four little tongues into each jamb, one at the top and one in the sill; some of the iron plugs remain.[1] The opes are 4 feet 2 inches high up the sides, or 4 feet 9 inches in all, and are 8 inches wide. The altar has at each outer corner an attached octagonal shaft, and is covered with slabs neatly moulded at the edge, one with a slot for a pillar or candlestick; the whole is nearly buried. To the south was a small tabernacle with half of a cinquefoil head in the left jamb of a deep window recess, the light of which is single, but in other respects, save its lack of a hood, is closely similar to the lights of the east window. West from it is a rude, plain, pointed recess, or sedile. Its arch was turned over a wicker centre; a small carving of a human face projects near it. Between it and the chancel arch a door leads to the south stairs and was the way (I believe) to the pulpit. The stair is lit by a defaced window at the foot, and runs straight up the wall eastward with nineteen steps; the passage is only 22 inches wide. A number of very old-looking iron nails have been driven into the south wall of the chancel.

The Paintings.—The age of the paintings remaining in Irish abbeys has never been examined on scientific lines, and in a paper intended to give facts and avoid mere conjecture, I shall avoid dogmatism as far as I am able. There were traces of colouring—deep crimson and light blue—when I first saw the chapter house of Mellifont Abbey, county Louth, in 1880, usually in the deep-cut capitals. Dim figures of saints in red and green were once visible at Adare, and traces, I believe, remained so late as 1878. More elaborate paintings in red, yellow, and brown, showing the Trinity, saints, and angels, with foliage and other ornament, were found in the closed recesses in the south aisle of St. Audoen's Church, Dublin.[2] Red leaf-work and other ornament remained on the pillars of St. Canice's Cathedral, Kilkenny. A notable specimen of design, in black outline, was found in Knockmoy Abbey, of which Cliara was

[1] Otway gives a good illustration in his "Tour in Connaught," p. 300, and the R.S.A.I. Handbook, No. VI, p. 38, illustrates the interior.

[2] They have long since perished from soot and the weather, having been left open most inexcusably. I have made coloured drawings of them, and Mr. T. F. Geoghegan has an excellent photograph. An illustration of them was published in the Report of the Board of Public Works.

a cell. This still remains on the north wall of the chancel, and displays the once favourite legend of the three dead and three living kings, and the equally favourite design in later medieval hagiology, the martyrdom of St. Sebastian. There is also a design of the removal of our Lord's body from the cross. All of these were dated in the thirteenth century, and explained as representations of several kings of Connacht and of the execution of Dermot Mac Murrough's son, with other rather wild conclusions, by Petrie and the older antiquaries. There is no evidence that the alleged colours on the designs were anything save weather-stains.[1] In Quin Franciscan Abbey, County Clare, an elaborate design in raised stucco with I.H.S., the Sacred Heart, the Crucifixion, with St. John and the holy women, remains over an earlier tomb It was rudely sketched by Thomas Dineley in 1680, and I have made a measured drawing which I hope may be published soon; but no trace of colour remains in the stucco. None of these designs is in fresco, though the term is constantly applied to them, and I think all, except the last, are earlier than the Reformation.

The design in Clare Island differs from all those previously described. The arch of the vaulted ceiling was first turned over wicker centering. The rough face was covered by a good undercoat, on which was painted an ornamental design in deep, rich crimson, later than the "Easter Sepulchre," as it appears on the edges of the stonework there; the joints were also painted with it, and an illegible inscription appears on the side of the south window recess. The whole was then covered with a later coat of soft, coarse plaster, roughened, and a finer and harder layer spread over it to carry the painting; the bands of the imitation groining and rough sketches of the designs in the sections were graved (the first carefully, the others rudely) with a sharp instrument. Unfortunately the soft under-coat has proved its ruin; it swelled, broke the harder layer, and got overgrown with a dark-green alga, which is destroying all before it. Of the older work I have been able to recover very little definite. On the soffit of the doorway to the south stair are red bands to either side, with a saltier between, and red lines for imposts to either side. There were, as I must note lower down, inscriptions in the recess of the south window of the chancel, and evidently the head of the credence table arch, or shrine, was relieved by red bands on a thin coat of plaster, following the lines of the arch and cusps. The Easter Sepulchre had a broad band round its

[1] Beranger in 1779 examined them with Bigari, a professional fresco-painter, and found that the designs were bare, black outlines with no trace of colour. The green was found not only on the clothes but on the faces of the figures. (Roy. Hist. and Arch. Assoc., now R.S.A.I., vol. i, ser. iv (xi consec.), 1870, p. 241.) The catalogue, R. I. Acad., p. 350, states that they were coloured in green and yellow, but the account was derived from the copy made by MacManus for the first Dublin Exhibition. Some of the figures are illustrated (Irish Penny Journal, i, p. 227, and R.S.A.I. vol. xxxiv, p. 242, and xxxv, p. 419.

arch, and finials and thin lines at each point. At this place the fact of the plaster of the painted ceiling and its corbels overlaying the red painted stucco is very well seen. The Board of Public Works has done everything to preserve the ceiling, but in vain; the damage had too long set up from water soaking through the floor above for anything now to be effective. The colours used are a fine and rich scarlet in the older painting; an orange red, a chocolate brown, a rich golden yellow, and a dark slate blue, the last for the ribs and corbels. There was a fifth colour which alone has faded out; it is, where most evident, a faint grey, and was probably purple or light blue. I will call it "blue" for brevity, making no assertion thereby. The Rev. E. A. Lavelle, curate on the island, informs me that he has been told that even in 1862, when the new chapel was commenced, the paintings were in good preservation. Unfortunately no one sketched them so far as is known. The present attempt has come nearly too late. (Plates IV–VI.)

The east wall was decorated with yellow sprays and bands on a "blue" ground. The shallow arch over the altar recess had two thin bands of yellow on the outer edge, and a broader one next the vault and sides. From the bands spikes or leaves projected inwards, with here and there a trefoil or fleur-de-lys in the central space. Between this and the outer bands were V-like ornaments, like chevrons. Round the arch and sides of the splay were bands with curved ornaments or leaves between, and all the flat surfaces facing westward were relieved by tree-like ornaments, branching out into spirals, curves, and pear-like fruit, perhaps a reminiscence of the flowers, "knops," and branches in Solomon's Temple. Only slight traces of the plaster remain inside the splays; it seems to be scribed all over with angular patterns, impost, and other broad bands, and rows of shield-shaped beading.

The roof is far more complex. We may examine it from the west numbering the spaces between the ribs eastward, first along the north side, and then along the south, as we might examine it in the building. The framework consists of five ribs, one up the west edge, three in the centre of the vault, and one on the east edge. In each of the four bays so made are two ribs crossing at the crown of the vault; they run into long, thin wedges, where they join the main ribs, the last being parallel, or at least of fairly even width. Where the joined groining ribs reach the spring of the vault is a corbel painted on the wall. The corbels along the north have—1, three leaves; 2, a volute; the 3rd is defaced. On the south the middle one ends in an equilateral triangle, the others are defaced. The framework is deeply scribed, very carefully, to the square, into about eleven oblongs to each main rib, painted dark blue grey, and looks like inset tiles.

The designs so framed are very heterogeneous, for so far as one can see

there is no reason for any one group occurring in one place more than another. The north groups D and E have the slight connexion that the monsters are spitting fire at each other, the flames crossing the rib, while F and G in the south may imply that the greyhound is pursuing the animal in the next compartment. As a rule, the drawing is crude but spirited; the horseman and greyhound are full of life. Some of the cattle and goats are clearly in motion, and the stag, worried by the wolf, though motionless, is well drawn. The only other connected group is F north, the herdsman and his cattle and goats. The one unmistakably religious subject on the ceiling is the angel with the scales; but the wolf may symbolize Satan, the stag ("desiring the waterbrooks") the fervent believer, and the cock the need of vigilance, such symbolic designs being widespread. It may be too wild a guess that the conies (the "feeble folk that make their nest in the rock") may typify weak but faithful believers, as they do in late medieval treatises on animals (bestiaries). The two birds in K and L (south) are possibly the symbolic pelican and phoenix.

Along the crown of the arch at the summit of the interspaces were plaques or bosses of encircled crosses. The first has an outer ring of yellow, a thick one of red, and a cross of red segments, all marked on the soft plaster with a compass; a lighter cross has been painted over it as an afterthought. There are yellow patches in each segment of the stronger cross. The second (B) is nearly destroyed; it has two brown circles, with a ring of short red bars and a loop inside; the third (C) has red circles and a strong cross; one arm is leaf-shaped; all the others have perished with the plaster, much of which has fallen away.

As for the figures in the interspaces—North—A, three animals, one a yellow fox or dog, and two rabbits,[1] one red and one yellow; B, a large scribed figure of an angel holding the scales of judgment; the face and nimbus are yellow, the hair, edges of the wings, and bar of the scales, faded red, the rest is only scribed; C, covered with yellow branches and fruit on a "blue" ground; D, a long scribed serpent divided into squares of red and "blue"; from its open jaws spout flames, thin lines of red and yellow across the roof-rib at a second monster[2] in E. This has a wolf's head, lion's body, and eagle's claws, with perhaps a trace of wings; it is red, and over it in the narrow angle is a trace of a red figure. Below all is a very curious design, apparently a Chinese dragon in brown, with a wing and three red tails. It is, however, only when we examine it carefully that its whole interest is apparent. The artist scribed

[1] Rabbits were introduced only very recently into Clare Island.

[2] One recalls the old tale where the men of Connacht see two beasts, each as big as a mound or peak fighting so furiously that fiery swords darted out of their jaws and reached to the sky. (Voyage of Bran, vol. ii, p. 60, from Egerton MS., 1782.)

a wolf[1] at full gallop, with a hound swinging from its throat; afterwards he (or the painter if two were at work) retained the wolf's head, turned its body into a wing, and painted the dog so as to form the body, adding tails and paws as required. F has a cowherd in a close-fitting yellow cap and tunic, with red borders and long wand over his shoulder, and a red staff, ending in a triangle, under his arm. Below is his herd of cows and goats, the latter with waving horns; below them a strange red-beaked head, nearly gone. G has a large red horse, nearly covered by yellow and "blue" trappings and reins. A man stands before it; he has red hose, and a "blue" tunic, with fringe and belt; below is a spirited sketch of a red man on a yellow, rearing horse, prancing westward. The bay has some trace of a yellow animal, and a red man with a conical cap and aquiline nose. The other north bays, K, L, M, N, are destroyed, save parts of the ribs, by green growth.

The south side, A, a large, yellow stag, with red antlers and "mane," with a red wolf hanging from the stag's throat by teeth and claws, its hind legs kicking up. B is defaced; C has a large red cock, cleverly drawn by a few scratches, and floreated yellow and red sprays; D has a man in red and yellow tunic, tight hose, the left yellow, the right and the sleeves red, and red knee-caps. The tunic forms a kilt, and is held in by a waist-sash, ending in streamers and a red bow. He is stooping and holding a long pole. Below is a red, oval figure, with a fan-like projection. In E are faint red animals overhead, and a red man leaning over a yellow object. F has several more animals, then a large red hound at full speed, very well painted. Below is a harper in long yellow robes, holding a characteristic Irish harp, with six red strings and a red frame relieved by a yellow line. G has two yellow dogs, and a very natural prowling red wolf. In H is a yellow tree, with pear-like fruits, and in K a red hound, a yellow animal, and a faint trace of some red figure, which when carefully examined in good western light reveals itself as a bird with a hooked-beak, crest, a curved tail like a cock, and yellow legs.[2] L has a large yellow conventional bird, outlined in red. It has curved neck, serrated wings, and triangular tail, with a curved red object and some red lines below. It is very probably a pelican, a favourite symbol of Christ. Here the designs end, as M and N are bare of plaster, the wet caught by the east gable overhead having run through the vault, and rotted all at that end, especially in the south-east corner.

Hardly a trace remains of any design on the side walls. The older painting, however, shows nearly everywhere if a flake has fallen from the

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[1] The last wolf was killed in Connacht about 1700.

[2] First recognized by Dr. G. Fogerty, R.N.

later plaster; but no pattern is discernible, save at the inscription now illegible at the south window, over the little tabernacle, and, as I noted, in the painting and scribing of the crucifixion in the "Easter Sepulchre."

Overcroft.—Ascending the south stair we reach the room over the chancel, a rather unusual feature in late buildings, though found in the early oratories of Friar's Island and St. Flannan's, Killaloe, St. Kevin's Church at Glendalough, St. Columcille's House at Kells, Meath, and the later ones of St. Doulough's, near Dublin, and St. Mochta's, Ardee. Later ages thought it irreverent to put any residential room above the altar. The heights of this part are as follows:—13 feet to the upper floor, 21 feet 10 inches to the water table, and about 25 feet to the top of the gable above the ground in the church, and 5 feet 6 inches more in each case above the outer level. The upper room is well preserved, and measures 15½ feet wide and 19 feet 9 inches long east and west; the walls are 3 feet thick, crowned with slab gutters, and the windows do not seem to have been glazed, but may have had inserted wooden frames with glass, and certainly had shutters turning in sockets. The eastern one has a wide splay and an ogee-headed light commanding a beautiful distant view of Croaghpatrick. The south wall has the lintelled doorway to the stairs, and a deep window with broken light looking to Inishturk and Caher Island, and the cliff fort of Dunnagappul. In the west wall are an ambry, a window with a small light and large splay looking into the nave, and near the north-western corner a doorway which evidently gave access by a ladder to the gutters of the nave. The north wall has a very small door to the sacristy stairs and an oblong window. There is no fireplace here or elsewhere in the building, showing how little outer fashions reached this remote island.

North Wing.—A passage only 20 inches wide with eight steep steps leads from the overcroft to the vaulted floor of the upper room of the north wing. The room is greatly defaced; the west wall has a recess next the church, and the east a recess and sill of a window.

The stairs in the west wall are all removed, but the ground has been raised so much that the broken summit is easily reached. The vault is so flat and so badly built that the greater part has fallen away, some very recently; despite the new concrete cover, the roots of the vegetation have pierced the arching everywhere. There are two windows to the east, but built up, and, strange to say, not visible outside. The north part is levelled. The downput of a small garderobe appears at the head of the stair; the latter was lighted by an unglazed slit, and had two pointed doors nearly buried. Creeping through these we find the cell at the squint in the north wall of the chancel. It is about 6 feet long and 3 feet wide with a small ope to the north, which with the ope into the church makes it cruciform. It may have been used by

a penitent or an anchorite; it is barely large enough for a man to lie in, and is too small for an *inclusus* such as occupied the little cells at St. Doulough's and elsewhere.

MONUMENTS.—Outside the chancel to the south is a slab with a small shallow basin from which three cuts radiate irregularly. In the west wall of the enclosure beyond the modern Roman Catholic church is a fine pillar-stone 11 feet high and 18 inches by 9 inches thick; the south face is engraved with the outline of a long Latin cross neatly cut. Besides the O'Maille tomb there are no monuments of any great age, though we read of the burials of Donall, Murchad, and Dermot O'Mhaille in the thirteenth century. Whether the famous Grania was really buried here and not (as tradition on the mainland says) at Burrishoole Abbey, we have no decisive evidence. Probability rather favours her burial at the last or Doonagh.[1] "A skull with golden earrings in its ears!" was long shown at Cliara Abbey as hers, and Caesar Otway in his somewhat unreliable "Tour in Connaught" (1839) tells a wonderful story of how, shortly after his visit to the island, "a speculative Scotsman" sailed round the coast clearing every churchyard of its stacks of bones to make into manure; among the rest Grania's skull and its earrings disappeared. Even Otway allows the rest of the tale, how one tooth and earring were found in a boiled turnip in Ayrshire later on, to be "rather apocryphal," and he inclines to believe that the skull, with its earrings (which still continued to be shown), was the former one, if not the genuine relic.[2]

None of the inscribed tombstones date before the last century. In the chancel are those of Bridget (Bratch), wife of Edmond O'Malley, died 1802, aged 48 years; and Thomas O'Malley, 1807, aged 34, put up by his brother Michael. In the graveyard are still later tombs—Thady Malley, died 1826, aged 84, put up by his sons, John, Anthony, and Michael; John O'Malley, died 1828, aged 48; another John, died 1842, aged 51: also, of other families, Walter Barrett, died 1837, aged 19, by Peter Barrett, and Edmond Toole, died 1837, aged 21, by his father, Charles; all the others were later than 1870.

Grania Uaile's Castle (O. S. 85).

The latest of the ancient buildings on Cliara is the peel tower beside the little harbour at the south-east corner of the island.[3] It derives its interest rather from its reputed builder, "the Dark Lady of Doona," Grania Uaile,

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[1] Her only recorded residence is at Carrickogolhy or Rockfleet near Burrishoole, but her father Doharra O'Mhaille is said to have held Cliara in 1588.

[2] *Loc. cit.*, p. 301.

[3] The illustrations in Caesar Otway's "Tour in Connaught" (about 1838), p. 298, and the Journal of the Roy. Soc. Ant. Ir., xxv, pp. 244–5, are very poor, and the natural features too low.

than from its own beauty or interest. It is devoid of architectural features, and is lamentably defaced and modernized. The situation is rather picturesque on a low rocky headland with a fine outlook commanding all the coast across and to either side of Clew Bay. The builders deliberately avoided the higher ground which could have extended their outlook past Caher Island and Inishturk to Bofin. The summit of the tower is not lofty enough to make up for the lowness of the site. Otherwise the situation is good, being fenced to the east by a pretty little cove, a perfect bathing-place, and on the other side by the crescent bay with its fine strand so suitable for beaching ancient ships. The castle rock is getting cut away by the sea to one side, and evidently was not fortified in early times.

The castle is of low square outline irregularly oblong, with bartizans, or rather turret chambers, projecting from the face of the angles to the north-east and the south-west on the level of the second floor. The faces measure outside—to the north, 35 feet; to the south, 33 feet; to the east, 26 feet 6 inches; to the west, 27 feet 6 inches, and have a batter for 9 feet up. The whole has been rough-cast, I presume when it was repaired for the coastguards by Sir S. O'Mailley in the earlier half of the last century. The battlements were then removed, and the chimneys and fireplaces added. The tower is evidently of the late sixteenth century, possibly (as tradition says) made by Grania; the masonry is poor and the mortar soft and sandy; the bartizans alone are vaulted. The defaced east door admits one into a passage 14 feet long and 2 feet 6 inches wide leading to the staircase; another broken door opens into the basement room. The latter has deep window recesses to the north and south; the lights are built up with loose stones; there was a shot-hole to the west commanding the landward approach, but it was closed by one of the fireplaces. The outer passage turns westward, and has ambries; a small one to the south and a large one under the stair; as there are only the traces of three broken stone steps, the lower ones were probably wooden for 6 feet up with perhaps a hiding-place underneath as in some English houses. Above these are a stone flight running westward up the wall, three steps to the next floor, sixteen more to the top one; they do not continue to the battlements. The ceiling of their passage forms inverted steps.

The second story, first floor, is as plain as the basement; it has a deep recess at the north window from which a narrow passage runs westward in the middle of the wall; this was once lit by a small west light, now closed; the north light is similar. It had not apparently got a garderobe, but there is a closed recess where it meets the west wall, and a passage perhaps ran into the part altered by the fireplaces and flues. In the north-east corner is a door to the bartizan; it is made of the only well-cut stonework visible in the

tower. The little room is about 7 feet square with a beehive-like, corbelled roof; it has a slit to the east, and rests on two double corbels to each side. The spaces between are, however, closed by solid slabs, and if it were ever open to protect the angle, it has been closed at least for a long time. The corresponding bartizan to the south-west is closely similar; its slit faces westward. The east window is large and oblong, with flag lintels and a small oblong light; beside it to the west is a high-arched recess probably for a cupboard or even a bedhead. The stair leads up through this window. The east window has a large arched recess which was flagged above the entrance, and possibly had opes to command the latter, but the flags are now broken. In the west wall is a similar recessed oblong light; a passage runs to the south-west bartizan; it is a couple of feet higher than the floor. Possibly a corresponding passage ran northward to the recess described above. The late flues cut into the west window recess, and run up the walls; the lintels are of wood, and the whole with the chimneys evidently quite modern.

The top room, besides a modern fireplace to the east, and a slight recess to the west, is remarkable only for its side passages roofed with slabs. The northern ran into the east corner; most of its roof has been destroyed; it has a north window and an eastern recess or ambry. On the same level is a square north window in a deep recess. The south passage also runs to the east, having a light in that end and one to the south. As I noted, the staircase runs into the recess of the more western north window. The bartizans are now weather-slated, with two lozenges neatly executed on each face. The slating adds to the unpicturesque appearance of the peel tower, save from the strand, where with the pier, boats, and the distant Croaghpatrick it makes a pretty picture. A wall, now levelled, ran from the south-west angle of the tower southward to the creek. The headland extends only for 155 feet to the east. Over the ridge to the south, we find a picturesque cove and some lofty caves or natural arches. (Plate III.)

Legend and History of Grania Uaile.

The legend of Grania Uaile is so instructive a side-light on the truth and error preserved by tradition after three centuries, that I think there is justification for studying it here. An old man named Henelly, of Ballintubber, wrote down the legend for the Ordnance Survey, 1838. Grania Uaile was called "nagcearbhach" because she kept a troop of professional gamblers and dicers among her attendants. She married John Burke of Glen Ilan (Gleann fhaolain) in Islandady Parish, and by him had a son, Tibbot na long. She was a pirate and plunderer, and the day of Tibbot's birth, her galley on board of which he was born was attacked by a Turkish privateer. The crew

lost heart, and sent to her for help. She cursed them, tied a blanket about her, and came up jumping and dancing with a "blunder-bush" in each hand. The Turks crowded to look at her, and when the officers were in a group, she fired, shot them all, captured their ship, and hanged all the crew at Carrick a howly. She was very proud of her warriors, and preferred a ship full of them to one full of gold. She besieged O'Loughlin of Burren, Co. Clare, but a cannon shot tore up the ground at her feet, and the clan mustered and put her to flight. She reduced much of Connacht by the aid of the Burkes, who elected her son to be Mac William Iochtair; and after all her raids, she died a natural death. Her favourite imprecation is said to have been "May you be twelve times worse this day twelve months," which the legend says she used to her own crew during the fight with the corsair and to O'Loughlin's gunner, adding to the latter, "It 's well you haven't knocked me down." A long legend is told of her attempts to seize tribute from the Mac Awleys or Stauntons, from whom she captured Kinturk, but she was repelled from Luppertaun Castle.[1]

In 1839, the following legendary history of Grania Uaile was told to Caesar Otway. She was the daughter of Breamhaun Crone O'Maille,[2] chief of the district round Clew Bay, "the Uisles of O'Mealy"; he died leaving a daughter Grania and an infant son. Grania soon persuaded the clan to accept her rule, which she strengthened by a marriage with O'Flaherty. She built Hen's Castle, or "Cashlaun na Kirka"; thither she carried off the son of the Earl of Howth, to revenge the latter's want of hospitality, and she encouraged her husband, "The Cock," in his constant wars with the Joyces, till she got the nickname of "The Hen," whence her castle got its name.[3] At last the Joyces made a causeway and took the "Hen's Castle."[4] Some say they killed its inmates, but all agree that Grania escaped, and on her first husband's death married Mac William Eighter (Sir Richard an Iarainn Burke). They married "for a year certain," then either could divorce the other.[5] Grania waited till she had got her supporters into all her husband's castles; then she went to Carrigahowly near Newport, and waited his arrival. Mac William came up to the castle, and Grania looked

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[1] See Ordnance Survey Letters, Co. Mayo, vol. i, pp. 1–9, and vol. ii, pp. 249–264. The last (the original letter) gives a long legend of the death of her son Tibbot, but it is irrelevant to Cliara.

[2] Really "Doodara," the O'Mailly of Murrisk.

[3] Of course there is a divergent legend to account for the name.

[4] Otway's "Tour in Connaught" (1839), pp. 229–245.

[5] Grania herself states (Cal. State Papers Ireland, 1593, No. 62) "husbands now and then divorce their wives on precontracts, and even put their wives away without any lawful proceedings, and bring in others"; but the State Papers seem to show that her relations with Richard an Iarainn Bourke were more lasting than legend implies.

out with the words, "I dismiss you": so her second marriage ended.[1] She sided with Bingham[2] and the English against her husband's forces, and in gratitude for her efficient help Queen Elizabeth asked her to the English Court, where Grania met her as a sister queen.[3] She refused to be created a countess, but accepted an earldom for her little son "Toby of the Ship[4]"; some say it was on her return from England that she visited Howth, and carried off young St. Laurence.[5] Her favourite castle was that of Cliara[6]; there she kept her fleetest galleys; their cables passed through the window and were tied to her bed-post. She ruled manfully to the day of her death, and was laid in the holy ground of Cliara Abbey, the most able chief of her clan. She, the closest ally of the English,[7] even against the native chiefs, got idealized into a patriotic Amazon, and the song of "Grania Uaile" is still preserved and is based on this delusion. I have given the Cliara legend of her earlier marriage at Toberfelabreed.

In history[8] she appears as "Grainne ni Mhaille," or "Grainne na gcearbach," of the gamblers. By the latter title she is described in a panegyric on Shane O'Doherty about 1598.[9] She was a daughter of Doodarra O'Malley, some time chieftain of Upper Owle O'Malley (Murrisk); her mother was Margaret ny Malley, a daughter of Conogher O'Malley, of the same county and family.[10] Grania was wife first of Donnell O'Flaherty, chief of Ballinahinch, and secondly of Ricard an Iarainn Bourke, chief of Carra and Burrishoole. The latter succeeded Sir John Bourke as MacWilliam Eighter, and died in 1583. She first appears in history as driving away the fleet sent to besiege Carrigahowly in 1574; two years later she visited Sir Henry Sidney, who calls her "a most famous feminine sea captain called Granny

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[1] A similar legend is told of Maureen Rhue O'Brien of Lemeneagh, Co. Clare, 1640.

[2] Not Bingham but Sidney (Carew MSS. 1583, No. 501), and later on Malbie, this time against her husband.

[3] The visit was later, and as a humble petitioner.

[4] Theobald, ancestor of the Earls of Mayo; he married Meadhbh, sister of O'Conor, Sligo, and was only created Earl in 1628, thirty-five years after his mother's visit to London.

[5] Duald Mac Firbis in his "Great Book of Genealogies" says that Richard O'Cuairsci (MacWilliam Eighter, 1469–1479) "took the Lord of Beann Edair, and brought him to Tirawley."

[6] This is not borne out by the State Papers, in which Rockfleet or Carrigahowly was her residence.

[7] Sir R. Bingham, however, calls her "Grany Maly, a notable traitress and nurse to all rebellions in Connaught for forty years," Cal. State Papers Ireland, 1593, No. 18.

[8] See Mr. Hubert T. Knox in Journal Galway Archaeol. and Hist. Soc., vol. iv, p. 65. He has brought together much material. Much has been published in the Calendars of Carew MSS. and Irish State Papers. As Mr. Knox says: "The English records alone show what she was; she is mentioned by no Irish annalist."

[9] "Graine na gcearbhach he plundered." O'Doherty plundered Umhall in 1598. He was father of Sir Caher O'Doherty. O'Donovan knew of no other contemporary record of Grania Uaile (O. S. Letters, vol ii, p. 249). Hardiman's Elizabethan Map No. 1 records "O Male Grani."

[10] Her replies to the queries on her petition, Cal. State Papers Ireland, July, 1593, No. 62.

Imally." She offered him the service of three galleys and 200 men. Her husband was with her, but was evidently kept in the background.[1] In 1577 she had the ill-fortune to be captured by Gerald, Earl of Desmond, who finally handed her over to Drury, the Lord Justice. "Granie ny Maille, a woman of the province of Connaught, governing a country of the O'Flahertys, famous for her stoutness of courage and person, and for sundry exploits done by her by sea." She was imprisoned for a year and a half in the earl's castle and at Limerick, and Drury brought her to Dublin.[2] In 1580 "Richard Inerian" rebelled, and "Grany" helped Malbie to harass him, but three years later the pair were reconciled, and "Grayne ny Vale" was far less anglophile. Her husband died that year, and she lived at Carrigahowley Castle. The English suspected her of aiding the Bourkes in 1586. She was not very regardful of her old allies, and got into further trouble by taking three boats at Aran at the instigation of the O'Flahertys. However, it appeared that she did not know that peace had been made. It was in 1593 that she went to England to secure the property and rights of her O'Flaherty son and grandson, and her two sons by Sir Richard an Iarain. Owen, her son by Donall Ichoggy O'Flaherty, chief of Ballinahinch, had been killed on "a false alarm" of a rescue while in the custody of Captain O'Mullay[3]; but Murrogh, her son, and his son Donnell were alive. Her petition abounds in details of her long and chequered career. She naturally emphasizes her services to the English on all occasions. The other casual mention of her name is of little interest, nor is the actual date of her death recorded; but it can be seen that legend preserved much fact, and hardly exaggerated the character and exploits of that masterful woman—like all her race, "terra marique potens."

Folk-lore.

There is no subject connected with Irish archaeology on which it is so hard for a stranger to get information as folk-lore. Even when one has lived long among the people, and when they have got to trust one, much is held back for fear of misunderstanding. Accordingly I can add little, if anything, to what has already been done in this field.[4]

In the important group of lucky and unlucky acts may be classed belief in the evil eye and "overlooking," meeting a strange woman with red hair when starting for work or on a journey, or accepting bait when out fishing without

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[1] Calendar of Carew MSS., 1583, No. 501.
[2] Ibid., No. 109.
[3] Calendar of Carew Papers and State Papers (Ireland).
[4] Proc. R.I.A., vol. v, ser. iii, p. 63.

'paying" for it with a stone from the ballast or some other object of little or no value; giving fire out of a house on May Day, and taking a holy stone from Caher Island.

For luck, bonfires are lighted on St. John's Eve, and people make the sunward turn round them seven times in the name of the Trinity; cinders from the fire are thrown into the potato field to ensure a good crop; a small offering of a pin, button, rag, fish-hook, or even pebble should be offered on visiting Caher Island, and the fishermen used to take off their hats and reverence St. Patrick on passing it. Of the "good people" or "gentry," *i.e.*, fairies, firm belief subsists. Dr. Browne met a man who had seen over 100 fairies dressed in white, running on a mountain-side in the spring of 1896; other people had rescued a child from them. Fairies are mischievous beings—the least wicked of the fallen angels—allowed to haunt the earth till the Day of Doom. They steal new-born children and injure (or even mutilate) cattle;[1] women, children, and cows are protected from them by tying on a red cord. They produce the Will-o'-the-Wisp, the mirage, fairy islands, and phantom ships in which they sail over the islands.[2] Seals, too, are thought to be enchanted people, and to have stolen a girl from Bofin. If, however, one is shot, the following days are sure to be stormy. These animals do not like to meet a priest, and plunge into the sea if they see a man in a black coat. Ghosts are feared, but little is known about them; the puca infests a lake on Cliara, and gives its name to Foheraphuca near Dugort, in Achill, and the banshee is not unknown in Inishbofin. Blacksmiths are believed to have dangerous powers of cursing, especially by turning the anvil. Another evil rite is fasting for several days and boring a hole in a coin in the name of the devil, uttering an evil wish against a person. This is believed to be of deadly efficacy and is much reprobated.[3] Of cures (beside those wrought at Toberfelabreed, Caher Island, and Clochan Leo, on Inishark), head-measuring closes the skull and so cures headache. Herbal cures are in repute (usually nine herbs are boiled in milk), while the curative power of butter for erysipelas is well established in popular pharmacy. Sick cattle are cured by

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[1] See Otway, "Erris and Tyrawley," pp. 33, 72–77.

[2] See ibid., pp. 94, 95, for electrical phenomena and luminous insects on the west coast of this country. Mr. Henri saw a ball of fire on his flagstaff like the St. Elmo's fire.

[3] The horrible superstition of the "spancel," an unbroken ring of skin cut off from round a dead body, seems to have been confined to the Cross and Termon Carra district before 1840 (see Otway, "Erris," p. 90): "We have strooke hands to league with Death and made covenant with Hell." So also the "Cashlaun flaineen," which I have had the good fortune to photograph on Galway Bay, where it is still used as a fishing charm, was believed to wreck vessels in North Mayo in 1839 ("Erris," p. 389). The "Caslaan Pleminhin" was a miniature castle of nine stones with its door in the direction from which the wind was desired; in Co. Galway it is a miniature dry-stone fort of about 20 stones. See my photograph, Proc. R. I. Acad., vol. vi, ser. iii, plate xxiii.

boring their ears and passing a goatskin thong through one. There are also traditional child-birth charms in high repute. A child with the whooping-cough was passed three times under a she-ass and a drop of ass's milk sprinkled on it in the name of the Trinity.

Opposite these islands beliefs are abundant, including belief that stumbling over a grave foretells death in a year (certainly not verified in the case of antiquaries). The flint arrow-head is a fairy dart, but it also cures cattle struck by it if passed three times over and under the animal with proper incantations. There are fairies of the air, sea, and earth. One man danced to "the music of their sweet pipings," and died within a year.[1] The hearth should be swept clean, and new fire put down for their use at night. Ghosts of persons, dogs,[2] and a white cow have their place in local belief. The ghostly cow commemorated in the name of Inishbofin was turned into a rock by a witch; and water-horses inhabit the lakes, and try to tempt the unwary to ride, and then drown them like Sioda M'Namara's water-horse in County Clare.[3] The devil is feared as an agent of mischief as well as of sin; he even appeared to a woman in chapel and told her he did it because people were so careless there. Cases of demoniacal possession are remembered traditionally; protective straw crosses are placed in the roof of a house on All Hallows' Eve; a very solemn oath with one hand on a skull[4] used formerly to be taken in the Ballycroy district.

A much-dreaded rite, at least in 1839, near Louisburgh, was turning "the stone of Duan McShaun."[5] One of the magically endowed craft of the blacksmith was said to have been overmatched in cursing by a man (whom he had prosecuted for stealing cabbages) who turned the stone against him so that he died.[6] Another man turned it against the parish clerk and the window of Louisburgh church was blown in; and lastly, the great wind of January 6th, 1838, was supposed to have been caused by a malignant old woman turning the Leac.[7]

It is very unlucky to dig a grave on a Monday, to take a tobacco pipe off a grave, to build an addition to the west side of a house, or any addition if the house is built at a haunt of fairies. It is, of course, most unlucky to meddle

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[1] Proc. R. I. A., vol. iv, ser. iii, p. 104.

[2] I have heard of ghost dogs near Belmullet, Bangor, and Portacloy; for similar beliefs see "Folk-lore," xxi, p. 482. For cow ghosts, see Otway, "Erris," p. 34.

[3] "Folk-lore," xxi, p. 486.

[4] Proc., vol. iv, ser. iii, p. 105; Otway's "Tour in Connaught," p. 237 n.

[5] "Tour in Connaught," p. 295.

[6] For a malignant turning of stones at Kilmoon, Co. Clare, see "Folk-lore," vol. xxi, p. 49.

[7] "Tour in Connaught," p. 296. A similar belief prevailed in Inismurray; Hill, a man who turned the flag, was drowned; and the counter-belief sprang up that whoever got his wish from the stone never got an answer to a prayer to Heaven.

with an earthen fort; but I did not find that the promontory forts on Achillbeg or Cliara were so regarded. It is also thought unlucky to move into a new house; but if it becomes necessary, some of the danger may be forestalled by moving on Monday eastward and on Tuesday westward. The fairy legends of Inishturk are reserved for the section on that Island.

In the southern islands—Bofin and Shark—people avoid mentioning a priest or a fox[1] while fishing. This belief as to the fox prevails all down the coast despite the fact that the creature's saintly namesake, Sinnach mac Dara, is a deeply reverenced patron on Galway Bay. It is most unlucky to praise a child without adding the prophylactic, "God bless it," for should illness ensue, even some time after the praise, the people would certainly attribute it to the evil eye.[2] Another preventive is by signing the cross in the name of the Trinity. One old woman, in 1893, living on Bofin, was reputed to have this terrible gift of the evil eye, injuring by it both her neighbours and their domestic animals; and Lady Wilde records a case on Inishark.

One peculiar belief is that if one buys a cow at the New Year without putting some of her milk in one's boots, she is sure to "run dry."

The people on Bofin believe firmly in fairies; nay, one man has seen crowds of female elves clad in brown, while others have seen a number of little men in green, with two leaders in black. It is usual to spit on children to charm them from fairies. The "Fir dearg" and the Banshee, but apparently not the Leprechaun and the Puca, are believed in as common phenomena in these islands. Lastly, if a fairy changeling is left at a house, the only efficient way to get rid of it and to recover the real child is to set a pot to boil and to threaten to put the unwelcome substitute into it, when it will vanish, and the lost child be restored to the family.[3]

3. INISHTURK. (Plates VII–VIII.)

Inishturk has been allotted to the parish of Kilgeever,[4] and the barony of Murrisk, in Co. Mayo, opposite to which it lies, about 7 miles from the nearest shore. The name obviously means Boar Island; but it seems improbable that so formidable an animal was found in an island so far divided from the rest of the world, unless he emulated the swimming powers of the Welsh boar,

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[1] Knitting mittens for foxes and uttering praises to conciliate them were in use in more northern Mayo in 1839—Otway, "Erris," p. 145.

[2] Otway describes a case of reputed evil eye near Rossport ("Erris," p. 320).

[3] Dr. Browne, Proc. R. I. A., series iii, vols. iii, iv, v; Professor A. C. Haddon in "Folk-lore," vol. iv, p. 49; Lady Wilde, "Ancient Cures, Charms, and Usages of Ireland," 1890; "Ancient Legends, Mystic Charms, &c.," 1887; and Otway's "Tour in Connaught," 1839.

[4] Called in Lewis's Topographical Dictionary, Gilgavower and Kilgavower.

Twrc Trwyth, or shared the insular tastes of the Matail boar of Illanmattle, on the Clare coast.[1] Perhaps, after all, as Twrc Trwyth has been explained to be a sea-rover, and the pirates' harbour and fort are to be seen on Inishturk, the "Boar" may have been a warrior or robber. Several instances occur of such nicknames as "The Cock," "The Hound," "The Wolf," and "The Red Dog" in Irish records.[2] It is even probable that the original Mahon (Mathgamhan, bear) and Faelchu (wolf) got their names from their personal ferocity. So this may explain the name of the island without invoking the presence of an actual boar in so improbable a spot.

This beautiful island has been rarely visited, and never described archaeologically. It rises boldly from the sea, in wall-like cliffs to the north-west, and steep hills to the north, culminating in the dome of a crag on which stands the old signal tower, 629 feet above the waves at its base. The townlands of Mountain Common and Garranty seem devoid of forts or hut-sites. The old settlers seem to have congregated at the south-west corner, round the beautiful little harbour of Portadoon. Here rich soil in sheltered valleys, little streams and lakes, and the land-locked basin, with its beach and narrow entrance, all formed an ideal settlement for a primitive tribe—the cliffs white with sea-gulls, and the rocks abounding in seals and shellfish, while the harvest of the deep lay outside, sheltered by the island from the northern and north-western winds. The secure little creek of Coolport has now superseded the other harbour, as being free from a dangerous swell, and having a wider entrance.

Like Cliara, Turk is rich in "Ooghs," long narrow creeks with precipitous sides, ending in caves. Two in Garranty have great pits at the end. The more eastern, Ooghnalee, is a rock-garden of ferns and other plants, with a shelf (covered with bracken over 7 feet high) facing a tall triangular cleft. The others are Ooghdoul, Ooghnaman, Ooghfinnoge (from the royston crow), Ooghcat, Ooghmore, Ooghnascaddaun (herrings), Ooghduff, and Ooghnamucka near Dromore Head. North from it lie the Boughil rocks,[3] under a mighty cliff, overhanging the sea, and within are three long parallel valleys, lying east and west, in Ballyheer and Drumnashargan; the southern, ending in great storm-beaches, where huge blocks and slabs are heaped up, like cairns, walls, and dolmens, by the incredible might of the waves and gales of that fierce coast, bears the name of Turlinmore.

The place, so far as I have searched, is devoid of early history, first

[1] Mabinogion, and "Adventures of the three sons of Thorailbh mac Stairn."

[2] For MacTire (wolf), as a personal name, see Annals of Ulster, 1099. Faelchu and Faelad were common, especially in Ossory, and the head of the son of "The Cock" was publicly exposed at Singland, 1084–9.

[3] For the legend of the other Boughil (boy) rock, see under Inishark.

appearing about 1574 as Inysturke. Only one fort had been noted as existing. The Ordnance Survey Letters[1] only say that "there is a *kill* dedicated to St. Columba, and some small traces of a *dún*." The island belonged to the O'Tooles, who were said to be a Leinster tribe, but were also alleged to be derived from a certain Tuathal Ua Mhaille.[2] Dr. Charles R. Browne mentions a defaced *dún* in Ballycraggy, on a bold knoll over the land-locked little harbour. Of the *dún*, tradition says that it was built by pirates, who harboured their galleys in the creek below, screened by rocks from the observation of those sailing past. This "pirate crew" were the last Danes in Ireland who knew how to make the *bior lochlannach*, a priceless drink made from the heather-bloom. The fort was surprised and taken by the Irish, who slaughtered the inmates except one old Dane and his son, offering to spare the captives if they told the secret of the *bior*, or, as others said, the hiding-place of their vast treasures, the plunder of many districts during long years. The old pirate, fearing that the boy might be tortured or tempted into betrayal, offered to tell if his son were put to death, so that none of his kin might see his treachery. This done, the father tore himself from his guards, and ran, shouting insults, to the deep chasm, springing over the cliffs, and carrying his secret to Odin. A closely similar story is told in Kerry in connexion with the old mearings, said to mark the heather-fields. In Clare the stone fort of Caherscrebeen, near Leamaneagh Castle, is also reputed to contain, along with cellars full of gold, silver, and deer's fat, a vault full of the *bior lochlannach*.

Of the Chapel of St. Columba I found no trace in the overgrown graveyard, save some heaps of stones, reputed to be its remnants. I find no record of the sojourn of the "Apostle of the Hebrides" in Turk. He may have been only chosen patron, and it must be remembered that even the Norse venerated "Kolumkille," and the Icelanders dedicated a church to his name.[3] In the graveyard are some interesting modern cists, like those in Caher Island and in Corcaguiny, made of thin flags, in which the coffin is placed partly above the level of the ground, and all is then covered with stones—latest survival of the cist and cairn burial in Europe. Two square heaps of blocks, like the prayer-stations in various parts of Ireland, remain in the long valley south of the church, next the sea.

Dun Ballycragga.[4]—This fort lies so exactly on the bounds of Ballycragga and Ballyheer that it is hard to state to which it really belongs. Dr. Browne says the first, and as this gives a mark of distinction from the Dun of

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[1] Co. Mayo, vol. i., p. 476. [2] Some of the Ballyheer O'Tooles emphatically deny this.
[3] Landnamabok, i. 15. See "Folk-lore," iv, p. 229. [4] See Plates VII–VIII.

Ballyheer, I adopt his decision. The *dún* is a very striking structure, on the end of the chief ridge, between the parallel valleys so characteristic of Turk and Caher Islands. The builders knit their walls into every projecting rock at the head of the steep slopes, 100 feet up, and fenced the weak spot where the ridge continued eastward, at its most narrow point, by a strong curve of wall, with blocks 4 feet to 5 feet long. The ends are now nearly levelled. The rampart is usually from 4 feet to 6 feet high, and 6 feet to 8 feet thick along the flanks. It was probably once 10 feet to 12 feet high. The part to the north is a fine piece of work, well preserved, and rarely under 5 feet high outside. It is of large blocks with their smaller ends out, like "header" masonry, and is in a single section, with two faces and large filling. It has two opes in the face of the wall resembling gateways, but I think only gaps under the larger slabs. The south wall is more dilapidated. It forms a revetment, and is, in parts, 6 feet to 8 feet high. Near the gateway it was of two, if not of three, sections. Two remain. The bonding with the crag is worthy of the builders of Langough and Ballydonohan[1] forts. The sections near the gateway are 4 feet 6 inches and 3 feet thick. There may have been another section, 3 feet thick, on the edge of the crag. The outer faces were, as usual, of the larger stones, and the sections sit on low ledges of various heights. The gateway was in the middle of the south wall. It is 3 feet 8 inches outside and 3 feet 10 inches inside. The passage was 12 feet long to the outer section of the wall. It is levelled to the foundations, but seems to have had side walls projecting inwards. The passage runs down a crag, with natural steps as at Dun Aengusa in Aran. The first step is 10 feet long and 3 feet high; the next 7 feet 3 inches and 3 feet. Thence narrow ledges, bare footholds, descend 5 feet or 6 feet to a narrow path down the south-west flank. This descent is broken, steep, and overgrown. The garth enclosed by this wall is 171 feet east and west, varying, of course, greatly, as it is a long oval in plan, like Dundomnall near Belmullet. It is 14 feet 6 inches wide near the west bend, 46 feet to 47 feet towards the middle and at the rock outcrop, and 38 feet 6 inches at 30 feet from the east. The wall is nearly all removed at the west end. A heap of stones and earth, perhaps a collapsed hut, lies at the east end; and a heap and hollow may represent another house-site, at 60 feet from the west.

So very well-built and simple a fort on so commanding a position is probably of early date. The type of wall is found in Ireland connected with Bronze Age finds, perhaps of the fifth to the seventh century before our era, and was abundant in Gaul several centuries before its reduction by Julius Caesar

[1] Proc. R. I. Acad., xxvii (c), Plate xv. and p. 395.

The legend, however, is very probably right, for Norse, Danes, and other sea-rovers probably occupied so convenient a harbour and stronghold, "high on the beach their galleys drew," and lodged their plunder in the *Dún.*

Mr. Tim Toole "Austin"[1] (to whom I am indebted for much information, kind attention, and hospitality when he went with me over the south-western quarter of the island) tells me a curious family tradition. His grand-uncle, about a century ago, found a deposit of treasure, a vessel with lumps of gold, no ornaments being remembered, at the foot of the knoll, south from the gateway of the fort. He sold the rough gold for £40, but was told it was "worth thousands." It greatly supports this family statement that similar plain ingots of gold were certainly found among the heap of ornaments of the "great Clare gold find" near Moghane Fort, Co. Clare, 1854.[2] (Plates VII, VIII.)

Dun Ballyheer.—It is very unfortunate that the next two forts have been nearly swept away. The dangerous precipitous chasm of "Ooghmore" yawned, a danger to men and a constant death-trap for sheep and cattle, close beside them. The community determined to build a wall round its edge, and used the convenient store of material in the neighbouring *dúns.* The same has been done elsewhere for less urgent reasons, in mere wantonness and idleness, and the result is always regrettable.

The Dun of Ballyheer occupied a low, craggy knoll with a flat top. The wall closely conformed to the edge, and is still traceable. Fortunately the base blocks of its gateway were too large for convenient removal. The plan shows the irregular outline of a garth 117 feet east and west, 40 feet to 60 feet wide north and south. No sites are apparent, but a hollow runs along the eastern reach of the north side. The gateway was of large blocks; it faced the east, and a single stone, 7 feet 6 inches long, passed through the entire depth of the wall to form the base of the south pier, being at present 3 feet 3 inches high over the debris and 16 inches to 18 inches thick. The northern side had two blocks 3 feet 8 inches by 29 inches by 12 inches and 2 feet 7 inches by 29 inches by 15 inches, leaving a passage 3 feet 4 inches wide. Most of the wall was 6 feet thick, with base blocks 2 feet to 2 feet 6 inches long, but very little trace remains even of the foundation. (Plate VII.)

Dun Ooghmore.—In the angle formed by the main cliff and the great chasm at the east of Ooghmore was a small, strong fort. It had a dry-stone wall, nearly straight, about 78 feet long, built against a crag 6 feet to 9 feet high, and along a ledge. The enclosure is 36 feet deep, and triangular. Part

[1] The addition of a parent's name is usual in the western counties where the personal name is common.

[2] Proc. R.I.A., vol. xxvii, p. 219. Dr. Browne heard of a more recent treasure find in the Dun on Inishturk.

of the old wall was retained in the fence; it is of fine large blocks, 3 feet high and long; it varies in thickness from 6 feet to 9 feet, according to the contour of the rock. Slabs were set on edge inside the wall.

House-Sites.—It is very hard to examine a district consisting of so many hollows, ridges, and valleys; but, helped by Mr. Toole, and with the aid of Dr. George Fogerty and Mr. Praeger, I may hope, after two days' hard work and examination of the slopes with a glass from every salient point, that little of importance has been passed by.

(*a*) At Drumnasharganbeg, on the west bank of the little stream falling into Ooghnascaddaun, Mr. Praeger called my attention to a nearly levelled house. It abuts against a rock on the west side and is 25 feet across either way. There are at least four cells lined with large set stones, with walls 3 feet to 6 feet thick. The south-western room is oblong, the south-eastern buried in debris; the northern and eastern cells are circular, about 7 feet across inside. (Plate VIII.)

(*b*) In Ballyheer, about 100 feet from the north shore of Loughnamucka, in the long valley from Lough Allen to Ooghnamucka Bay, and at the foot of the ridge ending in Dromore Head, is a house-ring. It is about 40 feet over all, a couple of feet high, and heaped with stones, a well-preserved wall of earth, and large blocks 6 feet thick. In this valley the outcrops of a large and remarkable quartz vein give life-like representations of large white animals sitting up.

(*c*) Almost due south from the northern Allnerehoo cliff, opposite the bay between it and Dromore Head, is a five-celled house. Heaped with debris and partly rebuilt as a fold, the foundations are still preserved, and the northern cells remain up to the spring of the corbelled roofs. It is about 30 feet long north and south by 17 feet wide, and has five polygonal cells, the central being 8 feet by 12 feet inside. The two northern cells are so small (4 feet by 3 feet and 4 feet by 6 feet) that they were possibly store-rooms. The larger of them and the two others (6 feet and 7 feet long by 5 feet wide) were perhaps sleeping-rooms. It is remarkable to find this house unsheltered to the west, with a long ridge to concentrate the wind upon it; but similar choice of sites is found in Clare Island and Bofin. (Plate VIII.)

(*d*) It is hard to define the position of the next by the existing maps. Behind the most northern of the houses to the north-west of Portadoon rises a bold knoll, a reputed *sidh* or fairy fort, but with no trace of walls or earthworks to mark it as a *dún*, though a most suitable position for such. On its northern flank is a lower platform over marshy fields, once probably a lake. A path across which some large slabs are set leads between the knolls to the northern summit. There a curved row of large blocks, chiefly of snowy quartz, which with a

round flat platform 20 feet to 21 feet across, marks yet another house-site on that unsheltered summit.

SIDH.—Besides the last-named haunted knoll, the chief fortress of the fairy-folk lies in the commons to the north of the last. It is a remarkable site; there were evidently once two lakes above it, each banked up by a cross-ridge. The streams gradually cut deep channels through each ridge, and the lakes became marshy fields, the little stream still following its old course. In the southern gate-like gap the eastern rock rises straight like a wall, with a door-like recess, apparently closed by a slab of smooth grey stone; this is the portal of the Fairies' Palace. I am told that a shaft runs deep into the rock overhead, and is their chimney.

"Fantastic spirits are called by the Irish 'men of the *sidh*' because they are seen, as it were, to come out of pleasant hills to infest men, hence the vulgar belief that they reside in certain subterraneous habitations within these hills; and these habitations, and sometimes the hills themselves, are called by the Irish *sidhe* or *siodha*."[1] Tirechan's very early annotations give "viros *sidhe* aut deorum terrenorum aut fantassiam estimaverunt."[2] O'Conor translates Ath na sidhe in the "Annals of Inisfallen," "Vadum lemurum." The early Icelanders also "believed that they" (their spirits) "passed into the knolls at death."[3] The *sidh* is called "Campul na mucka," evidently akin to the Oogh and Lough na mucka to the south-west. I did not hear of any supernatural pig to account for these names; is there any connexion between them and the constituent of the island's name *turc*?

I was told that a young man, in bravado, threw sods of turf down the "chimney" in contempt of the inmates. By degrees he felt uncomfortable in his leg; then a dull pain and swelling; then he took to bed in constant agony. A poor "wise woman" received charity at his house, and, learning what had happened, undertook to cure the patient. She went out, gathered certain herbs, and made a hot poultice for his leg. Before long the swelling opened and she got out a long object like a *traneen*, or blade of grass; she then bound up the limb and it healed; the youth eventually recovered. It is evident that, whatever the cause, it was a mere case of necrosis of the bone. I recall similar treatment near Patrick's Well, Co. Limerick, about 1885, by an old servant, Michael Hazelton, an astrologer and herb doctor; but the patient after the bone was drawn out, had to go to hospital to get the wound to heal.

Some thirty years since this rock was still greatly feared. Another young

[1] See "Colgan, Acta SS.," March 17th, and Roderic O'Flaherty, "Ogygia"; also Dr. Joyce's "Irish Names of Places," ser. i, chapter v, and Lady Wilde's "Ancient Cures" and "Ancient Legends."

[2] Tirechan's annotations (Tripartite Life of St. Patrick, Rolls Series, vol. ii., p. 315) from the Book of Armagh.

[3] Landnamabok, 2–16.

man sent his coat thither, undertaking to fetch it by night; but "whatever he saw," he was so frightened that he ran for shelter to the nearest house. His friends, very anxious, went in a body to rescue him, and, only finding the coat, were in great distress about him till he returned by daylight, far less ready to boast or defy "the gentry" than before.

I found no early remains in the other half of the island, save a large heap of stones, which may be a cairn, and two pillars. The last lie to the east of Coolport Harbour, in Garranty, near the house of Mr. Faherty, to whose kindness I was also indebted during my visit. One is prostrate, 9 feet 8 inches long, with three faces 9 inches wide, and a fourth of 6 inches. The other, a slab of gray slate, is still standing, and is 6 feet 2 inches high, 4 feet wide, and 6 inches to 8 inches thick. I heard no name, legend, or statement as to their age and character, so merely record them.

4. CAHER ISLAND. (Plates VII, VIII.)

This striking little island, of slightly more than 128 acres in extent, with its bold north-western headland, is a very familiar object from Clare Island to Bofin, and from all the "opposing shores." Though barely so much as 200 feet high, it rises so boldly over the waves, and so far from its loftier neighbours, that it gives an impressive sense of loftiness and remoteness, with all the suggestiveness of an island monastery, set far from land in a ring of magnificent scenery.

There can be very little doubt but that the island took its name, Oiléan na Cathrach, from the ancient Cathair or stone ring-wall, a conspicuous object near the usual landing-place. O'Donovan, in 1839, however, was misinformed and misled into another interpretation.[1] He was told by Owen O'Toole, of Inishturk, and by Thomas Geraghty, the former owner of St. Patrick's "Black Bell," that there was no *Cathair* on the island. He accordingly was driven to speculation, and, with his informants' polite but valueless agreement, decided that it was called from the "city of the saints," *Cathair na naomh.* "City" is a very inaccurate rendering of *Cathair*; the word is used (with *Conghabhal*) for a monastery, as in the "Tripartite Life of St. Patrick," or for a bishop's see (Cathedra), and O'Donovan's "authorities" lived remote from cities, and could not even tell correctly the facts about the places they had seen. There is therefore no need to go beyond the obvious meaning.

O'Donovan tells how the remains are *Teampull na naomh* or *Teampull Phadruig*, the *leachtas*, or religious stations for penitential observances, the *Leabaidh Phadruig*, or St. Patrick's Bed, an early carved tombstone outside

[1] Ordnance Survey Letters, Mayo, vol. i, p. 471.

the east gable of the church, and the *Leac na naomh*, or saint's stone, a mass of conglomerate on the altar of the oratory. The last was used for a sort of ordeal—a wronged person used to go to the island, fast and pray, imprecating on himself the wrath of God, Patrick, and the saints, who had blessed the stone, if he was wrong. He then turned the *Leac*. If he was in the right (said Geraghty), a storm arose and boats and men were lost. O'Donovan objected that the destruction of innocent men's lives and property was a questionable proof of Divine justice, but Geraghty triumphantly silenced him by citing the miracles of Joshua; and O'Donovan could only bow before his robust faith. O'Toole took a more Christian view, that while unable to deny the power of the relic, he had little regard for its decisions, and wished that it were destroyed. It was, however, agreed that it punished perjurers who appealed to it. Dr. C. R. Browne[1] was told by E. O'Maille that the block had been thrown at St. Patrick by a "bad friend"; the saint, being unable to avoid it, signed the cross, and the block fell harmlessly to the ground. A similar legend is told at Downpatrick Head of how the saint escaped the spear of the Giant Geodruisge, hurled from the now isolated rock of Dunbriste.[2]

So holy was the island that boatmen, when passing it in 1839, took off their hats and said, "*Umluighmid do Dia mór na huile chumachta agus do Phadruig miorbhuilteach*" ("We make reverence to the great God of all the powers and to Patrick the wonder-worker"). So at Inisglora, farther to the north, and at Cruach mac Dara, in Galway Bay; opposite St. Grigoir's tomb in Aranmore, and at St. Senan's "sacred isle," of Iniscatha, off county Clare, the fishermen dip sails, raise oars, or in some way salute the local saint.

Another mark of the sanctity of Caher Island was that (as at Inishglora) no rat or mouse could live for even a few minutes on its shores, and the earth drove them from any house in which it was sprinkled. It was wrong to take any object from the island, but an offering should be left on it. Epileptic persons could be cured by a few minutes' sleep on St. Patrick's Bed. It is said that one visitor, who removed a stone from one of the *leachts*, met with an accident on the home voyage, and humbly brought back the stone to the very spot from which he had removed it. So also Rev. Cæsar Otway[3] tells us how the wooden image of St. Brendan, on Inishkea, was carried off as a palladium by smugglers, but they were pursued by a revenue cruiser and vexed by storms, and driven up and down the ocean, so long as they retained

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[1] Proc. R.I.A., vol. iii, ser. iii, p. 66.

[2] I gave the Downpatrick legends in a paper submitted to the Roy. Soc. Ant. Ir., at their Summer Meeting, 1911.

[3] "Tour in Connaught," p. 382.

the venerated object. I was told in Inishturk that the holy stone on the altar of Caher Island was taken by a French ship, which met with such storms that they threw it overboard, when the wind and the sea abated, and the stone was soon afterwards found on the beach of Caher Island. One version says it was the lamp-stone that did this. The same tale is also told of St. Leo's Bell, at Inishark, by the people of Inishbofin. The first published account by Mr. T. W. Rolleston gives the notes written by O'Donovan. It may be found in the *Journal*, Roy. Soc. Ant. Ir., vol. xxx., p. 257.

CAHERPATRICK.—There is a small house-ring or *Cathair*, called Caherpatrick, on the 1839 maps. It is of coarse granite and other boulders, the wall only about 4 feet thick and high. It is D-shaped in plan, the corners lying to the north-east and south-east. The garth measures 39 feet east and west, and 36 feet north and south. Inside there are no hut foundations. It stands upon a knoll. The gateway faces the south. An ancient way leads from it to the little lake of Kinkeel.

Beside it runs an old track eastward to the sea. It was called *Bothar na naomh*, the saint's road, in 1839, and was believed to run under the sea towards the Reek. The saint (Patrick) was said to have emulated the miracle of Moses by dividing the sea, when, driven in his chariot by St. Mionnán (Bionnán or Benen) and followed by a number of holy men, he visited the island.

Mr. Rolleston noted a walled headland, but would not decide whether it was an early promontory fort or not. It runs across the neck of the beetling headland of Kinrawer at the north-west end of the island. The rock runs back along the south or landward side, with a shallow little lake, and seems a tempting site for a fort-builder. Probably the exposed and narrow ridge, where, on the day of my visit, it was hardly possible to stand upright against the breeze, was too unsheltered, though indeed many of the fenced headlands are equally wind-scourged. The fence is barely 3 feet thick, irregularly concave to the land. There is no *debris*, and the site is evidently not a cliff-fort.

The coast names are Porttariff, Ooghnalura, Ooghdoul, Ooghatulskaun, Gubacappul, and Turlinveagh. We found the foundations of two huts. The southern, at the end of Porttarriff (Bull port), was a grassy house-ring, 29 feet over all, the wall little over 4 feet thick; the sea has cut away the drift-bank, on which it stands, to the west. Mr. Praeger noted another exactly similar and of the same size, behind the smaller creek at about 300 yards farther to the north. It is sheltered from the sea by a beach of upcast stones. The shore is rarely much over 20 feet high at the south shore of the island. Many old enclosures are traceable, but the island has been uninhabited since 1839. The fields were laid out in the curiously various "lazy beds" with C and S curves, common on Clare Island. (Plate VI.)

The Church and Stations. (Plates VII, VIII.)

The interest of the island lies in its religious buildings. It is very striking when we land at Portatemple to see every knoll and ridge crowned with little cairns and stones. I was told, indeed, that the number of these stations made the observances so severe that pilgrims were driven to seek other shrines of less strict requirements. The great pilgrimage, now in such high repute, and attended by many thousands of pilgrims, held on Garland Sunday to the summit of Croaghpatrick, has quite superseded the more obscure and less accessible shrines of St. Patrick.

The church seems of early date, but has been greatly rebuilt with thin slabs. It is a small oratory 11 feet 11 inches to 12 feet 1 inch long, by 8 feet 5 inches wide inside; 17 feet long, by 13 feet 5 inches at the west, 12 feet 7 inches at the east outside,[1] and its walls 26 inches to 27 inches thick. The east window, though apparently primitive, having a narrow lintelled slit and splay, has a reveal or jamb, and is not inclined, so is probably of no remote age. The west door has jambs, with slight imposts, but it too has a splay, not suggestive of early work. The arch is of singular and poor construction of absurdly thin, irregular slabs, set nearly upright, with a comb-like edge evidently once entirely concealed under plaster. The repairs probably took place in the fourteenth or, perhaps, even in the fifteenth century, but there is no architectural feature to date it by more certain methods. On the altar-slab, before the east window, is a mass of interesting objects, the chief of which is what is probably a stone hanging-lamp. It it oval, 10 inches long; the basin 5 inches by 4½ inches, with a raised border. At either end is a hole for a cord worked in from opposite sides, and a deep groove runs round the edge. It is filled and surrounded by a number of the usual offerings—pins, nails, fish-hooks, rosaries, shot, and copper coins, the act of homage, not the intrinsic value, being alone of importance. There is also the mass of conglomerate called the "saint's stone;" both are well seen in Dr. Fogerty's fine photograph,[2] which is itself a nearly complete record of the oratory.

The church stands in a very primitive cashel of large dry-stone masonry, an interesting evolution of the features of the earlier stone forts. It is 46 feet 4 inches east and west, and 22 feet north and south, leaving a clear passage round Templepatrick 3 to 4 feet wide on the south, and 5 to 6 feet wide on the north. The cashel is usually 3 feet thick, and much thrown down, especially to the north-west. The east wall contains a narrow passage such as we find in the early ring-forts of the Grianan of Aileach, and some of Fahan, Co. Kerry, and

[1] In Mr. Rolleston's account, Roy. Soc. Ant. Ir., vol. xxx, p. 360, "inside" is evidently a misprint for "outside."

[2] See Plate VIII.

elsewhere. It is entered by a primitive lintelled doorway 2 feet 4 inches wide, and, perhaps, 3 feet high. Over it, and at the same level to the south, are small niches like the ambries in huts at Dun Eoghanacht on Inishmore (Aran) Dingle, and elsewhere. In the east end of the enclosure, which is 24 feet long and 22 feet wide, stands a dry-stone altar, roughly 9 feet square, on which lie the "pumice-stone" block and other objects. Near the gable of the church, and to the south of its window, is the *Leacht*, a well-cut early tombstone carved with a cross with spade-like ends of two bands, the arms being detached triangles. Stones carved with crosses remain, two fencing the *Leacht*, one in each of the eastern corners of the cashel, and one at its south-western angle.

An oblong enclosure 20 feet wide, and practically of the same length as the cashel, adjoins the latter to the north; in it lie a cist-grave of thin slabs, 6 feet long, and another altar or station, with a standing stone in the middle. Another enclosure lies to the west, with a modern (or at least rebuilt) fold-like structure. A third lies to the south-east of the cashel. Indeed, it is not easy to decide which of all these buildings have any connexion with the church, or are of any great age.

On the low ridge to the north of Templepatrick is a row of stations. The northern (A) has a slab with a cross with expanded ends. Three more run to the south-east; the second (B) is not in line with the rest, and has a double cross formed with raised panels in the spaces; the third (C) has a cross, with its head indented like a cross *moline* in heraldry; its sides expand; near it is a basin 29 inches by 13 inches, cut in the natural rock. The other stations do not seem to have carved stones, except the great southern one. The principal one is on a bold whale-backed rock, and has a cross-slab. The cross is very slightly indicated by shallow indentations in the sides; bands run around these. The head panel, if ever carved, shows now no trace of ornament. In the centre is a weird figure, the hollow-eyed face alone clear; below is an interlacing, elusively clear at a distance, but nearly effaced out of all design on nearer view. (Plate VIII.)

There are at least five more small stations, one on the bank at the strand; each consists of a small heap, with a plain pillar rising in the middle.

Tobermurry (*Tobar Mhuiré*), the well of the Blessed Virgin, lies far up the island to the north-west of the church. It is still in high esteem and veneration, being visited and prayed at before any pilgrim leaves the island.

5. INISHBOFIN. (Plates IX, X.)

Inishbofin or Bofin, formerly in the Barony of Murrisk in Co. Mayo, was in 1873 restored with its companion, Inishark, to Connemara (Ballinahinch) barony in Co. Galway, to which in the fourteenth century it had belonged,

till the O'Mailles took it from the O'Flahertys about 1380. Roderic O'Flaherty alludes to these islands in 1684, giving us almost our only clue to their history:—"Northward of Ardolen (High Island) are Inishark and Bofin, isles of the country of Conmacny-mara in old times . . . but for 300 years now belonging to the Owles (Ui Mhaille), which, therefore, I omit, only that Inisark is of the same property with Bofin, and the saint therein worshipped, St. Leo, of whose reliques is a bell there extant." He then goes on to tell of St. Colman at Bofin in 668 from Ussher's "Primordia."[1]

In great contrast to its bold and mountainous neighbours, Clare and Turk, or to the rugged mass of Ardoileán to the south, Inishbofin lies, a low, featureless mass, on the water. It has, however, more picturesque features than appear at first sight. Dunmore is as bold a cliff, if not so high, as any in the group we have studied, and the dykes and chasms at Dunnahineena are impressive. It is surrounded by reefs and minute islands, and evidently its low shores are none the safer for ships, as the names Wreck Cove, Deadman's Cove, and Royal George Cove witness. As to its general topography, the whole western end, with most of the traces of early settlement, from Dungrania to Dunmore, is included in Westquarter. In the middle are Fawnmore and Middlequarter, where the bulk of the later inhabitants seem to have dwelt, and the legends and lay history centre. Here lay Aittigh Guarim and Guarim's Castle, which have left no trace, and opposite the last in Knock is the Cromwellian castle, said to be on the site of Bosco's earlier fortification. In the same townland, half a mile to the north-east, is the site of the ancient seventh-century monastery of St. Colman, which, like so many of the old religious centres of Ireland, sank to the status of a mere parish church. Possibly the earliest remains on the island are in the sandhills opposite Inishlyon in the townland of Knock.

There is a rich harvest of place-names. Dunmore, with its by-name Dunkeen, Alladoon, Glasillanadoon, Dungrania, Dooneen, and Dunnahineena centre round the forts. On the shores are Cooltra, with its convex strand; Turlinambaud and the creeks and gullies of Ooghmacan, Ooghnalee, Pollnatulla (a great cave with two inland opes, giving a fine view of its dark corridor), Ooghnadoby, Bunafea, Pollnalecka, Bunamullen, Lugnabuddogy, Ooghardlea, Ooghnastrappy, Ooghanunsa, Belnabraud (a "gorge"), cutting off Port Island at high water, Bellascoltaun, Rooduff, Preesaun (another cave and pit), Gubaranduff, Ooghacat, and Bellalyon. The rocks and islets are Glasillanaban near the Stags of Bofin, Feacarrick, two Glasillauns, Mweelanbwee, Carrickheelia, Carrigeen, Carrickaclogher, Glasillaunabelasty,

[1] hIar Connaught, ed. J. Hardiman, p. 115.

Carrickatroher, Scohadoogort. The lakes are Bofin, Loughaveeneeny, Loughnambraud, Loughgowlanagower (with the horrible hybrid "Gowlauna-goat"!), and Loughnagrooaun.

In Inishlyon are Ooghnagunnel (suggesting a guiding candle, perhaps for smuggling), and Ooghnagalliagh. Cloonamore, and much of Middlequarter and Knock, are a wilderness of little craggy knolls with bogs and pools, forming a featureless labyrinth, difficult (especially on a cloudy day) to find one's way through when trying to reach any object.

THE LEGENDS.—The Island of the White Cow (Inis bo finde), or, as Bede renders it, "Insula vitulae albae," derives its name from no mere animal, if legend is to be trusted. Ages ago Inishbofin was a spectral island, and floated about hidden by mist from mortal eye. At last some fishermen, lost in a fog at sea, deemed that they were nearing land. They cautiously approached the shore and lit a fire, or, as others say, shook the ashes out of a pipe. Touched by fire the island was disenchanted and fixed on its base, the mist rose and the wanderers found themselves on the "North Beach"—a shingle ridge.

> "On one side lay the Ocean, and on one
> Lay a great water, and the moon was full."

A ghostly-looking old woman was seen driving a white cow, and as soon as it reached the water she struck it and it became a rock. One of the men in anger ran over and struck the hag, who, with him, at once became a rock. Down to 1839 the cow has been seen "revisiting the glimpses of the moon" before any great disaster. This was told to O'Donovan in that year.[1]

The same year Caesar Otway[2] collected a variant from an Omey fisherman. Bofin was once a part of Hy Brasil. It was invisible, save at rare intervals, after which "it passed away again like a fog-bank." A mackerel-fisher and his son, from Omey Island, went far out to sea one night. They brought a "coal" of turf to broil their fish on a lump of blue clay, and were hard at work. At last they heard the song of birds and sounds of sheep and cattle, and saw they were in a queer, misty part of the sea. In their surprise they upset the fire, and, as it fell overboard, a beautiful island at once appeared. They landed, bringing fire on a bunch of seaweed, and saw a "lady full beautiful," dressed in green, driving a white cow to a lake. The young man caught the cow by the tail: she kicked, and the tail came off in his hand, and proved to be a root of seaweed. The elder man pursued the lady, who fled from the fire and plunged into the lake, and ever after Inishbofin remained disenchanted.[3]

The fairies, however, remain on it; they were heard romping and carousing

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[1] Ordnance Survey Letters, Mayo, vol. i, p. 485. [2] Tour in Connaught, p. 391.
[3] See Section 7, p. 74.

in the hills, and threw down showers of fish to tempt the inhabitants to eat the fairy food. A man who belonged to a confraternity was once "going by the rath side" of some unnamed fort, when a fairy man, with a long flagger (iris leaf), met him and struck him on the face. The mortal at once drew his black-hafted knife, and stabbed the elf, who groaned and fell. Terrified, the fairy-killer ran for help, and, on his return with some men, found only "a heap of slime, like what a dead frog turns into, on the spot"—the mortal remains of the fairy![1]

Mr. Cyril Allies—a member of an English family, who, till his recent sale, owned the island—when out shooting was told that he was surrounded by a number of fairy girls dressed in brown. His quarrymen on another occasion refused to work, as the rock was too hot from all the "good people" in it. It was the custom for old women on meeting a nurse with a child to spit all round them for protection.[2] The other folk-lore items are noted in the Clare Island section of this report, Dr. Browne's Papers, and Lady Ferguson's two books.

Forts and Huts.

Sand-hill Settlement, Knock.—Passing the Abbey, we find near the gang-way of tidal rocks leading to Inishlyon an interesting early settlement. There is first a midden of shells and burned stones at the extreme south end of the sand-hills. It contains charcoal and peat, quantities of limpets and periwinkles, a few oysters, mussels, and broken bones. Dr. Fogerty also found a very rude-shaped hammer-stone. Almost due west from the northern point of Inishlyon two huts had been built under the shelter of a low jutting rock rising about 6 feet high to the west of the low crag on which they stand. Each hut was surrounded by a mass of shells, but few occurred inside. The northern hut retains an undisturbed portion of the sand-hill, over 4 feet high in its centre, but the foundation is clear. It is not quite circular, the wall running in short, straight reaches, but curving between them. It is 21 feet across inside north and south, and 18 feet east and west, the walls, as usual, being between 3 feet and 4 feet thick. At 15 feet to the south is a more defaced oval hut-ring 3 feet thick and 18 feet north and south by 15 feet east and west inside. There are several other sites to the north of the bay, irregular patches of stones, burned pebbles and shells, but too indefinite for description. Mr. Richard Ussher found the skull of a seal in one (I think at the hut-rings), but it possibly got there in far later times than the Stone Age. (Plate X.)

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[1] Tour in Connaught, p. 395.

[2] A. C. Haddon: A Batch of Irish Folk-lore, "Folk-lore," vol. iv, p. 350.

Dunmore or Dunkeen (O. S., 9 b).—Though not the largest of the forts, the strongest is certainly Dunmore. The size implied by the name may be in contrast to Dungrania, the Dooneen, or to the house-ring, not far to the east of it. As such names are rarely true proper names, that of the Dun was more likely Dunkeen, the pleasant fort, as that name attaches to the cliff beside it. The Irish, alone of early nations, appear to have loved picturesque wild scenery, and to have embodied their delight in place-names, such as Ardeevin, Dromkeen, and such names. This phase of character has not died out among the peasantry, and I have often admired the unaffected, artistic pleasure of fishermen and herdsmen in scenery, and their sense of the poetical in nature.

In fortifying the great hill that juts out so boldly into the Sound of Shark, the builders secured an important outlook. From its summit, nay, even from its rampart, they overlooked Inishark, and away over endless reefs and islets to the walled mass of Ardoileán,[1] along the low shores and lofty peaks of Connemara, to the south and east, to Slyne Head and Cleggan, and northward to Achill.

The maps of 1839 show a long, straight rampart, from the southern cliff half-way across the headland; but O'Donovan was told by John Moran (an inhabitant of Bofin, on whom he had to rely for information, as he could not visit the island),[2] that "there was a fort in West Quarter, called Dún Mór, which was of earth, but is now just effaced." Dr. Browne repeated this from the Ordnance Survey Letters, without comment or marking its source, so till I noticed the early origin of the statement I was misled into supposing that the works shown on the map had been levelled just before his visit. This was borne out by the new Survey marking no works, but "site of," at Dunmore. It is indeed surprising, in face of this apparently unequivocal evidence, to have to record that the fort is still *extant*, though defaced, its plan, and even features, being still intelligible, and its ruin visible and well marked, even as far off as the Harbour; that it is *not an earthwork*, but a dry-stone wall; and that it is not *straight*, but boldly curved. This clearly shows the grievous wrong done to Irish studies by the parsimony of the Survey in providing no competent persons to oversee the marking of antiquities, which the new maps purported to give. I make this strong statement, not to reflect on the surveyors, who were not antiquaries, but to point out to students of Irish archaeology how little deductions, based merely

[1] For the antiquities of High Island we have a note by G. H. Kinahan, Journal Roy. Soc. Ant. Ir., vol. x, p. 348, and a careful description by R. A. S. Macalister, ibid., vol. xxvi, p. 197.

[2] Ordnance Survey Letters, Mayo, vol. i, p. 484.

on the records of this supposed authoritative survey, can be relied on in questions of archaeology. Also it shows what careful and prudent editing should be given to the Ordnance Survey Letters, which many well-meaning persons would circulate in Ireland, full of misleading statements, in hastily published editions. It is enough to back this allegation in the matter of the promontory-forts alone by stating that the 1839 Survey did not mark the early fortifications of Balor's Castle, Port Conaghra, Cashlaunicrobin, Dunminulla, Dun Fiachra, Dunaneanir, Port, Dunnaglass, Dunagurroge, the great and complex Dun of Kilmore, Dunnagappul, Dun Ooghmore, and this Dunmore, all in Mayo. A cliff-fort in Aran, with Doonaunmore, Anneville, Dun Gorraun, the huge Doonegall, Doonaunroe, Dundahlin, and Horse Island in Co. Clare, and Brumore, Doon Castle, the Cahercarberys (most important forts), the great rampart of Dun ruad, Dunmore, Moneenagurroge, Faillnamná, the upper fort of Doon, on Eask Hill, and Minard, in Co. Kerry, are also unmarked. All were recognizable; some were among the most imposing of Irish earthworks and cathairs, and yet they were left unrecorded; and many are still omitted on the new maps.

Dunmore-Bofin, as I may call it for distinction, consists of a single dry-stone rampart, of the best type of masonry. It runs in a bold curve from the south cliff of Dunkeen, remaining for over 60 feet, and leaving farther traces in set-stones, along a natural terrace, or shoulder, about half way up the slope. At the foot is a fosse-like hollow, evidently natural, but which could, with little trouble, have been continued as a fosse and earthwork round the foot of the slope. (Plate IX.)

The wall has two faces, the outer of fairly large blocks, 2 feet and 3 feet long by 2 feet to 2 feet 8 inches high and deep. Owing to the curve, the joints are unusually open. Over these, bonding deeply into the carefully packed rubble-filling of the interior, was a course of stones, 3 feet to 4 feet long, set as "headers," with the ends out. The inner face was of smaller masonry, and but little remains. The wall is still from 3 feet to nearly 5 feet high. At 32 feet from the south cliff, which is flaking off into huge "slices" at that point, are the remains of the gateway. It looks eastward, about E. S. E., and has parallel sides, 6 feet 3 inches apart, of large blocks. There were probably coursed piers, as at Dun Aengusa and elsewhere, to narrow the entrance. The passage is 10 feet deep. The wall is of one section, varying from 10 feet to 13 feet, and, perhaps, at one part 15 feet thick. Much remains, a few feet high, for 30 feet northwards from the gate, beyond which are slight traces of foundation; but the work of destruction has not ceased, and stones are still thrown down the slope or over the cliffs by idlers. About 60 feet back from it is an oblong patch of stones, 36 feet

long, north and south, by 12 feet wide; some set ones appear. Behind them rises a second steep slope, for about 65 feet. The top platform is about 25 yards wide on the summit. There are no hut-foundations apparent, and it was probably too storm-swept for residence. Indeed, the fort itself was probably uninhabited, save when, in the event of raiders landing on the island, the inhabitants fled, with their goods and cattle, to its friendly shelter.

House-Sites.—Eastward from Dunmore is a low ridge of hills, and along a natural terrace, to either side, we found five hut-sites. (Plate X.)

(*a*) The first is built against a low perpendicular rock near the west end, in full sight of Dunmore. Like all these sites, it has been long since reduced to its foundations. Probably it was largely built of sods, with stone facings. So little remains that we cannot tell whether the roofs were of stone; but the remains of corbelled roofs over the smaller cells on Inishturk and those of Inishglora and High Island suggest that some at least were so covered. It had four circular cells, 6 feet wide, and with walls 3 feet thick, grouped round a court, or larger cell, 11 feet by 9 feet.

(*b*) Farther eastward, on a bold green knoll, once cultivated, was a circular house-ring. Unfortunately it was included in the tillage-plots, when much corn was grown in the islands during the wars with Napoleon, and its interior was dug up along with its western side. It is like that of Loughnamucka on Turk, and those on Caher Island. It is, like the last, circular, and 39 feet inside; the wall of earth, stone-faced, and from 9 feet to 11 feet thick. The gateway faced eastward, with one block, 4 feet long; it is about 8 feet wide, but may have been originally about half that width.

(*c*) The third has a straight wall against the steep slope to the north, with large face-blocks, 4 feet to 6 feet long, and 3 feet high and thick. Against this was a court, or central room, D-shaped in plan, in the middle of which is a regular circular pit, 4 feet deep, evidently modern. Round it are five (or perhaps six) huts, usually oval, and about 6 feet by 5 feet. The north-western seems to be polygonal.

On the northern slope of the hill are two simpler house-rings, noted by the indefatigable search of Dr. Fogerty, while I was at work on Dunmore.

(*d*) The more western is also in sight of the great fort. It has gaps to the east and west, being much levelled and hardly 2 feet high; all the facing has been removed. It is oval, 18 feet north and south by 21 feet east and west inside. The wall is 9 feet thick to the north and east, and 6 feet elsewhere.

(*e*) Still farther eastward in a nook of the slope remains the northern segment of another ring, the rest entirely effaced. What remains is 6 feet

thick with large face blocks and an entrance 3 feet wide to the north-east. The interior is 15 feet across east and west.

At the opposite side of the island, in Cloonamore, near Dunnahineena, not far from the stream, and nearly opposite to Roonduff, is another enclosure.

(*f*) It is built against a rock on the western side in a shallow valley, and was D-shaped in plan. It measures inside 21 feet north and south, and 11 feet 6 inches east and west, being entirely of stone, mostly removed. It was, perhaps, a somewhat late fold, but its utilization of a cleft for a recess suggests that it may have been an old residence.

(*g*) Another hut, in equal dilapidation, abuts against the rock where a little pass leads up from the large boggy hollow between the loughs of Gowlanagower and Loughnagroovaun. It is 9 feet long east and west along the rock, and 7 feet wide. The latter lake, a clear little tarn, full of Water Lobelia, has, on the east shore, heaps of stones under the low cliff; but if they represent huts, no foundations are traceable. As large roots of bog deal and oak are found in the bogs here, as on Clare Island, there was probably no lack of timber for roofing the houses of stone and earth.

Dungrania or Dungrainne.—On the low west shore of the harbour near Turlinabaud and facing Bosco's Castle and the signal tower rises the remnant of a large table-like rock. It is nearly isolated, and is reputed to have been occupied by a castle of Grania Uaile, who defended from it (as her ally, "Bosco," did from the "Gun Rock" opposite) the approach to the port in which she, Bosco, and perhaps Guarim kept their fleets. The foundations of the castle were stated to remain on the platform in 1839.[1] Now, all that I saw belongs to a far earlier type, perhaps at the latest six or seven centuries before the "great sea-amazon" of the West.

The rock, exposed on its western flank to the whole force of the waves, is being rapidly eaten away. A bank of shingle brings us to the foot of the grassy eastern slope, which is easily scaled by a sheep track, over which we see the slight remains of a stone revetment along the steep bank, little more than the lower five or six courses remaining anywhere. The platform is richly grassed, a favourite resort for sheep, like Dunallia and Dun-Ooghaniska on Clare Island. It is about 50 feet high, from 12 feet to 36 feet wide, and 165 feet long; of course it was once far wider, to judge from the base, nearly square, as indeed the old maps show it. The southern end is washed bare by the waves for 30 feet from the edge. Then hut-sites occur with walls of earth and stones. The first is of three conjoined cells, with walls 3 feet to 4 feet thick; the western half is gone, the eastern adjoined the fort wall. The

[1] Ordnance Survey Letters, Mayo, vol. i, p. 484, "Grania's dún, from Graaia Wael Ny Maley"; it was a castle, and still traceable.

cells are 18 feet and 12 feet inside; a circular annexe, 15 feet inside, adjoins them on the north-east. At 142 feet from the south is another group, the eastern hut 18 feet inside, the remnant of the western 15 feet across along the cliff. At the northern end at the highest point is a single circular hut 15 feet wide; all are levelled down to usually a foot high. (Plate IX.)

It is noteworthy how common this type of fortified shore-rock is in the Mayo islands. Under the shelter of the large rock several lower, small, green-capped towers of drift remain on this shore. There is a similar curious natural fort of grass-topped drift on the low rocky islet of Glasillaunadoon off Dunmore, the last remnant of the earth-cap that gave the rock its name, "the green island of the fort."

Dooneen.—On the north shore of the harbour, between the road and the bay, near the modern church of St. Colman, rises a tumulus-like rock, grassy and with arched strata, called "Dooneen." From the name, we might conjecture that the top had been fortified, the works disappearing with the surface, like Duntraneen on Clare Island, as the rock was washed bare. The rock platform at Belnabraud, opposite Dooneen, does not show any wall, but I had not time to visit it.

Dunnahineena (O. S. No. 9).—The site of the only fort on the north or east side of Bofin is of far more geological than archaeological interest. It was once joined to the mainland by a steep descent and ascent, along a narrow neck, from a spur between two stream valleys, but the neck has long since fallen away, the landward half alone remaining. A wall-like dyke of volcanic rock very artificial in appearance still joins the islet to the mainland at its base, but there is no way of access to the summit from the landward side, though an active climber might, I believe, reach the platform from a boat, up the eastern (seaward) slope. The summit is about 2 acres in extent and covered with richer sward than the mainland; it is 82 feet high, and about 400 feet by 250 feet, as shown by the large-scale maps; their plan, with some added details, is given. The defensive works have perished with the approach, the cliff falls "laying bare the foundations unto the neck." We have not, however, to conjecture the former existence of a fort from the name alone, for a long reach of revetment wall of earth and stone is visible along the western side, near the top of the long grassy slope, probably unaltered since the rampart was first built. Half a hut-site is still to be seen on the crumbling edge of the cliff, opposite the neck, possibly once guarding the gate, like a porter's lodge. Towards the centre of the platform there is also a low mound, so very regular, as seen from the high ground opposite, that it is possibly a ring-mound. Whether this be so can only be settled by a visit to the summit by some fairly experienced person. (Plate X.)

The cliff at the hut-site has fallen so recently that the rock is raw and bare, and the debris lies loose and dry on the edges; none of the rich orange lichen, or bosses of sea-pink, that we see elsewhere, has had time to grow on the new surface, whether of the cliff or of the earth bank above it, on which the hut rested. Next to the west of the arch of strata opposite the neck, appears another fresh surface; it is probable that the fall of the southern cliff, to the right, took place very long ago. The great blocks of the fallen neck choke up the gully below; the weak point was evidently the curved strata of the neck, of which only a knife-edge remains to landward. The name Dunnahineena (some think) means Finnguine's Fort (Dunadh).

There is a Lough na Veeneeny on the westward side of the island. The coast, though low, is pretty; the labyrinth of rocks and bogs in Cloonamore, opposite which is the *dún*, has been already noted.

St. Colman's Cell and Church.

The story has often been repeated from the record of the Venerable Bede,[1] how in A.D. 667 Colman, the saintly Abbot of Lindisfarne, for thirty-seven years a Columban monk of Iona, and probably a native of Connacht, whither he retired, entered into the unhappy Easter controversy. This was at the time a subject of bitter dispute, threatening to separate the Church in Ireland and its daughter in Scotland and northern England from all communion with the other western churches. We need not repeat the discussion of Wilfred of York with Colman, before King Oswy, but respect for St. Peter made the King decide against the Irish usage, despite his love and veneration for the abbot. Colman, defeated but attached to his national observances, determined to leave Lindisfarne. He opened the grave of his great predecessor, Aidan, and secured some relics of that abbot; and then, accompanied by a number of British and Irish monks, who adhered to him against royal and episcopal decisions, he retired, with all the Irish and thirty Saxons, to Iona, and rested, comforted by the sympathy of its monks. Then again they faced the waves and storms round Donegal and across the broad bay of Sligo, down the coast, and rested not till they came to Inishbofinde, the Isle of the White Cow. There they chose a site for their rude little church (probably, like that of Lindisfarne, of hewn timber) and their little cells, of which all trace has now disappeared.

The place was well chosen, not far from a fine crescent strand, in a sheltered valley, near a lake and possibly among a friendly population of

[1] Ecclesiastical History, Liber iii, c. 25, and iv, c. 4. Ussher's "De Primordia," p. 834. Annals of Ulster, 676. The Four Masters, 667 and 674. Roderick O'Flaherty, "hIar Connaught," p. 115.

simple islanders, perhaps even kinsmen of the abbot. It promised endless peace to all; but the Irish, whether grown restless from their journey, or in search of old friends, wandered away, and left all the work to the Saxons; even the harvest was neglected, and quarrels arose. Colman saw that two incompatible races (no longer held together by the tradition of an old-established monastery) were better apart. He took the thirty Saxons and moved inland to Mayo, where he bought a site for his third monastery; there the English monks could be ruled on their own lines, as the Irish were on theirs. He ruled over the two houses till his death on August 8th, 674 or 676. The first date is that of the abbacy of St. Choenchomra, Colman's successor at Bofin, and therefore probably the real one. Choenchomra was reverenced also as a saint on July 23rd. St. Baetan succeeded him as Abbot of "Inismore" (or Inishbofin), and died on January 14th, 711 or 712. On that day another abbot, of unknown date, Luighbe, is venerated at Inishbofin. Whether Colman died or was buried on this island, or at Mayo, does not seem to be recorded; probably the more important abbey on the mainland was his resting-place, but, of course, relics must have been preserved on Bofin.

There are great difficulties in following out the history of the island; the name is not uncommon, and may lead to confusion, especially with the islands of the same name in Co. Donegal and Lough Ree, the last with an interesting early church and a late abbey, embodying a decorated romanesque window from a building of the period about 1100. It is rarely that the scanty records give us any clue as to what "Inisbofin" is intended. The rectory of Inishbofin was impropriate to the Marquess of Clanrickard, a sure sign that it was at one time monastic property.

The church is described in the Ordnance Survey Letters[1] as "very old and curious," but it deserves neither epithet. It is a very commonplace building, with no trace of carving or ornamental features, and probably no part remains that is over five hundred years old. Whether the heaps of loose stones in the graveyard are, as certain imaginative writers have fancied, the remains of the cells of Colman's monastery, there is nothing to show. The only possibly early object which may well date from the time of the founder is the primitive bullaun stone, or font, now lying in the south window. The coign stones of the door and windows have all been removed, the sill of the north window is alone *in situ*, the splay arch of the east window is not of cut stone, nor could I find a single block with moulding or carving among the weeds and debris. The church is 70 feet 6 inches long (including the buttress 5 feet) and 23 feet wide outside; it is divided by a gabled wall, though this was evidently

[1] Mayo, vol. i, p. 484. Rev. John O'Hanlon conjectures that Choenchomra was not of this Inisbofin.

an after-thought. The building is 36 feet 6 inches long to the north, 37 feet to the south, and 17 feet 9 inches wide; the walls are 3 feet thick. A defaced door leads into the western compartment, evidently separated for a priest's house and sacristy, a room 17 feet 9 inches square; the west end is down, and the two narrow side windows are defaced. Rows of plain corbels, along the western half of each side, suggest an upper floor, or perhaps a gallery, when it was included in the church. The south doorway of the church had a rather flat relieving arch covered with shell mortar; the door turned in stone sockets, of a type common about 1480. The doorway lies 3 feet 6 inches from the west wall, and the broken side windows are about the same distance from the east, and nearly opposite to each other. The northern (as we noted) retains its sill. It was unglazed, but had a weather-shutter, turning in a socket, as was common in castles of the same period. The basin-stone, or font, is a block of grey conglomerate, 25 inches by 27 inches, with a round basin 15 inches across. The large east window commands a beautiful view of the great mountains on the mainland. The splay is 5 feet wide, with plain jambs and a segmental splay arch, over which is a very neat relieving arch.[1] To the south is a broken recess, or ambry, filled with bleached skulls, very frail and weathered; beside it in the south wall is a smaller ambry, perhaps for a credence-table. The gable is propped by clumsy buttresses, over 5 feet square, packed with dry rubble. The northern, its case of mortared masonry having been broken, is now hollow, the dry, loose material having slipped out; the southern is intact. How the published accounts gave "61 feet by 23 feet outside" is impossible to explain. (Plate X.)

There are no early monuments, and few modern ones with inscriptions—a beautifully carved headstone with a pathetic epitaph commemorates the Rev. Henry Basil Allies, who died in July, 1897, after twenty-nine years of priesthood. Inside the church, in the north-east corner, is a long Latin inscription in such unusual lettering as to suggest that the sculptor copied his exemplar blindly. It commemorates the virtues and labours of Rev. Martin Fadden, the coadjutor on the island, who died in March, 1820, and whose unsparing efforts to tend the living and bury the dead of his flock, whose bodies he brought hither with his own hands during an epidemic (of cholera morbus), are recorded. The epitaph alludes to the church—"Hic intra muros veteres Sancti Colmani ecclesiae dormit." At the east window on the altar-site is a table-tomb of James Mac Cormack, September, 1875, and in the end room, one of Essex Summons Philips, February, 1834, aged 5, the son of Essex Philips.

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[1] A very inaccurate view is given in Canon O'Hanlon's "Lives of the Irish Saints," vol. i, p. 197.

The site of the traditional well of St. Colman was forgotten before 1839; the modern, white-washed well-house enclosed that of St. Flannan, the mid-seventh century patron of Killaloe, Co. Clare; I have not found his connexion with Inishbofin, but he was a worker in islands as far north as the Flannan Islands north-west from Scotland, where his venerable "boat-shaped" oratory still remains, with some beehive cells.[1] He was also reverenced at Bunowen, Ballindown Haven, and Irrosflannan on the Connemara coast. He was son of Thoirdhealbhagh, a so-called King of Thomond, not recorded in the regal lists, but an ancestor of Brian Boru.[2]

Secular Buildings.

The legends of the islands[3] are in inverse ratio to the history. The two protagonists of the tales (later than those of the white cow and of St. Colman) are "Bosco" and "Guarim" (or Gorham), who have as yet no place in history. Aittighe Guarim, near Bunnamullen Bay, was demolished for material for the priest's house before 1839;[4] Mr. Cyril Allies tells me that a quern stone was found when a hole was dug on the site in recent years, but not even the foundations were disclosed. It was not unusual to bury a quern stone, generally a broken one, as a sort of symbolic sacrifice, in the foundations of a house. Of Guarim's castle there was only a tradition of the site on the high ground not far to the north of the new church, in 1839. Guarim was "a certain old chief" who quarrelled with the monks of St. Colman over the question of tithe. Not content with refusal, he laid an ambuscade, captured six monks, and put them to death at a spot in Middle Quarter, where their blood still rises from the ground on the anniversary of the crime. Scandalized at the sacrilege, even his hardened followers turned against him; they bound and brought him to Renvyle Castle, where he was tried and condemned to be left chained on a rock at low water, for the tide to drown. Since then it is alleged that no Gorham can enter the priesthood.

This is evidently the legend that, in recent years, originated the story and the name of the "Bishop's Rock," unknown either in name or legend in 1839.[5] The Cromwellian soldiers are said to have drowned a bishop. The story is clearly unfounded, as it is unrecorded (so far as I have read the works) among

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[1] Roy. Soc. Antiq. Ir. Journal, xxix, p. 328.

[2] Proc. R.I.A., vol. xxix, p. 195. His life is published in "Acta SS. Hiberniæ, ex codice Salmaticensi," 1881.

[3] See Dr. Charles R. Browne's notes, *supra*, Proc., vol. iii, ser. iii, pp. 360, 363.

[4] Ordnance Survey Letters, Mayo, vol. i, p. 484.

[5] The statement in "Two Islands" makes it evident that the story was new to the natives, and astonished them when they heard it.

the martyrdoms, even of obscure monks and laity, so industriously amassed by Anthony Bruodin and other Irish monks of the period, and published on the Continent; and it is equally absent from the lists of bishops and from the wonderfully minute information (so far as I have examined it) in the Record Office, relating to the period from 1651 to 1660. That the Cromwellians were "zealous to slaying" in hot blood is certain; but after the enemy was reduced there was no hole-and-corner cruelty: all was harsh, cold, and in the open daylight, according to the letter of the law. The date of Guarim lacks even legendary consistency, one account[1] making him a contemporary of St. Colman, others an ally of "Bosco," and thereby of Grania Uaile, nine centuries later.

Bosco, whose name was attached to the castle embodied in the Cromwellian "Barrack" was a pirate, a Dane or Spaniard, who stretched a chain from his castle to the Cat's Hole, near Guarim's Castle, to protect the combined fleets of himself and Grania. He also placed a cannon on the "Gun Rock" for better defence. He used to throw his prisoners into the sea through an embrasure, still shown in the castle. He buried a large treasure somewhere in the ruin; but it is supernaturally defended, and when even a priest commenced to dig in the haunted courts, he was ordered to stop by a voice speaking in Irish from underground.

Bosco's Castle, or Cromwell's Barrack.—Though very featureless, the ragged mass of walls, opes, gables, and chimneys is distinctly impressive as seen across the harbour, or from its waters. Tradition says that it was preceded by a castle of Bosco, or of Grania Uaile. The latter, in all records known to me, only held Rockfleet Castle on Clew Bay; even her traditional chief castles of Doonagh and Clare Island are only mentioned as held by her father, and were certainly in other hands in Grania's day, so far as the Government recognized the ownership.

The history of the present building seems well ascertained, and I saw no remains in it that appear to be of earlier date than the rest, which is clearly of the time of the records. The island was surrendered to the Commonwealth in 1652, and its soldiers repaired an existing building of some sort, and used it as a barrack. After a few years they determined to abandon the station, and in 1655, Sir Hardress Waller and Colonels Hewson and Sankey recommended to the Council of State that the garrison should be withdrawn and the works dismantled. The Irish Government accordingly offered to any contractor the Galway barque "Elizabeth" (employed in bringing limestone for the intended "buildings of Buffin") and a sum of £600, on

[1] See John Moran's Letter, *loc. cit.*

condition that he would undertake to block the harbour. The Commonwealth, in the struggle with the Dutch, naturally feared lest the daring sea captains of the sister republic might use so convenient a haven. The task was clearly too difficult and unprofitable, and no one accepted the offer. Half measures, so usual in English rulers towards Ireland, were not a vice of the Cromwellian Government; if the harbour cannot be destroyed, it must be held strongly, was their decision, and the next year, June 3rd, 1656, the works were resumed.

They replaced the twenty-two small guns by larger artillery, and, the garrison having "come to stay," they appointed as chaplain "an able, pious, and orthodox minister of the Gospel." Sir Charles Coote was directed to consider whether Colonel John Honnour, the Governor of Boffin, should take steps to prevent the natives from keeping boats on the islands or on the adjacent coasts of Ir-Connaght and Mayo. This impracticable scheme was probably rejected. He, however, was ordered to remove all dangerous persons and ill-affected Irish, to appoint a magistrate, and make good highways towards the island, I presume through the trackless mountains and moors of the opposite mainland.[1]

"Bophin," like Aran, was made a penal settlement for priests and monks deported from all parts of Ireland. Bosco's Castle, like Arkin in Inishmore, controlled the unhappy settlement, sixpence a day being allowed for the support of each priest. The Cromwellians, once armed resistance ended, were harsh and stern, not wantonly cruel; nevertheless, the situation must have been one of misery, even for the garrison. A curious too-true picture might be drawn in a romance of the two strongly convinced parties holding such contrasted forms of Christianity, each person ready to die for the faith that was in him, and regarding the other side as a servant of Antichrist. Behind all rankled the unhealed wounds of a cruel civil war, and the sense of exile and separation from the persons, places, and pursuits most valued in the past, with intolerance whetted by the presence of the other party. Little else is to be told; the owner, John, the ninth Earl of Clanricard, in the reign of James II, was created Baron of Bophin. I know of no record during the reigns of Charles and James; but in 1691, after the surrender of Galway, a division was sent to Boffin to receive the surrender of Colonel Riordan, who held it for the latter monarch. The Dutch were now the allies of England, but the French privateers were still to be dreaded, so the garrison was maintained. After 1700 the place is rarely mentioned. The Clanrickards held it down to the nineteenth century; then it was owned successively by the Wilberforces and

[1] Council Books of Dublin Castle. See James Hardiman's notes in "Iar Connaught."

by Mr. Allies, whose kindness to Dr. Browne and to myself deserves the recognition of the Academy for aiding its workers.

As to the present inhabitants, Lewis says there were 1,462 in 1837, when it was the property of the Marquess of Sligo. Ecclesiastically it was part of the union of Ballynakill; the Marquess of Clanrickard held the rectory; Bofin had two private schools for about eighty children. There were 212 families in 1893; of these, 134 bore Irish, and 29 Anglo-Norman, names; the well-established families of Lavelle (17) and Scuffles (22) are reputed to be foreigners, but may be the Irish Mullavels (O Maolphabhaill) and the Anglo-Norman Scovelles.

The Building.—The fabric of "Cromwell's Barrack" consists of a long irregular enclosure, with variant bastions at each corner and a round turret on the south face. Inside is an irregular courtyard, with a choked well in the middle, and buildings to the north, west, and east. The stonework was once rich in well-cut coigns of blue limestone; but nearly all have been removed by lime-burners; the arch and a few jamb-stones of the gateway remain.

The site is well chosen, on a sort of headland, bounded by the harbour to the north and west, a convenient little creek running in at the latter side. A rugged hollow, partly quarried, defends the south side. To modern ideas the site is too much commanded by higher ground to the south-east, and has no fosses to that side. (Plates IX, X.)

The chief frontage is to the east, with the only entrance, a fine, round-headed door, recessed and chamfered, 5 feet 3 inches wide, though much injured by the vandalism of the lime-burners. It is in the middle of a curtain wall, 45 feet long and 6 feet thick, flanked by two bastions; a passage 32 inches wide runs along the top.

Before describing the ruins farther, I desire to point out that I was unable to complete to my satisfaction the plan here given, though the main court and its buildings and bastions are to scale. The western bastions were only roughly and hurriedly measured, so I desire my drawing to be considered as a sketch-plan, which time and weather did not allow me to finish.

Entering, we see the hole for a rather slight bar in the north jamb, a passage 6 feet wide and 18 feet long, and side buildings on either hand, 30 feet long. Each consists of two small rooms, with fireplaces in the inner angles, and large chimneys to each pair at the curtain. To each outer side of these buildings a passage 5 feet wide leads up to each eastern bastion by a sloping way. The bastions are "diamond-shaped," each inner face 12 feet 6 inches, and the walls 5 feet thick, with recesses and loopholes in each face, their stonework mostly removed. The range to the north side of the court is about 78 feet long. It has two rooms, the first evidently a kitchen, the other a

guard-room; the first is 30 feet long outside, and 24 by 18 feet wide inside. The next, to the west of the last, is 43 feet 6 inches long, and 19 feet wide, with a large window, flanked by ambries, in the west end, and three loopholes in the north wall towards the harbour; the south walls of both rooms are nearly levelled; portions of two windows remain in the first, with a small loophol commanding the sloping way to the north-east bastion, and a fireplace in th east wall. The partition wall has a door, and the north wall is blank; there seem to be traces of two doors and a window in the south wall of the west room. Separated from it by a passage 6 feet 9 inches wide, is the west range, probably a store—three gloomy rooms, each with a loophole in the west, and with great fireplaces and chimneys; but the face next the court is nearly all broken, and the end walls blank. Behind it a passage, 3 feet 6 inches wide, leads between it and the outer western wall over the creek. In this rampart are opes through which (doubtless by a crane) supplies could be raised from boats. Behind this, to either side, is a bastion, with parallel sides. The northern is 27 feet long; between it and the large room is a smaller bastion, projecting 5 feet, to sweep the northern wall, and 15 feet long. The small south-western bastion is 15 feet long, 7 feet 9 inches wide, with walls, as usual, 4 feet 9 inches to 5 feet thick. It, like the larger one opposite, has loopholes commanding the cove and southward. East from it, in the passage at the south end of the stores, a semicircular turret projects from the outer wall. The latter at 20 feet from the store bends back, with a small house in the angle. I did not find any garderobe in the ruin. The curtain wall runs straight from the angle to the south-eastern bastion without any other features save the narrow walk and loopholes along its summit.

6. INISHARK.

The island of Inishark is so closely bound up with Bofin in history and by nature that, although I was unable to visit it, I may give the results of the study of others with what I was able to see from Bofin, and learn about its remains.[1] The name is as yet unexplained, nor have I found any early record to throw light on it. It appears in 1586 as Enisherke and Enisharke; Roderick O'Flaherty a century later calls it Inisark. The Ordnance Survey has adopted the ugly, unnecessary, and cumbrous spelling, Inishshark. One popular

[1] Ordnance Survey Letters, *loc. cit.*, p. 485; "Lady Wilde, "Ancient Legends," i, pp. 119, 132, 143; "Ancient Cures," &c., pp. 141, 151–4; and Dr. Browne, *supra*, Proc., vol. iii, ser. III., pp. 359–365. Moran only enumerates the following remains on Inish Shark:—1, Stone cross, Leac Leo, to south-east of Leo's chapel; 2, Teampull Leo, a primitive little chapel; 3, Uaimh Leo on the south shore where the saint meditated; 4, Tobar Leo in the cave; and 5, Clochan Leo, round cyclopean hut.

explanation regards it as named from the Basking Shark so common in these seas, but this implies a hybrid name, half English half Gaelic, as debased as "Gowlanagoat." Others, like the interpreters of the name of Inisherkin,[1] Co. Cork, derive it from Earc, love; and others (more plausibly, but I believe without authority) render it "Earc's Island." Inishark contains about 580 acres, and the inhabitants are nearly all concentrated near the south-east corner, where the shore is lowest. It has steep and high cliffs to the north and west, and is so storm-vexed and so lashed by fierce waves that it is often impossible to land on it for several weeks at a time. I examined the sides next Inishbofin with a glass, in such good, clear light that even animals, geese, and sea-birds were visible, but saw no fences or entrenchments on the only projecting headlands on its coast. The shore names are Ooghnageeragh, Ooghnacappul, Ooghcurreen, Ooghnaveagh, Ooghnacromlack,[2] Ooghnagaragh, Ooghnacuragh, Oomeenashinnagh, Ooghanany, Ooghancarrickad, Ooghaneeny (at Shark Head), Ooghanavaud, Ooghvrisly, Lackagh, Lackataragh, Cromal, Dooneenapisha, Boughil and Cailleen. The last two, "the boy and girl," are two great rock-pillars, the last leaning over. Otway[3] was told that the girl had tempted the boy to sin, and goes on (whether to embellish the tale, or with local warrant, I know not) to state that their souls are the eagles nesting on the rocks, or that they are Adam and Eve. Outlying these are Glassillaun (two), Inishgort, and the two Inishkinnys. The early remains comprise the following :—

Duneenapisha, "little fort of the peas," is a high cap of clay on a shore-rock; a grassy slope leads to it on the landward side, and there seem to be a ditch and mound across it, near the southern end.

St. Leo's Church, or *Teampul Leo.*—It has been repaired, whitewashed and is used as a chapel whenever the curate visits the island. In 1870 it was in a lamentable condition, much broken, and used as a cattle-pen; it had a neat slit window in its eastern gable. The *Leac Leo.*—A slab carved with a chalice, and a figure with extended hands, supposed to be a bishop, is now set on the eastern gable of the church. Another cross of better workmanship inside the building is regarded by some as the real *Leac.*

Clochán Leo.—A dry-stone cell, 6 feet wide by 11 feet to the south and 9 feet to the north; the beehive roof has nearly all fallen in. The north-east corner is square, and the others rounded. The doorway was only 2 feet wide, and 2 feet 6 inches high, and was at the south-east corner. The hut stood in

[1] The old name was Inis aircin, not seircin. Lady Wilde suggests Inis-Erk (Ancient Legends, p. 57).

[2] Whence Mr. G. H. Kinahan asserts the presence of a fancied dolmen.

[3] Tour in Connaught, p. 394. The custom of "improving" folk-tales (common down to far later times) renders it hard to eliminate Otway's additions.

an irregular, dry-stone cashel, somewhat oval, 60 feet east and west by 45 feet north and south; the entrance was 3 feet wide, and to the north-east. It was entirely defaced before Dr. Browne described it.

STATIONS.—There are fourteen religious stations marked as "monuments" on the maps. One of them is a granite boulder, with a *bullán* or basin in it. The natives, after performing rounds at the stations and praying at the well, sometimes sleep in the *clochán*. I found no record of the patron, St. Leo; his festival is on April 11th. The map marks a "Cloghancongleo," a ruined hut on the south-east point of the island. It resembles a defaced cairn or house-ring as seen from Bofin.

Other relics of Leo are his footprint when he stepped down on to a slab after completing the roof of the *clochán*, and his cave. The latter is called *Uaimh Leo* and *Fuath Leo*, lying south from his church in a creek. His well is not in the cave, as stated in the Ordnance Survey Letters, but at the head of the cove.

The chief relic was, however, the bell. O'Flaherty, as we saw, recorded its existence in 1684. It was of "brass," probably bronze or bronzed iron, but a bad custom arose of cutting off a portion as an amulet for those emigrating, and by 1846 the bell had been entirely broken up. A few portions are said to have been kept concealed with jealous care by old people in Bofin. Legend said that the bell was once carried off by some French sailors, who were so vexed and endangered by storms that they turned back, one version says, "from the Bay of Biscay," and restored the bell, or, as others say, cast it into the sea. It was soon afterwards found on the shore by seaweed-gatherers. The same story was told me in Inishturk, but it was about the holy stone of Caher Island.

7. SPECTRAL ISLANDS.

The story that Inishbofin was once a floating island till fixed by a spark of fire[1] is a form of one of the most interesting legends of the west coast of Ireland. Unlike so many beliefs, it rests directly on visible facts, the mirage and the evidence of the submergence of the coast. Science has traced the old river-beds of the Shannon and Erne far under the sea, and has recognized the sinking of the Porcupine Bank and Rockall; but the sunken bogs and tree-stumps told everyone what had taken place in the past. For many centuries it has been embodied in early Irish literature. The "Voyage of Maelduin," probably far older than its earliest extant copy about 1100, tells of roofed *dúns* and an inhabited country seen under the waves and of the "thrice fifty

[1] *Supra*, p. 58.

distant isles in the ocean to the west of us, larger than Erin twice is each of them or thrice."[1] The Dind Senchas tells of Connla's well under the sea.[2] Giraldus Cambrensis, in the late twelfth century, not only noted stems of trees covered at high tide in North Wales,[3] but tells a legend similar to that of Inishbofin, if not referring to that place. Among the western isles of Ireland was one called "Phantastica," a "cumulus" emerged from the waves where no land had been visible. The islanders supposed it to be a whale or sea-monster, but it remained motionless; so some lads went out in a *curach* (navicula), but failed to reach it on two successive days. On the third day, advised by an old man, they fired a red-hot arrow at it, and it at once became stationary and habitable, for "fire is hostile to anything phantasmal."[4] James Hardiman cites an old manuscript in the Academy's Library which says that (like the gods of Hellas) the Tuatha De Danann hid in "floating islands, with a wind that evermore keeps them out of sight of shore." These lands lie far out to sea, though "sometimes perceived by the inhabitants of Oulis and Iris" (O'Maille's country, Umhall and Erris), and from "Calbegs" (Killybegs) in Donegal. Several seamen saw it when at sea; one Captain Rich tells of the land and harbour, with two headlands, which vanished in mist, for "the enchanters could, by magic skill, conceal their land from foreigners. William Hamilton, of Londonderry (M.P. in 1663), relates circumstantially how "O Brazile, the enchanted island," had been seen by multitudes off the coast of Ulster (probably Donegal). Captain John Nesbit, of Fermanagh, settled at Killybegs and traded with France. On one voyage, March 2nd, 1675, he found himself in a dense fog off an unknown island, in less than 3 fathoms. He and eight persons (three are fully named) saw it; he and three officers landed and saw woods, cattle, horses, sheep, and black rabbits; the travellers came to a castle, but no person answered them from it. They returned to the shore, and lit a fire, for the evening was cold; but a hideous noise ensued, and they took the boat and fled to the ship. Next day they saw a gentleman and his servants on the shore and brought them off. He said he had long been imprisoned in the castle by an enchanter; but the lighting of a fire by Christians had wrecked the main tower and broken the spell. Nesbit brought them to Killybegs, where many believed their story on seeing their old coins and hearing their out-of-date language and ideas.[5] Hamilton (as told by a Quaker) states that he was destined to disenchant the

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[1] "Voyage of Bran" (ed. Kuno Meyer), vol. i, p. 12.

[2] Dind Senchas (ed. Whitley Stokes), Revue Celtique, xv (1894), p. 458.

[3] Itinerary in Wales. Book I, c. 35.

[4] "Topography of Ireland," Dist. II, c. xii.

[5] James Hardiman's Irish Minstrelsy (1831), vol. i, p. 367, copied by T. Crofton Croker in the "Tour" of Boullaye Le Gouz, p. 68.

place; and he tells his correspondent:—"your cousin, a wise man and a great scholar," took out a patent under Charles I to hold the island.

Boullaye Le Gouz, in 1644, one evening, when approaching Ireland, saw (he says) a spectral land, from 1 to 3 miles away, with trees and cattle; and the pilot told him that it and similar islands near Greenland were often seen, and that there were floating islands further north near the Pole.[1]

Roderic O'Flaherty, in 1684, mentions the visionary island of O'Brasil, or Beg Ara, seen from Aran, and how at the rocks of Skird in the same bay phantom cities, towers, "blazing flames and smoak," were seen, with even people running, and, at times, ships and corn-stacks. One Morogh Ley declared that he had been carried off to O'Brasil for two days in August, 1668. Later legend tells how he brought back a medical work now in the Academy's Library, called "the Book of O'Brasil." O'Flaherty says that about that time some fishermen were carried two days out to sea from the Owles (O'Maille's country) and saw an unknown land, with sheep, but were in 30 fathoms of water beyond the Imaireboy cod-bank.[2] I myself have seen, on at least three occasions in 1868 and 1872, from the cliffs near Kilkee, County Clare, an apparent island, with hills, trees, towers, and smoke, after sunset, near the horizon.[3]

The European belief in mysterious islands probably sprang in a great degree from the Lives of St. Brendan. These stories had commenced before the Norse wars, but may have been shaped by the discoveries of the Vikings along the American coast. It was probably during the twelfth century that the later versions of the legend spread through the Norman Settlements from Ireland into Europe. The 1280 map of Richard de Haldingham at Hereford Cathedral does not mark any island outside Ireland; but, in 1339, A. Dulceti marked on his map a large island, about 60 miles west of the coast of Munster. The far superior Catalan map in 1373 named this island as "St. Brendan's Isle," and gave another, "The Isle of Mam," farther to the south. The 1459 mappa-mundi of Fra Mauro, executed for Alphonso V, King of Portugal, marks Brasil—"I. del Berzel, anesta isola de hibernia, son dite fortunato": but the knowledge of Ireland itself is mere ignorance.[4] Solerio's map, 1385,

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[1] "Tour in Ireland" (ed. T. Crofton Croker), p. 3. Archbishop Ussher, in "Hibernia," mentions the "Lo-a Miranda" seen by St. Brendan on the ocean.

[2] Mar Connaught (ed. James Hardiman), pp. 68, 69, 72. The Book of Ley has the date 1434 written in it. Readers will remember Gerald Griffin's poem on the Aran fisherman lost in the pursuit of Hy Brazil.

[3] Journal R.S.A.I., xxx, p. 289, and xl, p. 121, and "Guide to Islands," vi, p. 24. "Folk-lore," xxi, p. 481.

[4] The only cities named are "Stariforda" (? Carlingford), "Garafonda" (at Waterford), and "Domborg" (at Cork). See also early maps in Nordenskiöld's "Facsimile Atlas."

gives "Brazir" off Spain. In 1492 the great Behaim globe, without America, shows "Brasil" to the west of Donegal and two unnamed islands below it.

In the two centuries after the discoveries of Columbus it was to be expected that the constant voyages in the outer ocean would soon undermine all belief in the mythical islands of "Brazil," "the seven Bishops," "St. Brandan," "Buss," and "Mam," but such was not the case. Even such a cartographer as Abraham Ortelius, in the "Theatrum orbis terrarum," in 1589, shows "Demar" and "Brasil" to the west of Ireland in his map of Europe, and "Bund" to the west of "Brasil" in the map of the world.

In the middle of the following century a Dutch map (made during the wars of the Republic with Cromwell) shows Brasil in about the position of the Porcupine Bank; while, in 1680, the "English Atlas, printed for Moses Pitt in London, marks "Brazil" and "Maida"—the former a large island due west from the Land's End and to the south-west of Ireland.

The last notable retention of O'Brasil, foreshadowing its relegation to folk-lore, is that of Guillaume Delisle. He retains "Bus," "Frislande," and the "Roche de Bresil" in the map of Europe, 1724, while in that of the British Isles, in 1702, he has a pregnant note: "Dans ce parallele, 51° latitude, et un degré de longitude, quelques Cartes Marines representent une Isle a laquelle elles donnent le nom de Brasil; et a 46 degréz et demi de latitude et 356 degréz de longitude, ou environ, une autre quelles appellent Asmanda. Je ne Scay Sur quel fondement ces deux Isles ont été placées, mais j'ay de la peine a me persuader qu'il y ait des Isles, si peu éloignées de nos Côtes, qui nous ayent été inconnues jusqu'icy." But the Rock of Brasil is marked on charts till 1865.

The whole subject deserves far wider investigation and elucidation than it has received in this paper; but it is of sufficient interest (and, by its effect in encouraging Columbus, of world-importance) to call for some notice in treating of some of the Irish islands in which it formed an unshaken article of belief from time immemorial.

The legendary islands of the coast correspond to shoals—the Cantillons' Island to rocks in Ballyheige Bay, Kilstapheen to a shoal in the Shannon Estuary, Kilstuithin to sunken rocks in Liscannor Bay, County Clare, and Monaster Ladra to a dangerous reef opposite Annagh Point in County Mayo. This seems to imply that Tir Tairngire and Magh Mell originated in the same way.

Legend in Aran says that Hy Brazil appears once in seven years (like the land off North Mayo); that in County Clare asserts that Kilstuithin does the same, and that whoever sees its golden-roofed towers rising over the sea or glinting deep beneath the waves dies before its next appearance.

As for the Mayo lands,[1] "Mickletony" O'Donnell, of Termoncarra, told Caesar Otway that some twenty people had seen Monaster Ladra, and one had pursued it for several days in his boat to try to disenchant it. This "druid land" was often seen from Iniskea and Inisglora. Owen Gallagher, a servant of Otway's friend, Lieutenant A. Henri, when lost at sea, beheld looming through the fog an unknown island, landed and found it inhabited by "seal men." Henri, before 1840, had heard of this land as extending from Teelin, in Donegal, to the Stags of Broad Haven. A woman named Lavelle had seen a pleasant land about a mile off Dunminulla at Portacloy; it had hills, cattle, and *drying* clothes under the sea. A Ballycastle man had seen it twice at intervals of seven years. Had he seen it a third time, he could have disenchanted it: but he died the day before the completion of the twenty-first year.[2] It is said by the ancient Irish that when Tir Tairngire is disenchanted the sea will break over the present lands,[2] and that the sea is to overflow Hy Fiachrach, and, at last, cover the floating cairn at Tra Eothaill.[3]

Note.—Monuments in North Mubrisk (O. S. 95, 96).

From Clew Bay southward, though little is shown on the map, several interesting monuments remain. I have to thank Mr. Praeger for the following notes:—

(1) Among the sandhills south of Emlagh Point and close to Lough Cahasy is a cross-inscribed pillar 5 feet by 2 feet by 1 foot. The cross is "Maltese" and encircled; there is said to have been an inscription, but none remains. (2) The sandhills here and also at Dooaghtry, six miles southward, abound in midden remains. (3) Near Cross Lough on the upper side of the road leading south is a circle of irregular stones rarely 4 feet high. (4) At Tullavranna in a sandy plain is an earthen mound 20 feet high and 30 feet across, preserved by gravestones some 9 feet long and having a primitive church Templedoonmore. A stream cuts into the edge exposing coffins, bones, and skulls (see *Irish Naturalist*, xx, 193). (5–7) Three ring-forts at Aillemore, Cloonlaur, and Stookamore. South from Louisburgh, in Tobernahaltora, is (8) an unmarked dolmen, the chamber, 8 by 5 feet, with a cover, 7 by 6 feet. Mr. G. H. Kinahan describes a curious slab-structure at Aillemore also south from Louisburgh. It is 13 by 5 feet. Borlase notes it, and suggests that there may be an "altar" at the former site. This record of a supposed poor district suggests how much has still to be done by Irish antiquaries in this single county.

"Erris and Tyrawley," pp. 79, 98, 247, 401, and Otway's "Tour in Connaught," pp. 387, 439. Revue Celtique," xxvi (1906), p. 49.

[2] Book of Leinster, f. 239 b, "De Matribus Sanctorum."

CLARE ISLAND SURVEY.—WESTROPP: ARCHAEOLOGY.

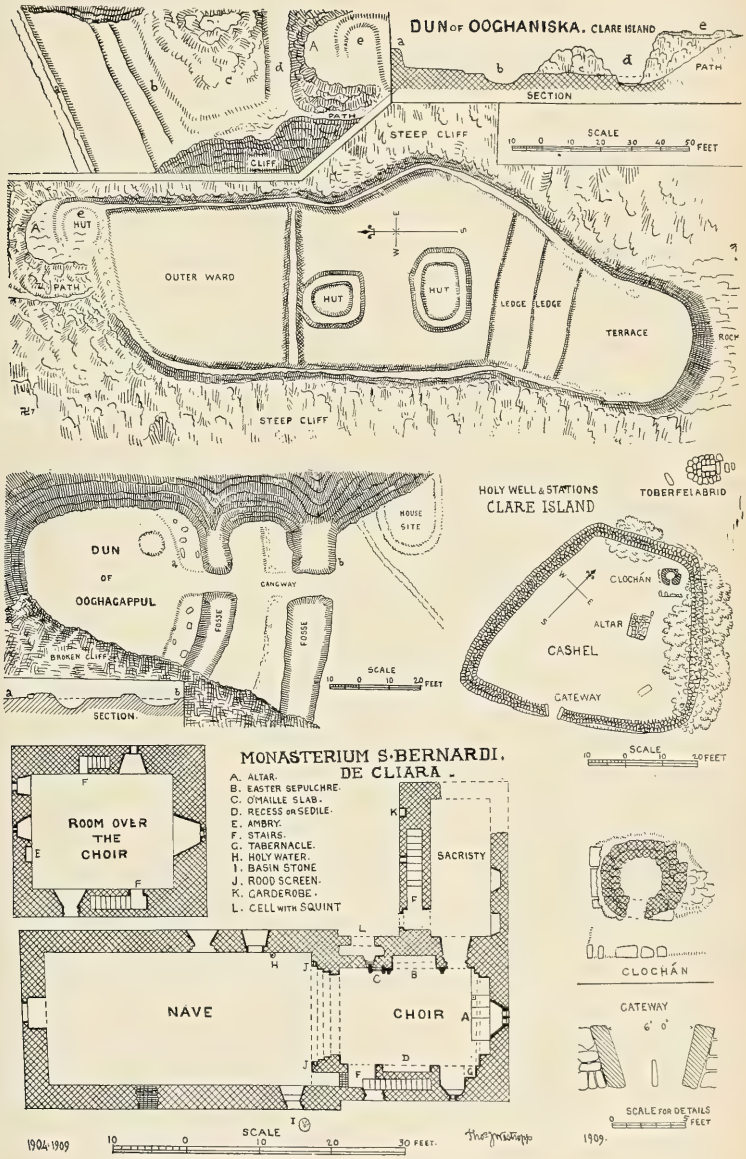
Clare Island Abbey from the south-east.

Clare Island Abbey from the west.

O Maille tablet, Clare Island.

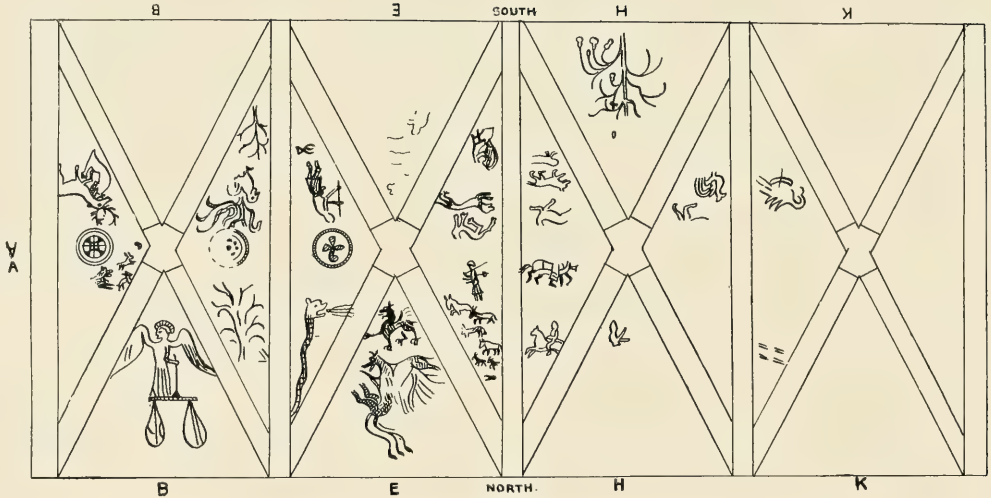
Cross, Clare Island.

CLARE ISLAND SURVEY.—WESTROPP: ARCHAEOLOGY.



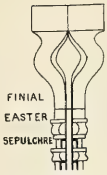
CLARE ISLAND.

CLARE ISLAND SURVEY.—WESTROPP: ARCHAEOLOGY.



1909 DIAGRAM OF CHANCEL VAULT - CLIARA ABBEY. FIGURES SOMEWHAT ENLARGED FOR CLEARNESS.

SOUTH WINDOW.



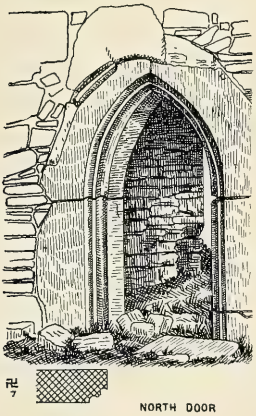
FINIAL EASTER SEPULCHRE

CORBEL IN CHOIR

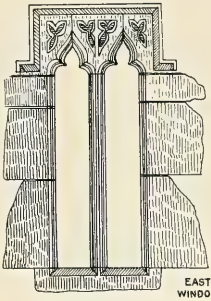
EASTER SEPULCHRE

EAST WINDOW MOULDINGS

HOLY WATER STOUP, NAVE

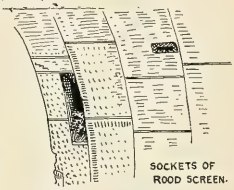


NORTH DOOR



EAST WINDOW

ALTAR



SOCKETS OF ROOD SCREEN.

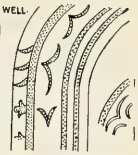
ANCHOR-STONES, TOBERFELABRID

BASINSTONE AT ABBEY

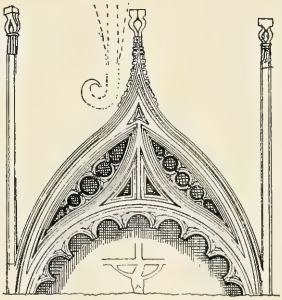
1909

PAINTED CORBELS

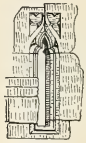
THE HOLE-STONE, ABBEY WELL



PAINTINGS. E. WINDOW



EASTER SEPULCHRE



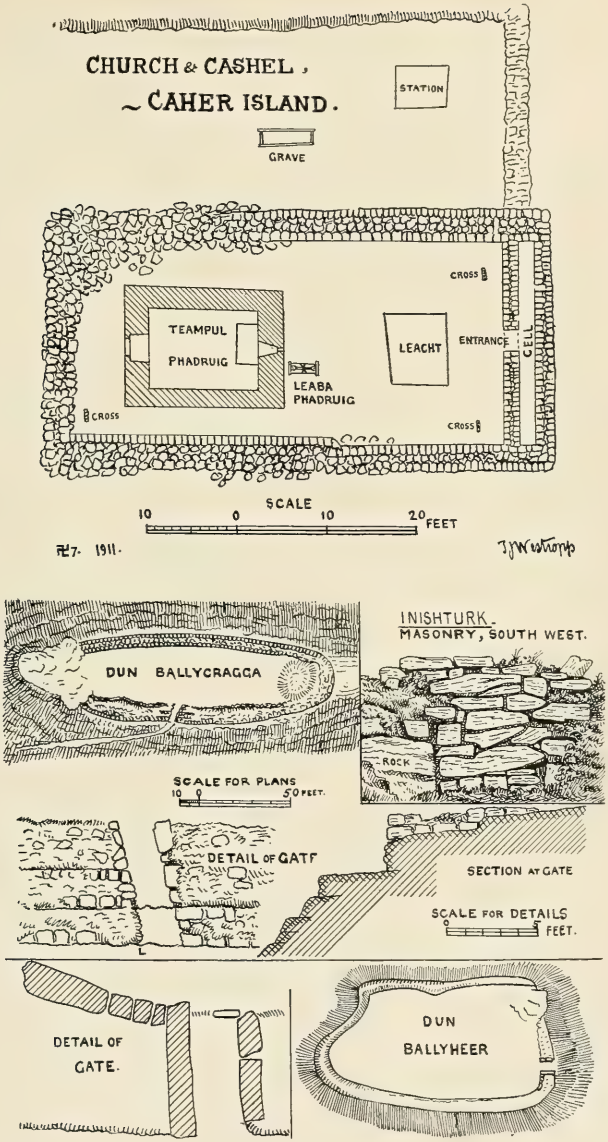
SOUTH WINDOW

Clare Island Abbey and Wells.

Clare Island Survey.—Westropp: Archaeology.

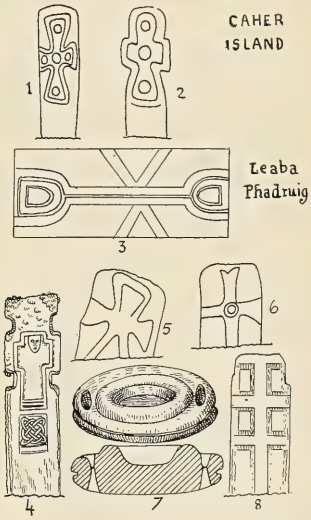
CLARE ISLAND.

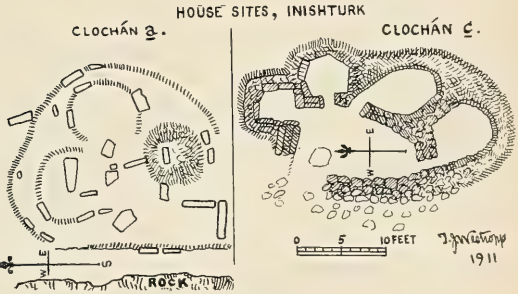
CLARE ISLAND SURVEY.—WESTROPP: ANTIQUITIES.



Caher Island and Inishturk.

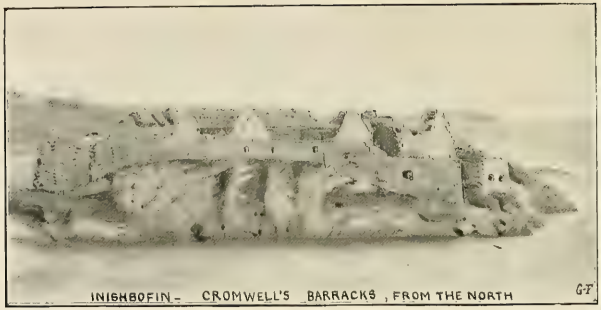
Clare Island Survey.—Westropp: Antiquities.

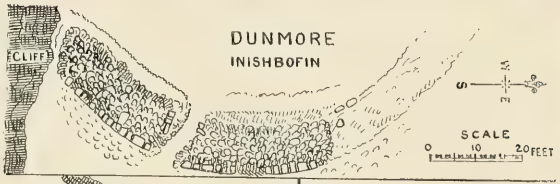


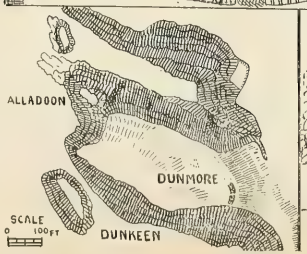


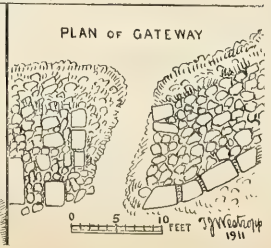
INISHTURK AND CAHER ISLAND.

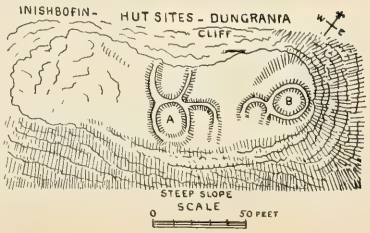
CLARE ISLAND SURVEY.—WESTROPP: ANTIQUITIES.





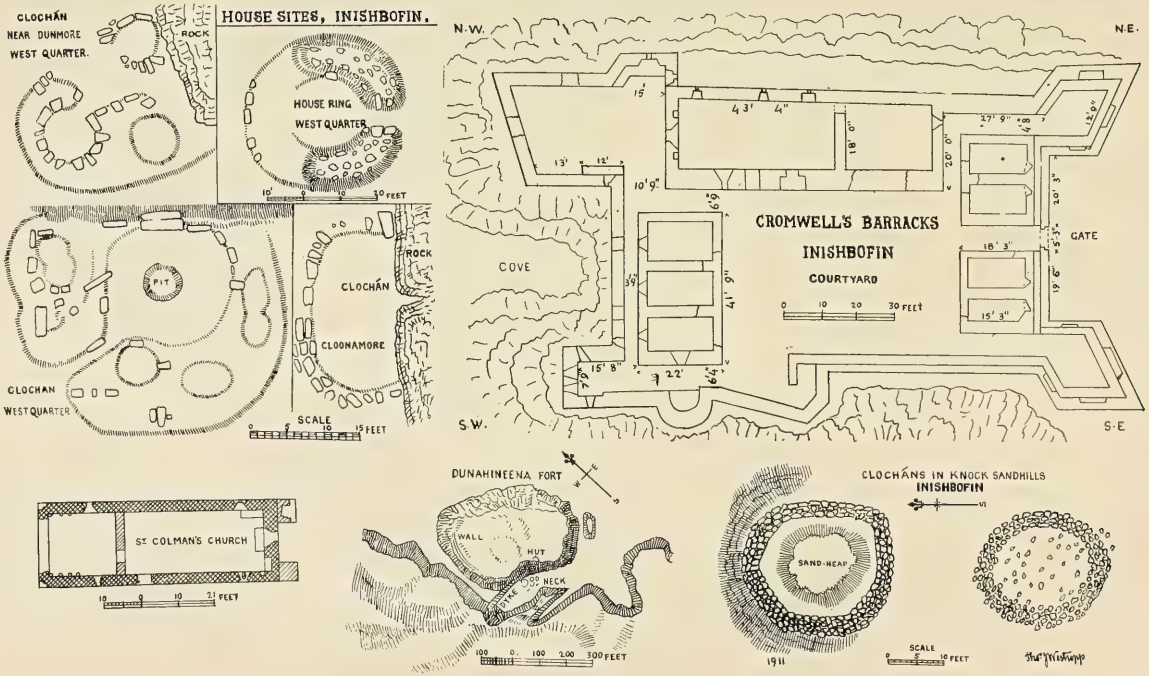






INISHBOFIN.

CLARE ISLAND SURVEY.—WESTROPP: ANTIQUITIES.



Inishbofin.

Clare Island Survey.—Westropp: Antiquities.

3

PLACE-NAMES AND FAMILY NAMES.

By JOHN MACNEILL.

Read January 27. Published April 30, 1913.

The list of place-names of Clare Island collected in this paper will, I trust, be found to have a scientific value from several distinct standpoints. The Ordnance Survey maps do not aim at recording fully the topographical names for divisions of land less than townlands; there is probably no principle on which they act in inserting or omitting the names of smaller divisions.[1] The townland names have acquired a sort of legal status, and thereby a definite degree of public recognition, and yet in many instances the division of the country into townlands has been a matter of arbitrary choice. Most of the townlands are, no doubt, divisions marked out and named by ancient tradition. In a large number, however, new names have been substituted in recent times for the old names, and even within living memory new townlands have been created at the will, apparently, of the landowners. For example, I have been unable to trace the name of the townland of Hazelbrook, in which I was once resident, at Portmarnock, Co. Dublin, in any record earlier than 1840. Until about that time, the land now so named was part of another townland. How satisfactory the topography by townlands is may be judged from the fact that some of them contain less than 40 acres and others more than 4,000. In Clare Island, the townland of Fawnglass contains 75 acres 2 roods and 14 perches, and the townland of Bunnamohaun contains 1182 acres 1 rood and 3 perches. The Ordnance Survey map, on the scale of six inches to the mile, names no subdivision of the latter townland, which is about two miles long and one mile broad and comprises more than one-fourth of the island. Bunnamohaun now contains no human habitation, and consists almost entirely of rough grazing and waste land. But the name shows that part of it was formerly inhabited, since it means "the low ground of the cabins." It is further evident that this name has been artificially extended in signification. "The low ground" must have been the western side of the island, or a portion

[1] The six-inch maps of Clare Island contain just one name, not well transliterated, of a smaller division, "Rooaunbeg." out of the many recorded in this paper; the much larger adjoining division, Ruain Mór, is not named on the map (Mayo 84).

thereof; but at present the townland so named happens to include the whole ridge of Cnoc Mór, which is the highest part of the island.

The Irish place-names, as they appear on the Ordnance maps, are often so distorted that the semblance of the originals is wholly obscured. The effort to represent the sounds of the names to an eye accustomed to English spelling comes often very wide of its mark. The majority of the names on the Clare Island maps are a record chiefly of the failure of an impossible task. Many of them can convey no even proximate notion of the sound to a reader of English, and are more likely to misguide than to guide a reader of Irish. It was doubtless the difficulty of dealing with such material that caused the Ordnance Survey officer to get confused occasionally, not only as to the forms of names, but also as to the places to which the names belonged. I note that in atlases for general educational use, place-names in Scotland, which are commonly spoken with their Gaelic pronunciation, are printed in their Gaelic spelling; and if this method fails to indicate the pronunciation to everybody, it yet secures historical accuracy. The other method, used in our Ordnance maps, fails in both respects.[1]

The scantiness of prehistoric and early historic structures in Clare Island has been noted in Mr. Westropp's paper (Part 2). The place-names bring under notice two sites, each named *Sidheán*, of which one, in the townland of Glen, is probably an artificial tumulus, and the other, near the lighthouse, seems rather to be a natural hillock. In both cases certainty could only follow exploration. The economic history of the island gathers a few facts from topography, and even a few facts are of more scientific value than any number of fancies. The general history and ethnography of the island cannot afford to ignore the rather remarkable evidence contained in the list of surnames.

Professor Wilson, in his paper on "Agriculture and its History," Clare Island Survey, Part 5, has stated the problem, "How far were the older Clare islanders true Celts, and how far were they modified in blood and in economy and custom by the Norsemen?" A large proportion of the family names bring with them a sufficient historical record to solve this problem—at least to the extent of enabling us to state it afresh on a structural basis of ascertained facts. Of true Celts, as a distinct race, ancient history and modern ethnology are alike ignorant. There is no Celtic racial type; and the only precise meaning that can be attached or ever has been attached to the name Celts is that it denotes a people whose language is or was Celtic. We have evidence that Clare Island once contained a population

[1] The more accurate preservation of the place-names of Wales, besides enabling some dull folk to think themselves humorous, has greatly facilitated the study of Welsh history and archaeology.

largely, if not mainly, representing racial elements older in western Europe than the Celts. We have also evidence, in Clare Island and the adjoining mainland districts, of almost incessant streams of immigration during many centuries, and these streams can be traced to many parts, not of Ireland alone, but of the continent of Europe, not in legend but in fully authenticated history. So far as I know, there is no evidence of any colony of Norsemen in or near the island during the period of the Norse migrations; but the surnames bear witness to the presence in some degree of a later-coming Hebridean element which is largely of Norse descent.

Some of the place-names will be seen to reflect bygone conditions of agriculture. *Tuar Mór*, the name of what remains of the most westerly village, means "the great bleachgreen." Another place is called *na Tuartha*, "the bleachgreens." The present generation in Clare Island has never seen a field of growing flax; much less has it had any experience of the spinning of linen thread or the weaving and bleaching of the linen fabric. Yet these things were familiar to every generation from the Great Famine back to a time much earlier than the first appearance of the Norsemen on the Irish coast. The "Parliamentary Gazetteer" of 1845, in the article on Westport, gives the following information on the authority of Mr. Inglis, who wrote in 1834 with reference to the linen industry:—

"The linen trade in this district, and most probably in other districts, is the source of all the extras which are obtained beyond the absolute necessaries of life. The land is let in very small portions; 7 or 8 acres is about the usual size of a "take." Potatoes are raised for the family consumption; grain, to pay the rent; and the flax is destined for clothing and extras. The decline of the linen trade has produced great want of employment; and the condition of the agriculturists throughout these districts has very much deteriorated..... The linen trade was extensively carried on here; and eight years ago as many as 900 pieces were measured and sold on a market-day. Now the quantity scarcely averages 100 pieces. Taking the whole district, including Westport, Castlebar, Newportpratt,[1] and Ballinrobe, about 500 pieces are sold weekly; and about 30,000 persons are supposed to be more or less employed in the trade. No trade gives such universal employment as this; not fewer than 60 persons are employed, from first to last, in preparing a web of linen."

The word *gort*, "a cornfield," is of frequent occurrence among the place-names in the more cultivated parts of the island. The "Parliamentary Gazetteer" says of Clare Island: "Much grain is shipped for Westport; large quantities of sea-manure are landed; and about 340 men and boys

[1] Newport, Co. Mayo.

divide their cares between farming and the fisheries." The working male population then was about equal to the entire population at present. From Westport, in 1835, the export of corn, meal, and flour amounted to 14,624¼ tons. "Considerable shipments of corn were formerly made at Newport; but they do not now exceed 1,000 tons a year, most of the trade having been removed to Westport." Corn, like linen, has long ceased to be a staple article of commerce in the district of Clew Bay. The authority quoted makes no mention of the export of live stock from Clare Island at the period 1841–1845. In Mr. Kilgallon's account of the recent export trade, quoted in Professor Wilson's paper, p. 45, there is no grain or other tillage produce, only live stock and wool. Since 1845, the industrial civilization of the island, and indeed of the mainland for the most part, has been lapsing from the agricultural and manufacturing to the pastoral stage.

Among other kinds of grain, we need not doubt that wheat was grown in Clare Island, as elsewhere in Ireland, from prehistoric times. The Irish names for wheat, *cruithneacht* and *tuireann*, cannot be dated as borrowed words. The word *cruithneacht* seems to have originally meant "Pictish produce," from Cruithni, the Irish name of the Picts, who formed a large element in the prehistoric and early historic population. There was formerly a water-mill on the island. A small group of houses, where the northern road crosses the stream in the townland of Maum, is still called *an Muileann*, "the mill." The stream is *Abhainn an Mhuillinn*, "the river of the mill," and it flows from *Loch an Mhuillinn*, "Loughavullin," "the lake of the mill." *Muileann* appears to be a loanword from Latin, but is of great antiquity in Irish. A legend ascribes the invention of watermills to Cormac mac Airt, a pagan king of Ireland. In A.D. 651, two sons of Blathmac, king of Ireland, went marauding in Leinster. They were pursued, and forced to hide themselves in the wheel of a corn-mill. The mill was set in motion, and the two princes were crushed to death. Verses made on this event are thus translated by Kuno Meyer:—

O mill
that hast ground corn of wheat,
This was not a grinding of oats (?)
Thou groundest on Cerball's grandsons.

The grain the mill grindeth
Is not oats, but it is red wheat:
Of the branches of the great tree was
The feed of Mael-odrán's mill.[1]

[1] Hibernica Minora, ed. by Kuno Meyer, p. 73. See also the Annals of Ulster, A.D. 650 (= 651). The word translated "oats" (?) in the first stanza is *serbland* = or, in the Annals, *serbaind*. It seems

The minute nomenclature of the coast-line is inherited from a time when the business of fishing gave more occupation to the islanders than it does at present. During the years 1890 to 1902, I was accustomed to spend a considerable part of my summer holidays in the middle island of the Aran group in Galway Bay, and had thus an excellent opportunity of closely observing the manner of life of the inhabitants, which must somewhat resemble the former life in Clare Island before recent economic changes had come into operation. That similar changes have not worked out in Aran is probably due to the unfitness of the islands for corn-growing on a commercial scale, and for pastoral existence. The extensive growing of corn for export in places like Clare Island must have operated on habits of life in the same direction as the economic division of labour under modern industrial conditions has affected the working population of manufacturing districts. In highly developing one form of industry it must have induced a degree of atrophy in other forms. The collapse of the staple industry, consequent on the repeal of the Corn Laws, found the rural community unable to restore the varied industrial activities of their former existence. Pasturage, a still simpler pursuit, took the place of corn-growing, but was less productive, and ultimately more than three-fourths of the population disappeared.

In Inishmaan, the middle island of Aran, these changes did not take place. The area of the island is less than two-thirds of the area of Clare Island, and most of the surface is bare rock. There is no peat, and the islanders have to buy their fuel from Connemara. In 1841 there were seventy-eight families in Inishmaan. When I was visiting it there were over seventy families. Except the school-teachers and their households, the whole population of working age were engaged in a great variety of occupations—fishing, the curing of fish, and the preparation of fishing-apparatus; even fishing-line, of excellent quality, was made from thread; there being no safe harbour for sailing-boats, the only boat used was the curach, manipulated with such skill and ease that the boat and the rowers seemed to be parts of one active and highly organized animal; rock-fishing was also practised; every suitable patch of ground was cultivated, chiefly for potatoes and rye, the chief use of rye being to supply straw for thatching, and the thatch of the houses was annually renewed. Nearly all the clothing worn by men and women was the product of their

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to mean "[material for] bitter ale." In fact, Meyer quotes a variant reading, which has not the negative, and might be rendered: "It was a grinding for bitter ale thou groundest on Cerball's descendants." In the second stanza, the ordinary word *corca*, now *coirce*, is used, meaning "oats." The mention of "*red* wheat" is interesting, as implying that the red and white varieties were both known. "The great tree" means the monarchical line of Niall of the Nine Hostages.

The two men were sons of Blathmac, king of Ireland († 665 or 668), son of Aed Sláne, king of Ireland († 604), son of Diarmait, king of Ireland († 565 or 572), son of Cerball.

own industry; their shoes were of untanned hide, and were so suitable for the rocky surface of the island that I was always glad to substitute a pair of them for my boots. The hides for making shoes were bought in Galway, and cost about £1 each. A patch of osiers belonged to each house, and the weaving of baskets was a household occupation. The preparation of kelp was another industry common to all; most householders possessed a few sheep, a cow, a mare, or a donkey, and some pigs; the pigs and the surplus offspring of the other live stock were exported.[1] The great range of activities required for all these occupations made the islanders alert and resourceful beyond any experience of mine in other places. During one of my visits a "slip" was a-building to make better provision for the launching and landing of the curachs. For this work the Congested Districts' Board supplied a foreman, cement, and tools. The dressing and laying of the stone were done by the islanders, whom I saw at work with mallet and cold chisel as if they had never known any occupation but that of stonecutters. The contrast in economic history between Inishmaan and Clare Island explains how the one island has been able to maintain a population hardly, if at all, less than it was when the population of Ireland was at its maximum; while the other island, nearly four times as populous in 1841, has at present almost exactly the same number of families as Inishmaan.

In Inishmaan, as in Clare Island, every outstanding feature of the coast-line bears a distinctive name; but the maintenance of the fishing industry keeps these names in constant use. I was fortunate enough in Clare Island to find a guide who was born before the Great Famine, Padraic Mhac Thuathail, born in Inishturk, but brought up from infancy in Clare Island; hale and active in mind and body, keenly observant, courteous, and eager to assist me. He is one of the best speakers of Irish that I have met, and a good speaker of English, too. In both languages he deliberately chooses the words and phrasing to suit his thought, as a poet or a good orator does, instead of using the ossified phraseology which is customary with most people. It is probable that many of the places named by him could no longer be named by many of the islanders. Indeed I was told by others that only he and one other man could be found to supply me with the correct place-names.

Professor Wilson has called attention to the situation of the Clare Island homesteads which, at first observation, seems to bespeak a degree of indifference to the fishing industry, since they are not placed so as to give the best access to the sea. The situation of the homesteads in Inishmaan is somewhat similar, though all the men and grown-up youths are engaged in

[1] The cultivation and manufacture of flax, however, were only remembered by the oldest inhabitants.

fishing, and also in the seashore work of kelp-burning and gathering seaweed for manure. All the houses are far from the sea. The sites are, no doubt, dictated by a sound traditional instinct, in which several needs are expressed. In these exposed western islands every site is not suitable for a house. In fact, only the more sheltered sites are suitable. A spring of good water must be sufficiently near at hand. The house must be so placed that those who are at home can look after the cattle and sheep-grazing in the open. In mountain districts on the mainland this last consideration appears often to govern the choice of site, the houses being placed at or near the edge of the rough grazing, in apparent disregard of convenience in other respects.

At present the houses in Clare Island are dotted here and there singly or in pairs. Older maps show them grouped in small villages, and village sites are still easily traced. My guide, Padraic Mhac Thuathail, born in 1841, remembers many inhabited homesteads forming hamlets which are now deserted.

Among some of those who had visited Clare Island before me on the work of this Survey I found the impression that the Irish language was almost unknown to the islanders. Bearing in mind my experience of other places of which a similar repute prevailed among visitors, when I met any of the islanders about whose knowledge of Irish there might be a doubt, I spoke to them in Irish only, and I found that the middle-aged and elderly folk in every part of the island could converse in Irish. The younger adults and the children have at most a small stock of Irish words and phrases. English is now consequently the common language of intercourse, and many who can speak Irish well rarely do so.

The local dialect of Irish is not to be distinguished in any general respect from the dialect of Partry and Joyce's Country, the nearest districts in which I had previously made a stay. Its phonetic system is the best preserved of all the extant Irish dialects known to me, that is to say, is the most fully in conformity with the orthography of early modern Irish. The main departure, common to all the dialects of Connacht and Munster, is the weakening of *ă* and *ea* in an initial syllable followed by a long syllable, e.g., *brŏdān* for *brădān* ("salmon"), *críogān* for *creagán* ("a piece of rocky pasture"), The diphthongation or lengthening of short vowels in certain positions, which characterizes the dialects of Munster, the Aran Islands, and Connemara (though with varying outcome in the various dialects), is not found in the dialect of southern Mayo, except in the one instance, common to all the modern dialects, of *ă* lengthened before long *r*, as in *barr*, *ard*. Both in Partry and in Clare Island I noted occasional phonetic tendencies suggestive of northern influence. The very characteristic rounded *ō*, normal in Connacht

and Munster, often became unrounded or open in unstressed syllables, e.g., in the ending *-óg* of nouns, *-óchaidh* of verbs; and the *ă* of unstressed *-ach*, normally a neutral vowel in Connacht and Munster, e.g., in *suarach*, was sometimes heard with its typical value as in stressed syllables. I would ascribe these northern traces to the transplantations of Ulster people to Connacht in the seventeenth century, in part, perhaps, to the influx of Hebridean *galloglachs* during the three preceding centuries.[1]

In the list of family names particulars of the recorded or traditional origin of a considerable proportion of the families now settled in Clare Island have been supplied. The notion exists that because the islands and coastlands of western Ireland are on the outer edge of the Old World, their inhabitants must in a specially high degree be representative of an aboriginal West European stock. The mere inspection of a map does not afford sufficient foundation for an assumption of this kind. Even if one is entitled to judge the matter *a priori*, there are other considerations that cannot properly be overlooked. The coastlands and the adjoining seas, since remote prehistoric times, have always been the freest highways for the redistribution of the human race. Mountainous, marshy, or heavily forested inland regions have always been the least accessible, and, with the exception of wholly barren deserts, the least tempting lands for newcomers. The predominantly maritime distribution of prehistoric megalithic structures in western Europe and north-western Africa indicates an extensive migration coastwise, and reaching to Ireland, at a period which at the latest was early in the Bronze Age; and must have preceded the Celtic immigrations traced from central Europe, a region, according to Borlase, almost or wholly devoid of structures of the kind. Since the Atlantic Ocean was the limit of early migratory movements in a western direction, we should rather expect its fringes to exhibit the maximum of accumulation, with a strong tendency in the conquering and dominant newcomers to wear down and wear out the older and weaker elements.

In the ancient folk-migrations displacement of one population by another is likely to have been of rare occurrence, and perhaps never took place except in cases when the invaded population could find another territory in which they might live in freedom. For conquering invaders, the most valued acquisition, ministering at once to their wealth and ease and self-esteem, must have been a subject population. The displacement of the language of the

[1] Surnames from the Hebrides and Argyle, belonging to families largely of Norse extraction, are frequent in western Connacht. The *galloglachs* ("gallowglasses") of Irish history were mainly Norse-Hebridean mercenaries. Rogers (MacRuaidhri), MacDonnell, and MacSweeney or Sweeny are *galloglach* surnames common in co. Mayo. MacAlpine and MacAuley are probably of like origin.

conquered by the language of the conquerors has sometimes created in a later age the illusion of a displacement of population. The Anglo-Saxon conquest of England is a case in point. Conversely, popular history ignores the Norse occupation of the Hebrides and the Norse dominion there for more than four centuries, and takes the modern Hebrideans for an extremely Celtic people, because in the long run the Gaelic language displaced the Norse language in that region.[1] In like manner, the population of southern Scotland is often supposed to be Anglo-Saxon, for no better reason than that an Anglian dialect has, in quite modern times, become exclusively the popular speech. Anglian colonization, as a matter of historical fact, did not extend beyond the eastern maritime region. Buchanan, writing in 1589, says that Gaelic was then "*magna ex parte*" the language of Galloway. It was also, *magna ex parte*, the language of the Scottish Lowland settlers in the north of Antrim as late as the first half of the eighteenth century.

Displacement, however, took place in other ways after conquest. The dominant class in a country is often the least prolific. It was otherwise with the Celts in Ireland. The rapid increase of the Gaelic nobility can be seen as clearly in the annals as in the genealogies, and stands in strong contrast to the very frequent extinction of the male line in the pedigrees and histories of the Norsemen and Franco-Norsemen.[2] Some have supposed that the Irish surnames in "O" and "Mac" are not ordinarily evidence of descent from the ancestors in whom they originated; that the subjects of an Irish chief were accustomed to assume his surname. I have never found any evidence of such a custom, even during the period when the privilege of the "five bloods" might have made it acceptable. Dubhaltach Mac Fir Bhisigh, the last of our hereditary genealogists, did not believe that the custom existed. He seems to have been challenged about it, perhaps by his friend Sir James Ware, and his answer is emphatic. He is discussing the question whether racial origin may be traced by means of physical characteristics, and he says of this criterion:—

"Though it may not be found true in all cases, there is nothing inconsistent with reason in it. And further, it is an argument against the people who say [ironically] that there is no family in this country which the genealogists do not trace up to the sons of Míl. And notwithstanding this,

[1] The Hebrides remained closely attached in intercourse and politically subject to Norway until 1263; but the Norse conquest was not merely a political conquest like that of England or of parts of Ireland by the Normans. That there was a very complete Norse colonization with a prevalence of the Norse language is proved by the fact that a large proportion of place-names in the Hebrides, amounting in some of the islands, it is said, to two-thirds or three-fourths, are of Norse origin.

[2] See the Norse pedigrees supplied by Vigfusson, *Icelandic Sagas*, vols. i and ii, and compare the descent of the Norman dynasty in England, and of the lordship of Leinster and the earldom of Ulster after Strongbow and De Courcy.

even though it were so, it would be no wonder; for, if a man will look at the sons of Míl, and the great families that sprang from them in Ireland and in Scotland, and how few of them exist at this day, he will not wonder that people inferior to them, who had been a long time under them, should not exist; for *it is the custom of the nobles, when their own children and families multiply, to suppress, blight, and exterminate their farmers and followers. Examine Ireland* and the whole world, *and there is no end to the number of examples of this kind to be found*; so that it would be no wonder that the number of genealogies which are in Ireland at this day were carried up to Míl."[1]

We have no grounds for questioning this testimony, offered by an ardent adherent of "the race of Míl," the dominant Gaelic people of ancient Ireland, as to their custom of making room for their own kindred by squeezing out the plebeian folk. The examples to which he appeals for corroboration are sufficiently abundant.

The contempt of the dominant Gaelic people for the older conquered folk is frankly expressed in another passage, quoted by the same authority "from an old book."[2]

"Everyone who is black-haired, who is a tattler, guileful, tale-telling, noisy, contemptible; every wretched, mean, strolling, unsteady, harsh, and inhospitable person; every slave, every mean thief, every churl, everyone who loves not to listen to music and entertainment; the disturbers of every council and every assembly, and the promoters of discord among people; these are the descendants of the Fir Bolg, of the Gailiúin, of the Liogairne, and of the Fir Domhnann, in Ireland. But, however, the descendants of the Fir Bolg are the most numerous of all these."

The customary "suppression" of plebeians to make room for the patrician race must have been a gradual process, too petty to obtain notice in the chronicles. There are, however, examples of suppression in a more conspicuous degree. The story of the descendants of 'Umór,[3] who were of the Fir Bolg, tells that in the time of Cú Chulainn they were so oppressed with burdens by Cairbre Nia Fear, king of North Leinster, that they migrated in a body across the Shannon and settled on the western seaboard. The great conspiracy of the subject races throughout Ireland, a few generations later,

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[1] O'Curry, "MS. Materials of Irish History," p. 225. The Irish text, given in O'Curry's Appendix, is from the introduction to the "Book of Genealogies," of which the original is now in the possession of the Rt. Hon. M. F. Cox, M.D., and O'Curry's transcript, the only one, is in the Royal Irish Academy library.

[2] *Ib.*, p. 224.

[3] "Book of Ballymote," 30*a* 28. The story is told in prose, and also in a poem by Mac Liag, who died in 1016.

was caused by the oppression they suffered from the Gaelic ascendancy. The tract on the plebeian communities[1] says:—"From these a bondage-rent of service accrued over the free race of Ireland. That is to say, the free races deprived them of the lands on which they served; and they decayed, and the free races encroached upon them and took their land from them, so that the servile rent thenceforth was attached to the free races, being fixed upon their lands.[2] For all the men of Ireland are free except the people we have enumerated." Among those enumerated is Túath Macc n-'Umór, *plebs filiorum 'Umóir*, already mentioned and hereinafter to be mentioned in connexion with Clare Island and the district of Clew Bay. If these accounts are legendary, they come nevertheless from writers who were familiar with the relations between patricians and plebeians in their own time. Like things happened at a less remote period than that of which these stories are told.

O'Donovan, in a note on Ui Maine, "Book of Rights," p. 106, cites a life of St. Greallan to the effect that "Duach (*recte* Dui) Galach, the third Christian king of Connacht, permitted them to dispossess Cian, the Firbolg king of the district, which was then called Mag Sein-cheineoil." The dispossessed people was named Tuath Sen-cheneoil ("the Tuath of the Ancient Kindred"), and is one of those named in the list of the plebeian peoples (BB 255 *a* 24).

Annals of Ulster, A.D. 551 (=552). "Bellum Cuilne in quo ceciderunt Corcu Oche Muman ('of Munster') orationibus Itae Cluano ('of Saint Ita of Cluain Ciedail')." The Corcu Oche (Corc[o] Oige) are named in the list of plebeian peoples, l. 15.

Ib. A.D. 751 (=752). "The annihilation of the Brecrige by Cenél Coirpri in Telach Findin." The Brecrige are named in the list of plebeian peoples, l. 20. Cenél Coirpri was a sept of the Ui Néill. "The annihilation of the Caillrige of Lorg by the Ui Briúin." The Caillrige (Cailraige) are named in the list of plebeian peoples, l. 12. The Ui Briúin, akin to the Ui Néill, were the dominant sept in eastern Connacht.

Ib. A.D. 752 (=753). "The killing of the Ui Ailella by the Greccraige." This was a revolt. The Greccraige were a plebeian people (Tuath Cregraighe, list, l. 26) partly settled under the Ui Ailella (BB 256 *a* 13), who were akin to the Ui Briúin, and occupied Tír Ailella (=Tirerrill barony, Sligo).

Ib. A.D. 776 (=777). "Strages Calraigi la Hu Fiachrach" ("by the

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[1] Ib. 255*a*: "Of the names of the rent-paying communities (*aithechthuatha*) and of their distribution throughout Ireland, according to the Book of Glenndalocha."

[2] The "Book of Rights" gives several instances of free peoples to whose lands a servile rent was attached: the Déisi of Munster, p. 51; the Luighne of Connacht, p. 105; the Delbna and the Ui Maini of Connacht, p. 107. To the list of tributes to the king of the Ulaidh (p. 168) is appended the statement: "These are his food-rents (*biatha*) from his free peoples (*saer-thuatha*), not mentioning his servile communities (*daer-thuatha*)."

Ui Fiachrach"). The Ui Fiachrach, akin to Ui Briúin and Ui Ailella, were the dominant sept in northern Connacht. The Calraige here named are probably the section from whom Glencalry in North Mayo is named.

Ib. A.D. 811 (= 812). "Slaughter of the Calraige of Lorg by the Ui Briúin. Slaughter of the Corco Roidhe of Meath by the Ui Maicc Uais." The Ui Maicc Uais were, like Ui Briúin, Ui Néill, Ui Fiachrach, and Ui Ailella, a sept of Dál Cuinn, dominant in Connacht, Meath, and most of Ulster.

Ib. A.D. 815 (= 816). "A battle is won over the Ui Fiachrach of Muiresc by Diarmait [king of Connacht] son of Tomaltach, and Fobren in the country of the Graicraige [=Grecraige) is burned and plundered, *ubi plurimi occisi sunt ignobiles.*"

This Diarmait died in 833, without having made sufficient provision for his posterity in the manner described by Dubhaltach. How his grandchildren repaired the omission is told by another genealogist (BB 102 *a* 30): "Uatu, son of Dathlaech, [son of Diarmait], with his sons and brethren [brothers and cousins], headed westward across the Suck; and the sons of Uatu slew in treachery at an ale-feast in one house [the chief men of] the Corco Roidhe of Fidh Manach all but a few." And "the sons of Uatu took possession of the lands of the Corco Roidhe" (100 *a* 20).[1] The year 900 may be taken as approximate date of this event. Corcu Roidhe was one of the plebeian peoples, Tuath Fhir Ruidi, l. 24.

That most of these acts of extermination are located in Connacht probably signifies that the plebeian communities there retained longest the power of resistance. Feebler elsewhere, they suffered perhaps less violent forms of "blighting" and "suppression," on too small a scale to be recorded in chronicles. It is sufficiently clear that there was a continued displacement of the inferior population by the dominant Gaelic element during many centuries.

The process was facilitated by the readiness of, at all events, the less opulent of the patricians to take to husbandry. "Five generations from king to spade," said an old proverb. That the transition might be even more rapid is indicated in the story in the "Fragmentary Annals" told of the grandson of a king of Ireland, himself afterwards king of Ireland, Fínnachta

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[1] These lands, not defined in *Onomasticon Goedelicum* beyond that they were west of the Suck, were in the district of Tuam, for the text cited above says that the race of Diarmaid further encroached (102 *a* 35) on the lands of Cenél nDubáin (barony of Kilmaine, co. Mayo) and of Cland Choscraigh (barony of Clare, co. Galway), and on the lands of the Soghain as far as 'Ath Glúinchinn (l. 41), = Bél 'Atha Glúinchinn, "Ballyglunin," where the railway between Athenry and Tuam crosses the Abbert river. Fidh Manach = Coill Fheadha Manach, "Killamanagh," west of Tuam, near Shrule.

(† 695), grandson of Aed Sláne († 604). "In respect of this world's goods, this same Fínnachta at the first was endowed but poorly: he possessing but wife and house, and, saving one ox and a cow, no stock at all."[1] The narrator is a re-furbisher of old chronicles for the benefit of those who prefer a well-told tale to a dry list of events. Whether his account of Fínnachta's early poverty and life as a husbandman be myth or fiction, he makes no wonder of it as a fortune that might fall to the lot of any king's grandson.

The seeker for an aboriginal race of men in Clare Island is likely to be disappointed. The island is the habitat of a population not less diverse in early distribution than the flora and fauna are at present. Nevertheless, as to the primitive inhabitants, there are some traditions worth noting. The tribe of the Sons of Umór has already been mentioned. The legend says that they were a branch of the Fir Bolg. They were driven out of Ireland into the surrounding islands by the Tuatha Dé Danann. In a later age they were driven back to the mainland of Ireland by the Picts. They then settled in Meath, but soon, as has been told, fled from oppression to lands west of the Shannon.

The tract which gives the territorial distribution of the rent-paying peoples (BB 255 *b* 36) is to all appearance an authentic document stating known facts. It has—

"Tuath Macc nUmoir in Dál Cais [= East Clare] and in Ui Fiachrach Aidhne [E. and S.E. of Galway Bay] . . . Tuath Chonchobuirni and (Tuath) Macc nUmoir in Ui Briuin [of Mag Seola, barony of Clare, Co. Galway] and around Loch Cime [Loch Hacket, on the Tuam side of Headford, Co. Galway] and in Cluain Fuiche [Cloonfush (?), W. of Tuam] . . . Tuath Macc nUmoir in Umall [the baronies of Burrish-Oole and Murrisk, Co. Mayo, including Clare Island]."

The poet Mac Líag gives the following places of abode of the Sons of Umor: Dún Oengusa in Aran, Loch Cime, Loch Cutra (near Gort, Co. Galway), [Magh] Aghair (between Ennis and Tulla, Co. Clare), Muirbech Míl (supposed to be the *muirbheach* or sandbanks at Kilmurvy and Portmurvy, Great Island of Aran) "Dál" with an *oenach* beside it (probably Tulach na Dála,[2] site of an ancient assembly-place and a modern fair, 4 miles N. of Tuam: *Onom. Goed.*), Rinn Bera (otherwise Cenn Bera, Kinvarra, on Galway Bay), Modlinn (a poetic name for Cuan Modh = Clew Bay), iath Aigli (the district of Aigle, at Cruach Phádraic, otherwise Cruachán Aigli, Mons Egli of L. Arm.), Laiglinn (unidentified), Dún Conchraide in Inis Meadhóin (now called Dún Conchubhair in the middle island, Aran, Galway), Tulach Lathraig

[1] "Silva Gadelica," p. 438.

[2] Hence Lally of Tollendall.

(Tillyra, Co. Galway), Rinn Tamain (Tawin, Co. Galway), Crích Aidne (=Kilmacduach diocese, Co. Galway), Boirenn (Burren barony, Co. Clare). (BB 30 *b* 10–20).

It is thus evident that the Race of Umor was anciently known as an unfree population, believed not to be Gaelic in origin, inhabiting, among other western tracts, the kingdom of Umhall, including Clare Island and the islands of Clew Bay.

Over them in Umhall ruled a patrician folk known as Fir Umhaill, the Men of Umhall, otherwise the Ui Briúin of Umhall. These were a sub-sept of the Ui Briúin of Connacht, descendants of Brión, who lived about A.D. 400, being a brother of Niall of the Nine Hostages. They belonged to the kindred called Dál Cuinn or Connachta, meaning not the inhabitants in general of the province of Connacht, Cóiced Connacht, the Fifth of the Connachta, but the dominant *gens* who ruled the province, and from whom it was named.[1] The oldest known habitat of this folk is defined by the name Machaire Connacht, "the plain of the Connachta," otherwise known as Mag Aoi. In it was the seat of their ancient kings, Cruachain Aoi or Ráith Cruachan ("Rathcroghan," Co. Roscommon).

The Connachta or Dál Cuinn afford the most remarkable example of the expansion of the patrician race. This expansion, in their case, can be traced continuously from the fourth century until the fourteenth, when Clann Aodha Buidhe, the descendants of Aodh Buidhe Ua Néill, king of Tyrone, 1260–1283, established themselves over a large part of the feudal territory of the earldom of Ulster, east of the river Bann. For an ancient list of the possessions of Dál Cuinn, before the feudal invasion, see my paper on "Early Irish Population groups," § 158. At the end of the list are the Men of Umhall.

In the genealogies of the Ui Briúin (BB 89), the first pedigree given is that of Domhnall Ruadh Ua Máille, dynast of Umhall, "killed by Clann Mebric and other foreigners (feudal settlers)" on Christmas night, 1337. He is twelfth in descent from Máille, the dynast from whom the surname is derived, and whose date should be about 400 years earlier. From Máille up to Conall Oirisen, son of Brión, there should be about sixteen generations. The pedigree has only seven, and therefore cannot be held authentic in detail to any point earlier than the eighth century. That the Ui Briuin were settled in Umhall in the eighth century is clear from the mention of "nepotes Briuin Humil" in the Annals of Ulster, A.D. 786. The family of Ua Máille was for many centuries at the head of this sept in Umhall. They were a sea-going stock.

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[1] The names Ulaidh and Laighin, in like manner, have a general and a strict meaning. In the strict sense, as used by the genealogists, they denote only the dominant dynastic races of ancient Ulster and Leinster.

"No one has heard of a man of Máille's race that was not a mariner."[1] The shape of their territory extending around Clew Bay from point to point (the baronies of Burrish-Oole and Murrisk), broad at the seaward ends, but a mere strip of coast at the head of the bay, strongly suggests Clare Island as the headquarters of their maritime domain, and explains the name "Ua Máille's Island," used in the Annals of Ulster (A.D. 1415). About one-fourth of the population of the island are descendants of Máille in the male line.

The place-names of the seaside were for the most part noted down in the course of a cruise round the island, beginning with the harbour at the east end and going thence northward, and so round by the west and south and back to the harbour. In making reference to the Ordnance six-inch maps, from which the englished forms of the names, so far as they are given, are here cited, it will be convenient to follow the same direction.

The names on the map are here given in *italics*.[2]

1. Clıapa, *Clare Island.* So usually, not Eıleán Clıapa.

2. An Ċéıb, *Harbour*, lit. "the quay."

3. An Tpáıġ, "the strand," from the Harbour northward, about a quarter mile in length, also named—

4. Tpáıġ Ḃpıġoe, "[Saint] Brigid's strand."

5. Leac na Tpáġa (pronounced Tpáḃa), "flagstone of the strand," forms the west side of the Harbour.

6. Leac na mḂó, "flagstone of the kine," a low rock surrounded by sand towards the north end of the strand.

7. An Ċopp Ġapḃ, "the rugged bend," a rocky point close to the Lace School, once a police barrack, noted "Constab. Bk." on the map.

8. An Coıléap,[3] "the quarry," on the rocky shore between an Ċopp Ġapḃ and Ceann na Coppa.

9. Ceann na Coppa, *Kinnacorra*, "headland of the bend," the most easterly point of the island. Here the divided swell of the Atlantic, sweeping round by north and south, meets again, and a great boulder-beach, V-shaped, raised by the waves, forms the limit of the land.

10. An Tuıpłınn Ḃeag, "the little boulder-beach," is the southern limb of the V.

11. Tuıpłınn na Stocán, "boulder-beach of the pillar-rocks," is the northern limb of the V. It ends northward in large rocks.

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[1] Topographical Poem. "The Ui Briúin in their seagoing ships" (Book of Rights, p. 106) must have special reference to the Men of Umhall.

[2] Departures from the normal Connacht pronunciation of the Irish names are specially noted when they occur.

[3] Another form of the word is Coıpéał. Both are derived from the French *carrière*. Many Irish words, often said to be of English origin, show by their pronunciation that they came into Irish from the French of the early feudal colonists.

12. Loćán Ceann na Corra, "the lakelet of Ceann na Corra," is a natural dam formed behind the boulder-beach. Note that Ceann in this name remains uninflected. A somewhat similar lake in Inir Meaḋóin (Aran), dammed up by a sandy beach, is called Loć Cinn Ġaimi[ṁ], where Cinn is genitive of Ceann; Ceann Ġaimi' "headland of sand." The presence or absence of inflection in such instances depends on the extent to which the words forming the name are felt to be separately significant or to have coalesced into a single term.

13. Carraig na bPortán, *Carricknaportaun*, "the rock of the crabs," a long reef running northwards from Ceann na Corra, and projecting from 200 to 300 yards into the sea to north of *Alnahaskilla*.

14. Ġaḃlán na hAirgaille, the angle of land beyond which the reef projects, "the fork of the oxter." Airgaill = "armpit," (*axilla, achselgrube*).[1] The reef is not inaptly compared to an arm held out from the body of the island. The name on the Ordnance map, *Alnahaskilla*, stands obviously for Aill na hAirgaille, "the cliff of the oxter"; but my guide refused to recognize it, correcting it repeatedly to the form I have given above.

15. Leac na Creaṫnaiġe, *Lacknacranny*, "flagstone of the *creathnach*," a low rock on the shore, west of Carraig na bPortán. Creaṫnaċ f., gen. creaṫnaiġe, is a form of dulse (dilisc) found growing on the shells of live mussels and preferred for eating to the ordinary kind that grows on rock.

16. Tón Tuaṫail, "Tuathal's butt," the ground above Leac na Creaṫnaiġe.

17. An Uaiċ[e] Beag, *Ooghbeg*, "the little cave."

18. Áirdeall, Ardal, "high-cliff."

19. Maolán na n-éan, "bare knoll of the birds," a rock in the sea. The name on the map is *Alnanean*, representing Aill na n-éan, "cliff of the birds," but was not recognized by my guide.

20. Leic a' Sgannail Mór, *Leckascannalmore*, apparently = "great stone of the scandal." Sgannal had doubtless some other meaning, for it is frequent in early Irish as a personal name, as is also its derivative Scannlán, whence the surnames Ó Sgannail "Scannell," and Ó Scannláin "Scanlan." A large rock on the foreshore. Beside it—

21. Leic a' Sgannail Beag, "little Leic-a-sgannail." Note that in these names, mór and beag have not aspirated initials, though leic is feminine. They are further instances of a group of words forming a noun independent of accidence.

22. An Colba, "the bedside," the cliff and promontory west of Leac a' Sgannail. Several cliffs in Inir Meaḋóin are named Colba, which is the

[1] The Old Irish word is *ochsal*, *oxal*.

ordinary name for the outer side or "stock" of a bed, and means a "bench" in earlier Irish. The point of the promontory is named—

23. Gob a' Ċolba, "beak of the Colbha."

24. Tanaiḋe Niocláir, "the shoals of Nicholas," a row of rocks covered at high water, west of Gob a' Ċolba. The foreshore over against these is named—

25. Bun a' Sgáirdáin, "the foot of the little waterfall."[1] In the little bay west of an Colba.

26. Port Liṫe, *Portlea.* I have no explanation of Liṫe.

27. Poll na n Gaṁnaiḋ, "pool or hole of the calves." At the north of the long beach of Port Liṫe. Gaṁnaiḋ = gaṁna, gen. pl. of gaṁain, "a grown calf." In most parts of Connacht, a short vowel ending, as in gaṁna, is often closed with an added *y* (i).

28. Leac a' Ṗríoṙúin, *Leckaprison,* "the flagstone of the prison."

29. Aill an Ṡaṫaiġ, *Allanahy,* "the giant's cliff."

30. Leic a' Ḃáid, "flagstone of the boat," close to Aill an Ṡaṫaiġ on the north.

31. An Calaḋ Beag, "the little haven," close to Uaċ Ċorragáin on the south. Calaḋ originally an adjective, "hard, firm." Then "firm land," as distinguished from soft marshy land on the bank of a stream or lake; hence the "callows" of the Shannon. Then "a landing-place," and so finally a small haven on the sea-coast.

32. Uaċ (or Uaiċe) Ċorragáin, *Ooghcorragaun.* I have no explanation of the second word, which may be a personal name.

33. An Leac Mór, "the great flagstone," north of Uaċ Ċorragáin.

34. Uaiċe Ḋaṁain, "the deep cove," takes the place of the Ordnance Survey name *Ooghanloughan* (apparently for Uaiċe an Loċáin, "the cove of the lakelet [rock-pool ?]," not recognized by my guide).

35. Leac na Cṙeaṫnaiġe, the second place so named, north of Uaiċe Ḋaṁain.

36. Uai'c na Mara (i.e. Uaiċ Mic na Mara), *Ooghmacnamara,* "Mac Namara's cave." The surname Mac Namara, originally Mac Con

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[1] "Scáirdán, a small cascade. An ear is formed by a river; a ṙcáirdán by a stream or ṙeadán. When rivers decrease in summer, their eara become ṙcáirdáin. *Old Cormick, of Erris*": O'Donovan, Supplement to O'Reilly's Dictionary. "Killough (otherwise Port St. Arne) . . . in the county of Down. . . . There is a remarkable well here called *St. Scordin's Well,* and highly esteemed for the extraordinary lightness of its water. It gushes out of a high rocky bank close upon the shore, and is observed never to diminish its quantity in the driest season": "Encyclopædia Britannica," fourth edition. The saint's name, still spoken of in the locality, seems to have grown out of the name of the well, probably tobar a' ṙgáirdáin. Sgáirdóg, equivalent to ṙgáirdán, is the name of a stream falling from the cliff a little west of the outlet of Owenmore river, on the south side of Clare Island. The basis of these words is ṙgáird = "squirt, gush, vomit," etc., verb ṙgáirdaim.

Mara, is found on the island. According to my guide, the correct name of this cave is—

37. Uaiċ na n'Oruideaċaí, "cave of the starlings." But the gen. pl. oruideaċaí is a modern colloquial form. We should probably expect Uaiċ na n'Oroo if the name were an old-established one. We found the cave frequented, not by starlings, but by swallows and rock-pigeons.

38. Carraiġ na Loċán, "rock of the pools," on north side of the last-named cave. Possibly, by some confusion, this name may have originated the *Ooghanloughan* of the O.S. map.

39. Leic Uí Ḃréanaill, "Ó Bréanaill's flagstone." The surname probably represents Ó Bréanainn, as Loch "Ennell" represents the older name Loċ Áinnin.

40. Stocán Ṁáire Ḟada, "the heron's sea-stack." The heron, corr ṡgréaċóg in Clare Island and the Aran Islands, is called familiarly Máire Ḟada, "long Mary," in Clare Island; Sioḃán Ḟada, "long Joanna (Julia)," in Aran. This rock is marked on the O.S. map by the misplaced and very much mangled name, *Carrickarelick.*

41. Dún Tráġa, "fort of the strand or ebb." The O.S. map has *Doontraneen,* presumably for Dún Tráiṫnín; but my guide would not hear of this name as correct. He pronounced tráġa (gen. of tráiġ) as tráḃa or trá-ú. In Omeath, Co. Louth, I heard the ancient pronunciation tráġa, with spirant ġ. In South Connacht and Munster, the pronunciation is trá, ġ becoming regularly silent after á, ó, ú. The place is an island at high water, and the site of an ancient fort, described by Mr. Westropp, Clare Island Survey, paper No. 2.

42. Dún Aille, *Doonallia,* "cliff fort," an ancient fort[1] on a high, almost isolated, rock. Close to it on the north, three rocks in the sea are shown on the map. The most westerly of these, nearest the main island, is—

43. Carraiġ na Roilleaċ, "the rock of the oyster-catchers." The position assigned on the map to "*Carrickarelick*" shows the looseness of the Survey work; and the form given to the name is well calculated to send the trustful searcher on a wild-goose chase for an ancient cemetery (reilig) in the vicinity of "Long Mary's sea-stack."

44. An Uaiċe Ḋuḃ, *Ooghduff,* "the black cave."

45. Ġob Uaċ Ġainiḋ, "beak of Uaċ Ġainiḋ," the point apparently indicated by "*Sraher*" on the map. Close to it, on the west—

46. Uaċ Ġainiḋ or Uaiċe Ġainiḋ, "cave of sand." I write ġainiḋ, as heard, for ġaineaṁ, gen. of ġaineaṁ, "sand."

47. Sráṫar, *Sraher,* "pack-saddle," a rock in the sea at Uaċ Ġainiḋ.

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[1] See Mr. Westropp's paper.

48. Coiḃa na Seiċe, "bedside of the hide," the cliff-face due east of the lighthouse.

49. An Leiceóg, the high rock on the northern point of the island A derivative of Leic, Leac, and similar in meaning.

50. An Ḟoireann, "the crew," a long sunken rock shown, but not named, on the map, close to land a little east of the northern point of the island. The jagged peaks of this rock, rising a few feet above the sea, when seen from the sea at a distance, present a very strong resemblance to men in a curach fishing. Hence the name.

51. Leic na Corra, *Lecknacurra*, "the flagstone of the bend." One might infer that the northern point of the island was called an Ċorr, "the bend," or Corr with some defining adjective or genitive; but I did not find such a name in use.

Here our course turns southwestward. The next name on the six-inch map, after *Lecknacurra*, is *Cushacappul*. This should represent Coir a' Ċapaill, "the horse's leg"; but my guide would not recognize the name. There is, however, a hollow in the high ground east of the lighthouse, known to him as Sáinn na gCapaill, "the pen of the horses."

52. Na Dáraċaí, or Carraig na nDáraċaí, a large rock in the sea about half a mile north of Leic na Corra, perhaps "the wild ones" (dáraċ, "bold, fierce, restless," O'Reilly). It is called in English "the Daisy Rock" or "Deasy's Rock," apparently mere sound-imitations of the Irish name. The O.S. map calls it *Calliaghcrom Rock*. This name properly belongs to—

53. An Ċailleaċ Ċrom, "the stooping hag," the rocky promontory of Clare Island, jutting out from the lighthouse northwestward. The O.S. map is again in error in marking *Calliaghcrom* as the name of the cliff on the edge of which the lighthouse stands, south of the promontory of An Ċailleaċ Ċrom. The map has thus two *Calliaghcroms*, neither of them in the right place.

54. An Ċarraig Ḟada, *Carrickfadda*, "the long rock."

The lighthouse was called by my guide an teaċ eólair, "the house of guidance" (so, réalt eólair, "guiding star"). The Irish name is not to be taken as a fixed proper name; but it is an interesting alternative to the more usual teaċ solais, "house of light," used in closer imitation of the English term.

55. Aill na Ḃó, "the cow's cliff," is the name of the cliff marked *Calliaghcrom* on the O.S. map, at the west side of the lighthouse.

56. Ḃinn an Iolra, *Benilra*, "the eagle's peak," rising over the sea to the height of 427 feet. Iolra, in Connacht dialect = iolar, "eagle." Ḟiolar is used in Munster and also in Tyrone.

The O.S. map has *Sheean* as the name of a rock in the sea. The name (Sioḋeán) belongs properly to a hill some distance inland (291).

57. An Mám Riabaċ, *Maumreagh.* Riabaċ "brown, brindled" (riab "a stripe"), is pronounced riaċ in Munster; and this form, spelled *reagh* or *rea*, seems to have been habitually adopted in the English writing of place-names. The name on the O.S. map seems to designate a sea-rock. It is properly the name of the adjoining height on the island.

58. An Aill Réiḋ, "the smooth cliff," at An Mám Riabaċ, probably takes its name from the absence of coves and promontories.

59. Tón na Siorra, "butt of the Siorr," at the southern end of An Aill Réiḋ. The Siorr is the hill to the east (286).

60. Aill na mBáirneaċ, *Alnamarnagh,* "cliff of the limpets."

61. Glaireileán na nGearaltaċ, "green island of the Geraldines," a large rock, unnamed on the O.S. map, in the sea opposite the southern end of Aill na mBáirneaċ. The name, in the form *Glassillangaraltach*, has been transferred on the map to another rock, Glaireileán Mór, nearly two miles farther westward (76).

62. Glaireileán Beag, "little green island," unnamed on the map, a rock in the sea, S.E. of Glaireileán na nGearaltaċ, and close to the western end of the boundary between Ballytoohy More and Ballytoohy Beg townlands.

63. Aill Tairb, "bull's cliff," south of Glaireileán Beag.

64. Tón Aill Tairb, "butt of bull's cliff," appears on the map as *Tonaltatarrive*, as though for Tón Ailt a' Tairb, "butt of the bull's ravine." Alt, "ravine," is very frequent in Ulster topography. It is fairly evident that someone familiar with Ulster Irish was engaged in reducing the place-names of Clare Island to the form in which they appear on the O.S. maps. In this name, Aill-Tairb becomes an uninflected group-word.

At this point, the western face of the island ceases to be a sheer lofty cliff and becomes a steep acclivity, rising to the height of 500 yards. On the coast-line of this slope, about a mile and a half in length, the O.S. map has only two names, one of which was not recognized by my guide. His list of names was taken down by me as we passed along in a sailing-boat. I am thus unable to locate with precision the places that the five following names should occupy on the map, which does not give them in any form. They were noted in the following order:—

65. Uaimín Dub, "black cove."

66. Aill a' Ċaorṫainn, "cliff of the rowantree."

67. Taman na Rón, otherwise taminaiġ na Rón: taman, "stump, block"; taminaċ, "a fine field in which daisies, sorrel, and sweet grass grow" ("Old Cormick of Erris," quoted by O'Donovan, Supplt.); na rón, "of the seals."

68. Sgrapa na nUan, "ledge of the lambs."

69. Leic a' Ċaorċainn, "flagstone of the rowantree," probably the rock marked on O.S. map (Mayo 84), close to the foot of the cliff, about an inch to the left of the place where the boundary between Lecarrow and Bunnamohaun townlands ends at the cliff on the N.W., and on the edge of the Ordnance sheet.

70. An Aill Mór, "the great cliff," the main slope from the summit of an Cnoc Mór (1520 ft.) to the water-edge.

Ooghduff, on O. S. sheet 84, at the place where the shore-line begins to bend to S.-W., can only stand for an Uaiġ Ḋub, "the black cave." I did not get the name from my guide. See Uaimín Ḋub, 65.

71. Poll a' Dúil, "hole or pool of the (. . . ?)." Among the meanings given by O'Reilly for dúl, the following may be pertinent; "a snare, trap, spring, gin; fishing with nets." It is, however, to be noted that for dol, O'Reilly gives "a kind of fishing-net; . . . a snare; link of hair." We may suspect some confusion here between dúl, with long u, and dol with short o, possibly through an alternative spelling, dul, for the latter word. In the sense of "a snare for fishing"—combining somewhat the meanings assigned by O'Reilly to both words—dol is the correct form. In Irish-English, "dulling for trout" is well known,—the fish as they lie still in a pool are snared with a noose of horsehair.

72. Carraig Poll a' Dúil, probably the sea-rock marked on the map beneath the name *Altatruffaun.*

73. Aill tSrupáin, "cliff of rivulet," the western part of the great cliff. Srupán, in Connacht dialect, = rruċán. After l, n, r, the aspirated ṙ (= h) often becomes t (written then tṙ or tr). The O. S. version of the name *Altatruffaun*, as with *Tonaltatarrive*, above, is an error likely to have been made by one familiar with the topographical nomenclature of Ulster.

74. Aille Leaṫuḋ, "cliff of (. . . ?)." The final syllable of leaṫuḋ may be phonetically represented by *hŭw*, the *w* being very lightly sounded. *ŭw* nearly represents the Connacht and Ulster pronunciation of the unstressed ending -aḋ in verbs and nouns. In Aille here, I am uncertain whether the final vowel is a mere helping vowel between final l and initial l, or represents the shortened form of the article—Aill a(n) leaṫaḋ, but a masculine genitive leaṫaḋ is most unlikely. I could not get an explanation of the name, and can only suggest that it stands for aill leaṫḋub, "half-black cliff," though in that case we should expect the article before aill. One thing certain is that the O. S. from *Allahan* is quite wrong, being an evident attempt to solve the difficulty of the name by inventing a new one, aill leaṫan, "broad cliff." Here again it is evident that the Survey official knew

Irish enough to be able to twist an unfamiliar word into one more familiar to himself.

75. Aill a' Ġrianraṁáin, *Allagreenramaun*, "cliff of the (. . . ?)." No explanation of ġrianraṁáin (not -máin) was forthcoming. It may be the name of a fish or bird, or perhaps a frequentative form of the verbal noun ġrianruġaḋ, "sunning, basking in the sun," as niġeaċán of niġe, "washing," ríoṁaċán of ríoṁ, "spinning." The writing of m for ṁ is further evidence of a certain degree of acquaintance with the writing of Irish on the part of the person who collected the names for the Ordnance Survey, since ṁ has the sound of *w* or *v*, retaining, however, the nasal quality in accented syllables.

76. An Ġlaireileán Mór, "the great green island," sea-rock at western end of Aill a' Ġrianraṁáin. Wrongly named on O. S. map *Glassillangaraltagh*, for Ġlaireileán na nGearaltaċ, already located (60).

77. An Ġlaireileán Beag, "the little green island," sea-rock south of an Ġlaireileán Mór, and named *Glassillan* only on the map.

78. Tón a' Tabair, "butt of the tower," the sea-front near the old Signal Tower. Tabar is merely the English word in Irish guise.

79. Tón Dabaċ, "butt of tubs." Dabaċ means also "a flax-dam" (O'Donovan, Supplt.). The O. S. version *Tonadowhy* may stand for Tón na dabaiċe (daiḃċe), with genitive singular instead of genitive plural.

80. Aill a' Ḃreáin Mór, "great cliff of the pin," overlooking the little bay south of the Signal Tower. Ḃreán, dialect-form of bioráin, "pin."

81. Aill a' Ḃreáin Beag, "little cliff of the pin," further south over the same bay.

82. Na Leacóġaí, "the flagstones," promontory south of the same bay.

83. Boo a' Ṁanaiġ, *Budawanny*, a high pinnacle on a narrow promontory. Boo = *membrum virile*; a' Ṁanaiġ, "of the monk."

84. Carraig na mBroll, *Carricknamrol*, "rock of the lamentations?" O'Reilly has burral "loud lamentation, a roar of grief," burralaċ "obstreperous in grief." Carraig na mBurral would pass easily into C. na broll in ordinary speech; as in Aran Is. mrŭχa for Muriċaḋ, brĭrtaχ for Muiriċeartaċ.

85. An Cromall, "the stooping cliff," over the inlet south of Boo a' Ṁanaiġ.

86. Na Cairle Corraċa, "the unsteady horses," rocks on the shore, on the north side of the south-western promontory of the island.

87. Ceann a' tŠeiṁdile, *Kinatevdilla*, "head of the beetle," sometimes translated "Beetle Head" by the islanders. "Séimdile reintile (read reintile?), a beetle for beetling clothes" (O'Donovan, Supplt.).

88. An Seiṁdile, "the beetle," the outer rock-island of the promontory.

89. An Seiṁdile beag, "the little beetle," the inner rock-island of the promontory.

90. An Glaireileán, "the green island," the peninsular extremity of the promontory.

91. Béal Ṡeáin a' Ċoire, "the mouth (i.e. passage) of John of the cauldron," between the outer and inner Seiṁdile.

92. An Béal beag, "the little passage," between an Seiṁdile beag and Glaireileán.

We now turn eastward along the southern shore of the island.

93. An Leic Buiḋe, *Lackwee*, "the yellow flagstone," a headland.

94. Uaiċ an Ṁadaiḋ Uirge, "the otter's cave," west of—

95. Carraig a' Ċroiḋe, "rock of the heart," headland east of an Leic Buiḋe.

96. Uaiċ (or Uaċ) Ḋaṁain, "deep cove," east of Carraig a' Ċroiḋe.

97. An Maolán Dub, "the black blunt rock," indicated on O. S. map by *Ooghmoylanduff*. The latter name, not used by my guide, should represent Uaiċ an Maolain Duib, "the cave of the Maolán Dub."

98. Leic a' Ġiolla Ṁóir, *Lackagilmore*, "flagstone of the big man," promontory on west side of Uaiċ an Ḃáid. Giolla, "servant, guide, gilly," becomes (like the English "fellow") more general in meaning when an adjective is added.

99. Uaiċ an Ḃáid, "the boat's cove," deep cove at the end of the townland boundary between Bunnamohaun and Strake.

100. Uaiċe na Ṁadaḋ, "cove of the dogs," on the east side of the promontory containing Poll na Madaḋ.

101. Poll na Madaḋ, "hole of the dogs," otherwise Poll a' ṁadaiḋ, "hole of the dog," a cavern extending from the east side of Uaiċe na Madaiḋ eastward about halfway through the promontory, then upward till it opens on the flat top of the promontory. It is flooded below at high water. My guide explained the name by saying that dogs to be destroyed were thrown down the hole, but the O.S. version of the name, *Pollawaddy* = Poll a' ṁadaiḋ, has only one dog in view.

101 A. *Ooghganny*, as placed on the O. S. map, seems to be the name of Uaiċe na Madaḋ, but is perhaps misplaced. It was not given by my guide. Synonyms used by different persons are not impossible. See Uaċ Ġainíḋ, 46.

102. Uaċ Laċnaċ, marked *Ooghnahawna* on O. S. map. I do not know what Laċnaċ means. 100 A. *Ooghnahawna* = Uaiċ na hAḃna, is evidently a genuine name, "cove of the river," as one of the main streams of the island

discharges into this cove. The spelling *awna,* where the pronunciation would be better conveyed to an English reader by *owna,* further bespeaks a writer acquainted with Irish spelling.

103. Uaiċ a' ḋilig, *Ooghadillis,* "cove of the dilisc." The omission of the final consonant in the O. S. name may be accidental; but on the Antrim coast the edible seaweed is known in English as *dullis* and *dulse.*

104. Uaiċ na nUan, "cove of the lambs," west of an Ḋún.

105. An Ḋún, *Doon,* "the fort," a fortified promontory.

106. Uaiċ an Ḋúin, "cove of the fort," east of an Ḋún.

106 A. *Ooghaniska,* Uaiċ an Uisge, "cove of the water," not on my list, is evidently a genuine name, as the cove so marked on the O.S. map receives a small stream from the land.

106 B. *Ooghnageeragh,* Uaiċ na gCaorać, "cove of the sheep," is not on my list.

107. An Ḃreacall, "the mottled rock," is the name of a broad rocky patch between the south road and the sea, beneath the name *Craigmore* on O.S. map.

108. Tón a' Ḃreacaill, otherwise Tón a' Ḃricill, *Tonabrickill,* "butt of the Ḃreacall." The second form, corresponding with the O. S. version, is certain to be the older. Indeed, Ḃreacall may be a popular etymological reconstruction of a name originally Ḃriceall. Áirdeall points to a final element *-ell* not *-all.*

109. Sgárdóg, "little waterfall," at east side of Tón a' Ḃricill. See 25, Ḃun a' Sgárdáin.

110. Uaiċe Ḃeag, "little cove," east of Sgárdóg.

111. Uai'c na Mara (contracted for Uaiċ Mic na Mara), *Ooghnamara* "Mac Namara's cove." See 36.

112. Carraig na Mara (for Carraig Mic na Mara), "Macnamara's rock," a long reef stretching into the sea, south of Uai'c na Mara. Mac na Mara is the popular variant of the surname Mac Con Mara, "son of Cú-Mara."

Ooghlannagh, printed on O. S. map under *Ooghnamara* in such a way as to leave doubtful the particular cove designated, is not on my list. It seems to represent Uaiċ Lachnaċ, placed by my guide much farther west, as shown above (102).

113. Uaiċe *Ned,* "Ned's cove," on west side of Carraig na Mara.

114. Ḃun na hAḃann, "foot of the river," where the Aḃainn Mór discharges into the sea. This and the newer form Ḃun na hAiḃne were both used by my guide.

115. Uaiċ an Ḟáil, "cove of the fence," at Ḃun na hAḃann. The O. S.

map has *Ooghvunanal* (= Uaiċ bun [or buin] an ḟáil), which my guide would not recognize. The name seems genuine, but may have arisen from a mixture of Uaiċ an ḟáil and bun na hAbann. My guide also said Uaiċ bun na hAbann.

Oomeennamuckmara (= Uaimín na Muc Mara, "little cave of the sea-pigs [i.e. porpoises]") is printed on the O. S. map right below *Ooghvunanal*; it is impossible to say what place is designated. The name was not recognized by my guide. Probably it represents Uaiċ Ṁic na Mara, wrongly understood and wrongly located on the map.

116. Poll a' Ċuraiġ, *Pitacurry*, "the hole of the curach or canoe." My guide would not recognize the O. S. variant, which may be genuine and now obsolete. Pit = *vulva*.

117. Eiṁ ḋá ṗort, "between two ports," the blunt foreland between Poll a' Ċuraiġ and Port na Praisce.

118. Port na Praisce, *Portnaprasky*, "Port of the pottage (or, of the wild mustard)." This and Port na Praiṡġe were both used by my guide. Praiseaċ, f., gen. praiṡġe and (of late formation) praiṡġe, is the generic name of a number of cruciferous plants and others popularly classed with them. Latin, *Brassica*.

119. Carraig a' Ḃráċair, "the friar's rock," a sea-rock opposite the mouth of Port na Praisce. There is a legend connected with the name.

120. An Ċill Ḃig (Ḃeag), *Kilbeg*, "the little church," an islet on the east side of Port na Praiṡġe.

121. Bun a' Ġrín, "gravel bottom," the upper side of the T-shaped cove of Uaċ Ċapaill. Grín, gen. of grian, gravel, sand.

122. Uaċ Ċapaill, *Ooghcappul*, "horse's cove."

123. Port tSruṁáin,[1] "port of stream," a small cove, receiving a tiny stream, east of Uaċ Ċapaill.

124. An Liaġáin, derivative of lia, gen. liaġ, "a great stone, pillar stone, etc.," east of Uaċ Ċapaill.

125. Port a' Liaġáin, *Portaleighaun*, "port of the great stone."

126. An Ġob Ḋuḃ, "the black beak," the rocky promontory east of Port a' Liaġáin.

127. Na Leapaċáí, "the flagstones," by metathesis for Leacpaċáí, a colloquial plural of leac. West of Port a' Ċuaille.

128. Port a' Ċuaille, *Portacoolia*, "port of the stake or post," just west of the *Pier* near the *Abbey*. The name is placed too far west in the O.S. map.

129. Port na Cilleaḋ, *Portnakilly*, "port of the church," rather perhaps

[1] The absence of the article may indicate here, as it often does in place-names, that a determining word or words have been dropped after the name.

"of the churchyard," since cill, anciently denoting a church, has the usual modern meaning of "burial-ground," the ancient churches being at best mere ruins, but the cemeteries around them being still preserved. The small harbour protected by the *Pier*. Cilleaḋ, with the ending pronounced *-ŭw*, is a new and local formation of the genitive, on the analogy coill, gen. coilleaḋ, "a wood."

130. Uaimin Ṗeadaír Uí Ḃraḋáin, "Peadar Ó Bradáin's cove," *Peter Salmon's Cove.* The surname Ó Bradáin is found on the island, and "Salmon" is the accepted English equivalent: ḃraḋán, "a salmon." On the east side of the cove—

131. Carraig a' Tuinn, or rather Carraig a' tṠuinn, "rock of the beam." Ṡonn, "a beam or post" (not from tonn "a wave," which would have given Carraig na Tuinne).

131 A. *Oomeengarve* = Uaimin Ġarḃ, "rough cove," marked here on the O.S. map, is not on my list.

132. Na Doireóċaí, the large sea-rock indicated but not named on the O.S. map below the name *Oomeengarve*, also the rock due east of it, named—

133. Doireóċaí Éamuinn, *Derraghyemon*, "Edmond's Doireóċaí." Of this word, which is plural, I have no explanation. Other rocks at this place are—

134. Carraig Ṫomáir Éamuinn, "the rock of Thomas (son) of Edmond," and—

135. Carraig Ṡeáin Aoḋa Ṁóir, "the rock of John (son) of big Aodh (Hugh)."

136. An Ḃeárna Ṡalaċ, *Barnasallagh*, "foul gap." Ḃeárna is also pronounced beárnaiḋ. Note that the O.S. map has *s* (restored) where the actual sound (written ṡ) is *h*.

137. Ṗoirt Tairḃ Beag, *Porttarriff beg*, "little bull's-port."

138. Ṗoirt Tairḃ Mór, *Porttarriff*, "great bull's-port."

139. Carraig na Searraiġe: my guide understood the name to be connected with searaṁ, "standing." In my opinion, searraċ, gen. searraiġe, is a normal Connacht variant of seirreaċ, gen. seirriġe, as carraigim is of coirreagaim, and the name may be explained as "rock of the plough or of the ploughland." *Carricknashasky*, the O.S. version, is not authentic, my guide informed me. If it were, it would stand for Carraig na Searġaiġe, "rock of the dry cow," and perhaps the O.S. officer here again substituted a familiar for an unfamiliar word.

140. Uaiċ an Domaiġ, explained to mean "the dummy's cave," east of Ṗoirt Tairḃ. If domaiġ represents "dummy," this name must be of recent origin.

141. Uaimín na Caorać Caoiće, "little cove of the blind ewe.' For this, the O.S. map has *Oomeenakinkeel,* as it were Uaimín a' Ċinn Ċaoil, "little cove of the narrow head," but my guide rejected this name as quite incorrect. It seems to have arisen from confusion with—

142. Uaiće 'n Ċaoil, "the cove of the narrow passage," which in O.S. spelling should have been given "*Ooghinkeel,*" but appears on the map as *Ooghkeel.*

143. Uaimín Gort na Muclać, "the cove of Gort na Muclach." G. na M. is a stretch of land north of Gob an Uaimín. The name of the cove seems to be represented on the O.S. map by *Oomeengubamonemeen,*[1] altogether rejected by my guide, and unintelligible to me.

144. Garrán, *Gurrawn,* east of Gob an Uaimín. O'Reilly gives the meanings "a grove or wood," and "mud."

145. Gob an Uaimín, *Gubanoomeen,* "beak of the cove," a promontory.

146. An Uaiće Leaṫan, *Ooghlahan,* "the wide cove."

147. Uaiće na Maiṡí, *Ooghnamaddy,* "cove of the sticks," named perhaps from driftwood.

148. Uaiće na Soilleaḋ, *Ooghnasellen* (a misreading for "*Ooghnasellew*"), "cove of the fat." Soill, ṡoill, "the fat of meat." The gen. ṡoilleaḋ, for ṡoille, is modern and local. See above, 129, under Port na Cilleaḋ.

149. Uaiċ na Ḋrire, "cove of the bramble." The O. S. map substitutes *Ooghnadrishoge,* representing either Uaiċ na Ḋrireóiġe, "cove of the bramble," or Uaiċ na nḊrireóg, "cove of the brambles"; ḋrireóg being a derivative and frequent synonym of ḋrir. West of Ḋún Clóca is—

150. Carraig na mBealaiġe, explained to mean "rock of the ways."

151. Ḋún Clóca, *Doon Cloak,* "fort of cloaks (?)." An ancient promontory fort. See Mr. Westropp's paper.

152. An Ċaṫaoir, "the chair," rock near Ḋún Clóca.

153. Port Ṫruiceaċ, *Portruckagh.* I have no explanation of ṫruiceaċ. Ruiceaċ would mean "wrinkled, corrugated," but the two words were pronounced slowly for me as written.

154. An Carraig Mór, "the great rock," extending eastward from Ḋún Clóca.

155. Ua' Nápla (for Uaiċ N.), *Ooghnapla,* "Annabella's cove."

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[1] The notes from which the names on the O.S. maps were taken must have got into confusion in this and other instances. I think that the notes may have contained "*Gortnamucklagh*" as the name of the adjacent piece of land, and "*Oomeen G.*" as the name of the cove. But in the preparation of the map, denominations of land less than townlands were generally omitted. "*Gortnamucklagh*" being thus ignored, when "*Oomeen G.*" came to be written in full, "*G.*" would be supposed to refer to the nearest name beginning with that letter among the names retained, viz. *Gubanoomeen. Oomeengubanoomeen,* which suffered again in transcription, would mean "the cove of the beak of the cove," a most unlikely name.

156. Uaċ Ċaiṫṙíona, *Ooghcatherina*, "Catherine's cove."

157. Uaiċ na Caillīġe Duiḃe, *Ooghnacallyduff*, "cove of the black hag (cormorant, shag)."

158. An Uaiċ Mór, "the great cove." The bare name *Oogh* on the O. S. map is obviously incorrect.

159. An Cnaiġe, "the knob," a high bluff overlooking an Uaiċ Mór.

160. An Uaiċe Ḋaṁain, also an Uaċ Ḋaṁain, *Ooghganamna* (!), "the deep cove."

161. Uaiċe 'n Ċuṙaiġ, "cove of the curach (canoe)," between the last-named and an Uaiċe Ċaol.

162. An Uaiċe Ċaol, *Ooghkeel*, "the narrow cove."

163. Uaiċe 'n Ḃáiṫ, *Ooghanwaud*, "the boat's cove."

164. Ceann na hUaiċe, *Kinnahooey*, "headland of the cove."

165. Uaiċe 'n Tuṙ, *Ooghantur*, "cove of the tower (perhaps, of the bush)."

166. Carraig a' Ḃainne, "rock of the milk."

The O. S. name is *Kinnawoneen*, which is a corruption of—

167. Ceann a' Ḃáḃain (báḃúin), "headland of the bawn," i.e. the enclosure still called—

168. An Ḃáḃan, the "bawn" of the castle. From it projects the pier, an Ċéiḃ, at which our circuit of the coast began.

Inland Names.

169. Baile an Ġleanna, *Glen*, "townland of the valley," named from the valley of the stream—

170. Abainn a' Ġleanna, "river of the valley," rising on the east side of Cnoc na bṙian, and flowing eastward till it enters the sea at the middle of the strand near the Harbour.

171. Barr a' Ġleanna, "top of the valley," district about the head of the stream, the most northern part of the townland.

172. Cnoc na bṙian, *Knocknaveen*, "hill of the Fiana," the chief height (729 ft.) in the eastern half of the island.

173. Creig na gColum, "crag of the pigeons," eastern spur of Cnoc na bṙian, north of the Presbytery, near the point where the boundaries of Glen, Lecarrow, and Fawnglass townlands meet.

174. An Leaṙgan, "the slope," on the north bank of the stream, north of the Presbytery. The final syllable is short.

175. An Loṙgán (derivative from loṙg "track" or luṙga "shin"), the slope facing east on which the Presbytery stands. Two fields east of the Presbytery, there is a small tumulus called—

176. Sióeán, "fairy knoll"; the fence passes over it.

177. An Máimín, "the little *mám*," hill on north side of Barr a' Ġleanna.

178. An Criogán Bán, "the white (grassy) crag-field," on north side of Fán Glas (241).

179. Coill an Áta, "wood of the ford," S.E. of Lorgán, north of the southern road, due north of Doon Cloak. The "wood" no longer exists.

180. An Currac Mór, "the great moor," the lower part of the valley, adjoining the strand on the west.

181. Na Ruainte (plural of a feminine noun Ruan or Ruain, meaning unknown to me), a long low ridge between the southern road and the cliffs on the south. The highest point of the ridge is marked 194 ft. on O.S. map. The slope north of this point is—

182. Taob na Ruan, "side of the Ruans."

183. Cúl na Ruan, "back of the Ruans," the N.E. slope facing towards the strand. West of na Ruainte—

184. Gort na Muclac, "cornland of the swine-ranges," above Gob an Uaimín. West of this—

185. Fál Buailead, "fence of cowfolds," at the S.W. corner of Glen townland.

186. An Bóthar ó Dheas, "the southern road." North of Gort na Muclac and Fál Buailead, the road passes through—

187. An Ġualac, a stretch of cultivated ground. I have no explanation of the name. (Ġual, coal, fuel. Ġuala, shoulder).

188. Currac na Ġualaige, "moor of the Gualach," north of Gort na Muclac.

189. Páirc Ṡéamuir, "James's field," west of Fál Buailead, north of Port Tairb.

190. Barr a' Ġuirtín, "top of the little cornfield," south of Béacán, (205), north of southern road.

191. Log a' tSeanraiġ, "the colt's hollow," and——

192. Log na bFéileacán, "hollow of the butterflies," two hollows on the west side of Cnoc na bFian and Béacán.

193. Bóthar Baile Tuaiḋ, "road of Ballytoohy," thence to the Abbey.

194. Bóthar na Leice, "road of the flagstone," an old track running east and west through the hollow in Lecarrow townland between Cnoc na bFian and Cnoc a' Máma. On its south side are—

195. An Ċreig, "the crag," N.W. of Barr a' Ġleanna (171), and—

196. Sgailp Leac a' Doirín, "cleft of the flat rocks of the little oak-wood," in the west of the valley.

197. Caolrac, "narrow place," a hollow below the cliff on south side of Bóthar na Leice.

198. Léana na bPoll, "marsh of the holes," a marshy place near Caolrać.

199. Leac a' Ġleanna, "flat rock of the valley," near Bóčar na Leice, which is no doubt named from it, in the valley north of Cnoc na bFrian.

200. Mám Ġrín, "hill-breast of gravel," N.W. spur of Cnoc na bFrian.

201. Taob a' Cnuic, "side of the hill," the southern slope of Cnoc na bFrian, north of the Gualach. In its eastern side—

202. An Fál Garb, "the rough fence," west of which is—

203. An Fál Úr, "the fresh or grassy fence." This and the preceding name are now given to stretches of land.

204. Barr a' Sgonnra, "top of the dry-stone fence (sconce)," the high ground north of Taob an Ċnuic, rising towards—

205. Béacán, "the beacon (?)," the hilltop marked 692 ft., north of the dividing line between Glen and Kill townlands.

206. Baile na Cilleaď,[1] *Kill*, "townland of the old church or churchyard." In its north-east corner—

207. Barr a' Baile, "head of the townland." The hill north of this is—

208. Cnoc an Ḟeóčain, "hill of the storm." South of Barr a' Baile, at the road, is—

209. An Ṗáirc Mór, "the great park or grass-field." South of this, towards the sea, adjoining Port Tairb, is—

210. An Ṗáirc Luaċra, "the park of rushes."

211. Creig na Ceartaď,[2] "crag of the (rag ?)," a rocky knob between the southern road and Port Tairb. There is another place (308) of the same name in Ballytoohy Beg townland.

212. An Meall Mór, *Malmore*, "the great lump," the south-western spur of Cnoc na bFrán. The south-western slope, above the Abbey, is named—

213. An Cnoc Bán, "the grassy hill." The adjective bán, "white," applied to land, denotes the bright green colour of a grassy surface, in contradistinction to talaṁ dearg, "red, i.e. tilled, land," and to the darkness of bog or heath.[3] Hence an bán, "the grassy turf," báirneaċ, "a grassy flat."

214. An Mainistir, "the *Abbey*." Close to it—

215. Tobar Ṗéile Muire, *Toberfelamurry*, "the well of Mary's festival," i.e. a holy well, associated with a "station" or pilgrimage on Ladyday.

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[1] The genitive cilleaď, replacing cille, is an analogical formation after words like coill, gen. coilleaď. I use the traditional spelling for the ending, -aď, which in Connacht and Ulster is pronounced somewhat like ŭw.

[2] Like cilleaď, an analogical formation, from ceirt "rag," or perhaps replacing cearvčan, nominative cearvča, "smithy."

[3] "Báirceanna bána i lár an ṗraoiġ," "green fields in the midst of the heather"; Connacht folksong, An Bóiṫrín Buiḋe.

According to Pádraic Mac Tuaṫáil, the name is Tobar Céile Muire, "the well of Mary's spouse," i.e. of Saint Joseph.

216. Stáca na Cille, "the pillar-stone of the church," a monolith with incised cross, now built upright on the fence of the churchyard.

217. An Muine Dub, "the black brake or shrubbery," east of and adjoining the Abbey.

218. na Breánraiḋe, "the fetid grounds," S.E. of the Abbey, adjoining Port na Cille.

219. An Gairḋa Dub, "the black garden," close to the Abbey on the west.

220. Gort na Gualann, "cornland of the shoulder," S.W. of the Abbey and adjoining it.

221. Currac a' tSagairt, "the priest's moor," adjoining Uaċ Ċarail, S.W. of the Abbey.

West of Cnoc na Bfian and N.W. of an Meall Mór, is a hollow containing three small lakes. Close to the most easterly lake is a spring or pool called—

222. An Poll Báiṫte, "the drowned or sunk pool, or the pool of drowning." The boggy ground about it is—

223. Léana an Puill Báiṫte, "marsh of P. B." From this is named—

223A. Loċ Léana an Puill Báiṫte, *Lough Leinapollbauty*, "lake of the marsh, etc.," but this name was not used by my guide. For the northern lake, his name was—

224. An Loc ó Tuaiḋ, "the north lake." The O.S. name is *Creggan Lough*, which doubtless stands for Loċ a' Ċreagáin, "lake of the rocky field."

225. Loc Meirgeaċ, "rusty lake," on the south, is wrongly called *Lough Merrignagh* on the O.S. map. There is no "n" in the name, but one has gone astray from the O.S. version of the next name—

226. Abainn a' Doirín, *Dorree[n] River*, "river of the little oakwood." It flows northward from the marshy hollow aforesaid, then eastward through Loc a' Ṁuilinn to the sea at Port Liṫe.

227. An Leiṫċeaṫraṁa, *Lecarrow* townland, "the half-quarterland."

228. Taob na Tulaige, "side of the mount," the rising ground west of the three lakes.

229. An Mám, "the breast of the hill," Cnoc a' Ṁáma, "hill of the Mám," the northern spur of Cnoc na bFian, west of Loċ a' Ṁuilinn.

230. Baile an Ṁáma, *Maum*, townland.

231. Leaṫċoill, "half-wood, wooded hillside," on the east slope of Cnoc a' Ṁáma towards Loċ a' Muilinn. Bushes in plenty are still there.

232. Poll a' Brandaid, "hole of the brandy," a pool whose position corresponds to that of the second *r* of the townland name "Lecarrow," O.S. sheet 85. The O.S. name *Pollabrandy* is printed as belonging to the stream flowing from the pool. The name, it is said, originated in the use of the pool as a hiding-place for smuggled brandy.

233. An Muileann, "the mill," where the eastern road crosses the stream near Maum townland, near Port Liṫe. Site of a watermill.

234. Abainn a' Muilinn, "river of the mill," rises near Aill Tairb on the west side of the island, receives Abainn a' Doirín, flows through—

235. Loċ a' Muilinn, *Lough Avullin*, "lake of the mill," in Maum townland.

236. An Learaḋ, a bushy hillside in north of Maum townland.

237. Curraċ a' Loċa, "moor of the lake," north and north-west of Loċ a' Muilinn.

238. Caolraċ, "narrow place," south of Loċ a' Muilinn.

239. An Máimín, "the little hill-breast," rising ground on N.W. of Fawnglass townland, S.E of Loċ a' Muilinn.

240. An Léana Bán, "the white marsh," north of Fawnglass townland.

241. Fán Glas, "green slope," *Fawnglass* townland.

242. An Cnoḡán Bán, "the white (grassy) rocky field," in the north of Fán Glas. Cnoḡán = creaḡán.

243. Béal na Corra, "mouth of the bend," a sharp eminence in Fán Glas; the road running westward through this townland turns S.W. and then north to pass Béal na Corra.

244. Ceap na nGabar, "the goats' division," *Capnagower* townland.

245. Tobar Brigde, "Brigid's well," or Tobar Féile Brigde, *Tober-felabride*, "well of Brigid's festival," a holy well near Ceann na Corra. Devotional exercises are practised at it. The second name indicates Saint Brigid's feast, February 1, as a day of special resort to the place.

246. An Stráca, *Strake* townland, probably "the streak or stripe," being a very long and narrow division.

247. An Ruain Big, *Rooaunbeg*, "the little Ruain," north of Poll a' Ċuraiġ. The O.S. spelling "Rooaun" supposes some such Irish form as Ruaḋán, and is misleading, Ruain being a monosyllable. The dative has replaced the nominative form in noun and adjective.

248. Abainn na Ruaineaċ Bige, "river of the little Ruain," a small stream discharging at Poll a' Ċuraiġ. So we have nom. sing. Ruain, gen. sing. Ruaineaċ, nom. pl. Ruainte, gen. pl. Ruan, rather heteroclite. Ruaineaċ and Ruainte seem to be late analogical formations.

249. Na Tuaṙṫaí, "the bleachgreens," western part of an Ruain Ḃiġ, east of an Aḃainn Mór. Pl. of tuaṙ.

250. An Aḃainn Ṁór, *Owenmore*, "the big river." "Faluiġeann ṙí i ṗéin i mBun na hAḃann, i n-Uaiċe Ḃun na hAḃann:" "it hides itself (ends) in Bun na hAḃann, in the Cove of Bun na hAḃann" (112, 113).

251. An Ṗál Íoċtaiṙ, "the lower fence," land between the mouth of the Aḃainn Ṁór and the Bṗeacall on the west. From it is named Uaiċ an Ṗáil (115).

252. An Ruain Ṁór, "the great Ruain," on the N.W. side of An Aḃainn Ṁór at this place.

253. An Ċṗeiġ Ṁór, *Craigmore*, "the great crag," north of the Bṗeacall.

254. Cṗeiġ-ṙliaḃ, "crag-mountain," the shoulder in the middle of the land, between an Ċṗeiġ Ṁór and an Cnoc Mór (the main summit).

255. Tṙiorġ Raiṫniġe, the enclosed fields on the south slope of Cṗeiġ-ṙliaḃ. "Tṙiorġ, grains, or the refuse of malt," O'Reilly. The topographical use of the word is not clear. Raiṫniġe, "of fern or bracken."

256. Aḃainn a' Ḋúna, "faluiġeann ṙí í ṗéin i nUaiċ an Ḋúin:" "the river of the fort: it hides itself in in Uaiċ an Ḋúin" (*Ooghaniska*, O.S.) Here two different genitives of ḋún were heard in one sentence.

257. An Coṙṅéal Ġaṙḃ, "the rugged corner," west of the lower part of Aḃainn a' Ḋúna, near the sea.

258. Na Polla Ġlaṙa, "the green holes," the hollow along which the road passes westward from Aḃainn a' Ḋúna.

259. An Leṙġin Riṫṫe, "the smooth slope," a long slope north of the road at this place.[1]

260. Na Cṙioġáin Ṗaḋa, "the long crag-fields," between the Leṙġin Riṫṫe and Cṗeiġṙliaḃ.

261. An Tuaṙ Mór, *Toormore*, "the great bleachgreen."

262. Aḃainn a' Tuaiṙ Ṁóiṙ, "river of the Tuaṙ Mór."

263. Loċán a' Ṗúca, *Loughanaphuca*, "the Púca's lakelet." "The Púca was seen there, and might be seen yet."

264. Aḃainn a' Ṗúca, "the Púca's river," flowing through Loċán a' Ṗúca.

265. Bṙáġaiḋ a' Ḃaile, "neck of the townland, or of the inhabited land," the angle of land between Loċán a' Ṗúca and the cliffs of the south-western

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[1] Leṙġin, dative of Leṙġean. Riṫṫe, passive participle of ṙiṫim, "I run," was explained as meaning "smooth." Compare ṙéiḋ, "smooth," ṙiaḋ, "a riding, a raid," Gaulish *rheda*, "chariot." But ṙiṫṫe has another meaning—tá an áit ṙeo ṙiṫṫe aġ a' ngaoiṫ, "this place is coursed by the wind, i.e. exposed to the wind": Arran, Galway.

promontory. Bráġaio, the lower part of the neck, where it joins the shoulders and chest.

266. An Binn Bric,[1] "the mottled peak," the south-western spur of the Cnoc Mór, north of Tuar Mór.

267. Fán na gCaorać, "slope of the sheep," western slope of an an Binn Bric, east of Abainn a' Púca.

268. Bun na mBoćán, *Bunnamohaun* townland, "bottom of the huts." The townland now consists almost wholly of Cnoc Mór and its slopes, the highest part of the island. It must have been named from the low ground on the west and S.W., no longer containing huts or houses.

269. An Talaṁ Bán, "the white (i.e. grassy) land," a general name for the south-western district, westward from Cnoc na Bfian and southward from an Cnoc Mór, to the western and southern coast-line.

270. An Cnoc Mór, "the great hill" (summits 1520, 1453, 1315 ft.), not named on O. S. map. Cnoc Ġrigiláb and an Binn Bric are its foothills on the south side. Its steep northern side is formed by an Aill Mór and Aill a' tSrufáin.

271. An Cloćar, "the stonework," along the sea at the Signal Tower on the western side of the island. Cloćar varies in meaning from a row of stepping-stones set in a ford to a stone building such as Cloćar Dúiliġ, the extant stone-roofed church of Saint Dúileach (St. Dolough's), Co. Dublin.

272. An Cóćra Donn, "the brown coffer" (Cóćra = córra). N.E. of Signal Tower.

273. Na Cornáin, near Aill a' Ġrianraṁáin. Perhaps plural of the plant-name, cornán (so pronounced in Clare Island = cárnán) carrit, *Cotyledon Umbilicus.* Cornán, "little goblet," is obviously the correct form of the plant-name, from the resemblance of the leaf and its stalk to a shallow drinking-glass with a slender stem. The name has doubtless been changed to cárnán, "heap (of stones)," in other places in allusion to the habitat of the plant, already signified by the epithet carrit "of the stone-fort."

274. An Bróćlóg, "the sultry place (?)." (Bróćal, "sultry heat"). Near Aille Leaćaḋ ("*Allahan*"). (Compare the meaning suggested for Ġrianraṁán).

275. An Leirġean Bán, "the white (i.e. grassy) hillside," east of Signal Tower.

276. Na Luirġne, "the shins," western face of an Cnoc Mór.

277. Uillinn a' Ċnuic, "elbow of the hill," at the foot of the steep eastern rise of an Cnoc Mór. Further east—

278. Béal a' Sgonnra, "mouth of the sconce (dry stone wall)," and—

[1] Dative for nominative of noun and adjective; an Beann Bréac.

279. Béal Uaimín Duibóg,[1] "mouth of the cove of (. . . ?)."

280. Foitir na Craoibe, "shelter or shrubbery of the branch (leafy tree)," near Aill Tairb. (Dinneen gives foḋar, nom. sing., foiḋre, nom. pl., "a wood, a forest; a woody swamp"; "woods, thickets." The word seems to be an ancient compound of fo and tír; "under-land.")

281. Na Guaille, "the shoulders," the long ridge rising from the hollow west of Cnoc na Brían to the eastern face of an Cnoc Mór.

282. Béal gan Argaill, "mouth without armpit," a hollow under Cnoc Mór at the head of na Guaille.

283. An Gaḃlán, "the fork," the upper valley of the Aḃainn Mór, enclosed by Cnoc Mór and na Guaille.

284. Bolg a' Ċnuic, "belly of the hill," lower part of Cnoc Mór, facing S.E.

285. Sgailp a' Trúir, *Sgalpatruce*, "cleft of the trews," on N.E. side of na Guaille.

286. An tSiorr, a hill near Aill na mBáirneaċ. (For riorr, O'Reilly has the meanings "vetches, wild pea, broomrape, orobanche." Dinneen has "riorra, m., a sharp rock in the sea rising nearly to the water's surface.") Pronounce like *shiŭr*.

287. Tón na Siorra, "butt of the Siorr," foot of the hill seaward.

288. An Baile Tuaiḋ, *Ballytoohy* townland, "the northern townland."

289. Baile Ċuaiḋ beag, *Ballytoohy Beg* townland.

290. Cnoc a' Loċáin, "hill of the lakelet," north of the Siorr. The lakelet is probably the marshy hollow known to workers on the Clare Island Survey as "the Lighthouse Marsh."

291. An Siḋeán, "the fairy hill," a noticeable smooth high knoll, covered with short green vegetation, north of the marsh. "Áit i bfuil ríḋe," said my guide, "tá cúirt acu annsin"—"a place where the *sidhe* are; they have a court there." I have not elsewhere met this ancient usage of the plural ríḋe in ordinary speech. In most places, na ríḋeóga, na riaraí, etc., are substituted, ríḋe being used in set phrases such as bean tíḋe, "banshee," na coin tíḋe, "the hounds of the *sidhe*." The *sidhe* were anciently gods, "the peoples used to adore *sidhe*;" *Fiacc's Hymn*. On the O.S. map, *Sheean* is placed as the name of a sea-rock. See above (174) for another Siḋeán which has escaped destruction in the most cultivated part of the island.

292. Foitir Ċarallaiġ, "thicket or shelter of Carallach (?)," south of lighthouse.

293. Sáinn na gCapall, "pen of the horses," a hollow beside the lighthouse.

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[1] Perhaps for Da Beóg, the indeclinable name of the saint from whom the heath Dabeocia is named.

294. Altán, a hill S.W. of lighthouse. Alt, "joint," in Ulster topography, "a narrow glen or ravine."

295. An Meall Mór, "the big knob," the lighthouse hill.

296. Abainn a' Dúin, "river of the fort," the stream that reaches the sea at Dún Aille.

297. Curraċ a' Dúin, "moor of the fort," the land west of Dún Aille.

298. Páirc Ruaiḋrí, "Ruaidhrí's field," west of the northern road, almost due west of Uaċ Ċorraġáin.

299. Curraċ Uaċ Ċorraġáin, "moor of U. Ċ.," the land west of Uaċ Corraġáin, and east of the road.

300. Abainn Uaċ Ċorraġáin, "river of U. Ċ.," the stream flowing into Uaċ Ċorraġáin.

301. Na Cloċa Sgoilte, "the split rocks," in the hollow round which the road winds, due west of Uaċ Ċorraġáin.

302. Creig a' Dilisc, "crag of the *dilisc*," a rocky knoll on west side of road, south of na Cloċa Sgoilte. Perhaps a place for drying *dilisc*.

303. An Sean-tuar, "the old bleachgreen," knoll at S.W. side of Curraċ Uaċ Ċorraġáin.

304. An Gort Mór, "the great cornfield." The road from the lighthouse southwards forks here, one branch leading S.E. to the Harbour, the other S.W. to the Abbey. An Gort Mór is west of the road north of the fork.

305. Sruḟán a' Ġuirt Ṁóir, "stream of an Gort Mór," flowing from Cnoc a' Loċáin to Port Liṫe. Also called Abainn Ṗort Liṫe, "river of P. L."

306. An Mac Alla, "the echo (lit. the cliff boy)," hill north of an Gort Mór.

307. Gort an Éadain, "cornfield of the hill-front," west of an Gort Mór and north of the by-road running east through Baile Ṫuaiḋ Beag.

308. Creig na Ceartaḋ, "crag of the rag (?)," north of the byroad. Ceartaḋ may be a local variant of ceardċán, genitive of ceardċa, "smithy."

309. Curraċ Ṁáire Ní Ṁáille, "moor of Máire Ní Mháille," east of an Gort Mór. Further east is—

310. Curraċ Ṗort Liṫe, "moor of Port Liṫe."

311. Leic a' Baile Ṫuaiḋ, "flat rock of the north townland," south of the place where the lighthouse road crosses the stream of Gort Mór.

312. Criogán Roiġleán, "rocky field of (. . . ?)," north of an Gort Mór, east of Cnoc a' Loċáin. O'Reilly has "raiḋleaḋ, darnel grass, *Lolium perenne*."

313. Na Tamnaċaí, "the grassy fields," the land adjoining Port Liṫe.

Islands and Districts near Clare Island.

314. Acaill, Achill. Eileán Acla, island of Achill.

315. Acaill Beag, Achillbeg.

316. Corrán, Corrán Acla, the mainland peninsula east of Achill; corrán, "a reaping-hook."[1] A promontory at Larne, Co. Antrim, is similarly named ("the Curran").

317. Umall, formerly called in English "the Owles," barony of Burrishoole (= Buirgeir Umaill, burgage of U.) known to Pádraic Mac Tuathail as Umall Uí Máille "U. of Ó Máille." The territory formerly included the barony of Murrisk.

318. Muirearg, barony of Murrisk. The Irish name, gen. Muirirge, is in common use.

319. Paráirte Cill a' Gaoibair, "parish of *Kilgeever*," bar. Murrisk, includes Clare Island.

320. Cathair Phádraic (= Pádraig), "Patrick's fortress," Caher Island.

321. An Baile Beag, Ballybeg island, "the little homestead."

322. Inis Geala, Inishdalla.[2]

323. Inis Tuirc, Inishturk, "wild boar's island." In rapid pronunciation, the name sounds like Inis Duirc.

324. Inis Bó Finn', Inishbofin, "white cow's island."[3] Properly Inis Bó Finne, but in Mayo a final short vowel is often dropped colloquially.

325. Inis Earc', Inishark, "Earc's island," for Inis Earca. Old Irish *Erc*, gen. *Erce*, *Ercae*, *Erca*, a feminine name, probably of a goddess.

326. Na Maolán, "the round-topped rocks," an Maolán Beag, an Maolán Mór, between Clare Island and Caher Island.

327. Na Biollaí, "the Bills," sea-rocks about eight miles N.W. of Clare Island.

Family Names.

The surnames of Clare Island present the clearest evidence of mixed streams of immigration from various parts of Ireland, and ultimately from various parts of the Continent. The following list of surnames was given to me straight off by Pádraic Mac Tuathail:—

"Na Máillig, Clann Tuathail, Mac Cába, Muintir Fhloinn, Clann Mhic Na Mara, Clann Mhic Gríadaig, M'Láibailliig, Muintir Dhuibe, Breathnaig, Muintir Rodaig, Muintir Mhuirí, Clann Giobúin,

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[1] But corr in the nomenclature of Clare Island means a headland, and in this sense may be the basis of corrán applied to a peninsula.

[2] There is a tendency to confusion between the palatal sounds of *d* and *g* in Mayo. Inis Deala may be the older form. See *Onomasticon Goedelicum* s.v. Inis Dele.

[3] "Insula vitulae albae," Bede, *Hist. Eccl.*, iv, 4.

Muinntir Ġallcoḃair, Baireádaiġ, Coinneánaiġ, Sgorail, Clann Mic a' Ġeimhiḋ, Móránaiġ (agus mórán daoḃta)."[1] To which were added later:—Branaiġ, Mórḃóirniġ, Mac Réill, Ó Broodáin, Búrcaiġ.

To attempt to trace the genealogical origin of all these families would here be too great a labour. I propose to deal briefly with instances in regard to which the information lies to hand.

Na Máilliġ: bearers of the surname Ó Máille. The ordinary English version of this name is "O'Malley," but in Clare Island and not seldom on the mainland, the usual version is "Melia" (rhyming with "dahlia"). "Mealy" is probably a variant. "Melia" exemplifies a very general custom in the anglicization of Irish names, the substitution of ē for ā.[2] The Máilliġ alone form about one fourth of the population of Clare Island. Their origin and history are well attested.[3]

Clann Tuaṫail: the surname of this family is Mac Tuaṫail. One householder gave me his name as Taḋg Mac Tuaṫail. My chief authority for the local family names and place-names called himself Páirraic Ó Cuaṫail (as it sounded), but called the whole kindred Clann Tuaṫail. (This variation of Mac to Mac, and thence to Óc, is not rare in Connacht. A young man once asked me to explain why his surname was Ó Cuí in Irish and Mac Hugh in the English version. Ó Cuí = Mac Aoḋa, and "Hugh" is the accepted English equivalent of Aoḋ. Another young man told me that his surname was Ó Cuarcáin in Irish and Durkan in English. Ó Cuarcáin = Mac Ḋuarcáin. So bunóc, "an infant," must, I think, be explained as bunmac.) There are four households of Clann Tuaṫail in Clare Island; and the local belief, I was informed, is that they are a branch of the Máilliġ, taking their name and descent from one Tuaṫal Ó Máille. The Annals of Ulster record the death of a Tuaṫal Ua Máille in 1316. Under 1413, they record that another Tuaṫal Ua Máille took service in Ulster as a leader of mercenaries. After a year in that occupation, he set out for home with his followers, who filled seven ships. A storm arose, and they were carried away to the Scottish coast. Certain of

[1] "And many of them," a play on the word *mórán*, "many." The variety of formulae here used is not arbitrary, but represents established usage. A similar variety is found in early usage as exemplified in the Genealogies and Annals.

[2] Another W. Connacht surname, Ó m'Ilia, for which a literary form Ó Maoilḋia, of questionable authenticity, is adopted, resembles "Melia," but has for its usual English equivalent "Molloy." "Molloy," in this instance, is the borrowed English version, longer and more widely in use, of the Meath surname Ó Maolmuaiḋ. The transference of English equivalents from one Irish surname to another often causes great difficulty in the tracing of family origins.

[3] Máille (probably = *Máilne* = *Mál* < *Maglos* "prince" + *-inios*), from whom his descendants took the surname Ó Máille, cannot be placed earlier than c. 850, since the custom of forming surnames like Ua Máille is not found before the beginning of the tenth century. His probable date was 900–950, twelve generations before Domhnall Ruadh Ua Máille, † 1337.

the Mac Suibhne name, hereditary chiefs of mercenaries, who accompanied Tuathal, were drowned "along with their people, both woman and man." Tuathal himself, his two sons, and their people, with difficulty got to land in Scotland. The incidents are instructive, in view of the movements of people, "both woman and man," by sea and land in the fifteenth century. Clann Tuathail are called in English "Toole." "*O datur ambiguus*"; and the western Clann Tuathail of Umhall are like to be mistaken for a branch of the eastern Clann Tuathail of Ui Máil (Imaal, co. Wicklow) through the now frequent change from Mac Tuathail to "Toole," which, under favourable circumstances, becomes "O'Toole."

Mac Cába, "Mac Cabe." There is only one family of the name in Clare Island—that of the hotel-keeper. He is, I understand, a native of southern Ulster. The Mac Cábas first appear in Irish history in the fourteenth century as leaders of *galloglachs*, i.e. mercenaries of Norse-Hebridean origin, under the Irish princes of Breffny and Oriel. They followed the profession of *condottieri* for two centuries or more, their chiefs being known by the titles of Constable of Oriel, Constable of Breffny, and Constable of the Two Breffnys, Fermanagh, and Oriel. The tradition of their Norse origin is still known in East Breffny (Co. Cavan). Distinctive Hebridean forenames, such as Alan (Aleinn), Somhairle (Sumarliði), were formerly frequent in their families.

Muinntir Ḟloinn, surname Ó Ḟloinn, "Flynn." Their origin would be difficult to determine. There were at least three great families of the name, one in Ulster, one in Connacht (district of Boyle, co. Roscommon), and one in Munster. Three households in Clare Island.

Clann Ṁic na Mara, surname Mac na Mara; old and literary form, Mac Con Mara. A noted Thomond family. Two households in Clare Island. One of the sea-caves or coves is named from them.

Clann Ṁic Ġriadaiġ, surname Mac Ġriadaiġ (Mag Riadaigh? Mag Riada?), "Grady." Compare the Ulster (West Scottish?) name, Macready, Mecredy. By taking the form "Grady," this surname is likely to be confused with the Munster "O'Gradys," properly Ó Gráda. On the other hand, many of the latter family, especially in their ancient home, co. Clare, have englished their name as Brady, which in turn is the normal English version of the South Ulster surname Mac Brádaigh.[1] The arbitrary process of inventing English equivalents for Irish names, whether of persons or places, tends to bring the history and meaning of the names into a welter of

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[1] A note to the Annals of Ulster (an. 434) derives this surname from "*bradach*, thievish"! It is from *brádach*, "spirited." In like manner, *brádán beathadh*, "breath of life," has been misread and misrendered, *bradán beathadh*, "salmon of life" (copied in Dinneen's Irish-English Dictionary).

confusion. The old song *Conndae Mhuigheo,* dating probably from the seventeenth century, mentions Aodh Ó Griadaigh, "a colonel in Cliara," Clare Island. There are seven households of the name in the island at present.

M'lábaillig, surname Ó Maol-Fábaill, colloquially Ó M'lábhaill, which takes in English the French-looking guise of "Lavelle." The family of Ó Maol Fhábhaill in the eleventh and twelfth centuries were at the head of Cenél Fergusa, a subsept of Cenél Eoghain. They ruled in Inishowen (co. Donegal), where a promontory stronghold gave to their chief the title of king of Carraic Brachaidhe (from Mrachide, an ancestor's name)—"Carrickabraghy." Without direct evidence, I would suggest that they may have come to Umhall after the Cromwellian war, and settled there under the O'Donnells of Newport, who were transplanted thither from Tir Conaill.

Muinntir Duiče, not native and probably not correctly named; in English "Duffy," the name of the lighthouse-keeper. "Duffy" usually represents Ó Dubhthaigh.

Breačnać, "Walsh." One of the most widespread surnames in Ireland. Sometimes englished "Branagh." It means "British," i.e. "Welsh," and originated among the numerous Welshmen who formed the main fighting strength of the "Norman" invasion. ("Wallace" or "Wallis," found in various parts of Connacht, has the same signification. In Irish it is Bhailis or A Bhailis). One household in Clare Island.

Muinntir Ruaig, surname Ó Ruaig, "Ruddy" or "Reddy." Three households.

Muinntir Muirú, surname Ó Muirú, "Murray." The Irish name is given as heard. I suppose the historical form should be Ó Muireadhaigh. Ó Moireadha, from the ancient Mairid, is also possible.

Clann Giobúin, surname Mac Giobúin, "Gibbons." "FitzGibbon" is another equivalent. Of "Anglo-Norman" origin, "Clann Ghiobúin of Umhall Ui Mháille" were settled west of Cruach Phádraic. Another branch has given its name to "Clongibbons" half-barony, co. Cork.[1] One household in Clare Island.

Bairéadaig, surname Bairéad, "Barrett." One of the chief families of the "Welshmen of Tirawley," settled in Connacht under the Norman De Burghs and FitzGeralds. Two households in Clare Island.

Coinnéanaig, surname Ó Coinneáin, "Cannon." ("Cannon" also does duty for another name of ancient celebrity, Ó Canannáin of Tir Conaill.) Two households in Clare Island.

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[1] See "Onomasticon Goedelicum," s. vv. Clann Ghiobúin and Umall.

Scofal, "Scuffle," also "Schofield." I am ignorant of the origin of this surname. One household.

Clann Mic a' Gimhrid, surname Mac a' Gimhrid, "Winter." The English version is nearer the mark than usual. Mac an Gheimhridh (literary form) means "son of the winter." I have not traced the surname. It probably arises from a by-name, in which case it would represent a subdivision of some other name. The full surname was perhaps Mac Mic an Gheimhridh, "son (i.e. descendant) of the Wintry Lad (one noted for campaigning or sailing during winter)," just as the full form of Mag Uidhir "Maguire" was Mac Meig Uidhir, "son of the Sallow Lad." Three households.

Mórán, surname Ó Mórán, "Moran." This surname seems to have absorbed another and distinct name, Ó Mughróin, the ending -óin being often displaced by the more familiar -áin. Ó Moghráin (Annals of Ulster, 1206) is perhaps a transitional stage. Four households.

Bran, surname Broin, "Burns." Broin is the genitive of Bran, and should be preceded by Ó or Mac, but, if my information is correct, stands alone as the surname. There may have been a local family with Bran for eponym. At any rate, I know of no link that could connect the noted Leinster family of Ó Broin, "O'Byrne," with the Connacht seaboard. Five householders in Clare Island.

Mórbórneać, surname. In English, "Gordon." One household. The key to this curious equation of names seems to be supplied by Mac Vurich in the Book of Clanranald (Cameron, *Reliquiae Celticae*, ii., p. 184), who calls the leader of the Gordon contingent under Montrose "*Mórbhar* [= mórmhaor] *Górdon* mac Marcos Huntli," i.e., Lord Gordon, son of the Marquess of Huntly. Some descendant of this house may have come to Ireland as a Jacobite refugee. Mr. John MacNeill, the musical-instrument maker, of Capel Street, Dublin, told me that his family came to Ireland as refugees after Culloden.

Mag Réill, surname, "MacGreal." This name, as given in Irish, is the colloquial form of the surname Mac Neill in Connacht and Ulster dialect. Before vowels and liquids, Mac becomes Mag in Irish, but not in Scottish Gaelic, the *g* being attached to the following syllable. Thus Irish Mag Aodha "Magee" contains the same elements as Scottish Mac Aoidh "Mac Kee, Mac Kay." In northern Irish, *gn* becomes *gr*, so that Mag Neill (Ma gnéill) is pronounced Ma gréill in Antrim Irish as in Mayo Irish. Instances of this surname in Connacht are found in the Annals of Ulster, under the years 1346, 1361, 1377. In two of these, Mac Neill, denoting the chief of the name, is wrongly rendered "son of Niall" in the translation. It is evident from these instances that Mac Neill was hereditary chief of *galloglachs* or Hebridean swordsmen. Like the Mac Cábas and other *galloglach* chiefs, the Mac Neills

were Hebridean and probably at least half Norse in origin.[1] One household in Clare Island.

Ó Broadáin, surname, "Salmon." *Brodán* is the normal Connacht form of *bradán*, "a salmon." One of the coves in Clare Island is named from a member of the family. The old form of the surname appears to have been Ó Bardáin. The family belonged to the Conmhaicne Réin (in part of Leitrim and Longford counties). The name occurs twice in the Annals of Ulster under date 1369; but the almost contemporary Book of Ballymote (161 *b* 3, 162 *a* 10) has the modern form Clann Bradain, Clann Bradan.

Búrcaig, surname ó Búrca (for De Búrca = De Burgo), "Burke." Of Norman origin. One household.

In sum, of 71 families in Clare Island, about 25 belong to the Dál Cuinn group, which dominated the northern half of Ireland from the fourth century to the thirteenth. The oldest known home of this group was in the north of Roscommon county. Five families, of which three were originally Welsh, are descendant from colonists of the "Norman" invasion. At least two families represent the Norse-Hebridean *galloglach* element, which flowed freely into Ireland after the detachment of the Hebrides from Norway in the thirteenth century. The Gordon family is probably of Scottish origin, and of much later immigration. Two families bear a Thomond surname. About one-half of the surnames are thus of ultimately remote regional origin. It is not unlikely that a large proportion of the remaining half, which have not been traced, are no less exogenous. This, however, is to be noted, that the tracing of families through their surnames and genealogical traditions and record is in the main concerned only with the male line of descent.

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1 The Norse adopted the Irish name Niall (genitive Néill) in the form Njal. The populations of Barra and South Uist, the chief habitats of the Mac Neill family, are largely of Norse descent.

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GAELIC PLANT AND ANIMAL NAMES,

AND ASSOCIATED FOLK-LORE.

By NATHANIEL COLGAN.

Read February 27. Published April 12, 1911.

CONTENTS.

I. Introduction.

The Gaelic names entered in the following lists were all found current more or less widely amongst the country folk or fishermen of Clare Island and the mainland shores of Clew Bay during the years 1909 and 1910. They were all, without exception, collected "in the field," and were written down phonetically as soon as the particular plant or animal species or genus to which each name applies had been satisfactorily made out. Anyone who has ever engaged in this fascinating branch of inquiry, or rather exploration, knows what large demands it makes on one's time and patience, and as the writer could devote to the work only the scanty leisure saved from his special line of research, the marine mollusca of the Clew Bay area, the following lists can make no claim to completeness. They record actually current Gaelic names for about 120 species of plants and animals; yet there can be no doubt that much more remains to be done in this direction even on Clare Island itself, where a visit in the spring season would certainly be rewarded by the addition of several plant names.

Gaelic folk-speech is unquestionably copious in terms denoting natural objects. But it is easy to overrate this copiousness, as some uncritical enthusiasts have done; for it must be borne in mind that a very large number of species of plants and animals, which the scientific observer discriminates at a glance, are habitually lumped together by the Gaelic

peasant as they are by the peasant in all countries. His names are often generic rather than specific; and whole groups of plants and animals with which he has no immediate concern, the groups of the inconspicuous, the innoxious, and the useless, are passed over by him unnoticed and unnamed. Thus the plant and animal nomenclature of folk-speech must always fall short of the copiousness of the finely—often only too finely—discriminative nomenclature of science.

In dealing with Gaelic popular names of plants and animals perhaps the most formidable difficulties to be overcome are orthographical and etymological, difficulties of the closet rather than of the field. Having first of all made sure of the particular plant or animal to which a given name is applied by the common consent of "knowledgeable" persons born and reared in the district, and having satisfied yourself that you fully apprehend the often obscure sounds which make up the spoken name, you must then proceed to represent these sounds in writing according to the recognized rules of Irish Gaelic orthography. At once you are confronted with etymological problems, since your efforts to arrive at a correct spelling of the name are well-nigh inseparable from attempts to fix its precise meaning, and with many, perhaps with a majority of Gaelic plant and animal names, this meaning is past finding out. Herein lies a subtle temptation which one must constantly guard against, the temptation to set up a hypothetical meaning and to strain the pronunciation so as to make it square with the hypothesis, and so justify a spelling conveying both sound and sense. Some intrepid attempts which have been made by grave writers at a solution of the etymological problems presented by Gaelic plant names remind one of nothing so much as Swift's famous derivation of 'ostler' from 'oat-stealer.' And this temptation to vitiate the linguistic record works quite as powerfully in folk-speech as in literature. The unlettered peasant is in all ages just as impatient of meaningless names as is the student, and just as prone to force a meaning where the true meaning has become obscured.

In preparing the following lists a severe curb has been placed on this tendency to an unscientific use of the imagination, and as a result it will be seen that no attempt is made even to so much as suggest a meaning for a large number of the names given. In Gaelic folk-speech, as in folk-speech all the world over, the origin and meaning of such names have become hopelessly obscured by long ages of phonetic corruption. We must, in fact, accept them as labels or marks of identification rather than descriptive or allusive terms.

Many popular names of plants and animals in Gaelic as in English folk-speech are of very local application. In some cases, indeed, their extension may be little more than parochial. The following lists do not furnish any

examples of such extreme localization in Gaelic nomenclature, yet they offer some striking analogies in folk-speech to the phenomenon known in natural history as discontinuous distribution. For instance, our Common Reed (*Arundo Phragmites*), known in Clare Island as Gioloċaċ, takes on the utterly distinct name Coirgeaṁaċ in Achillbeg, separated from the island by only some 3 miles of sea-passage; the Yellow Flag or Iris (*Iris Pseud-Acorus*), the Seillirtiuṅ of the island, becomes the Seillirtioċ of Cloghmore, near the southern opening of Achill Sound, hardly 4 miles distant; while the Common Periwinkle (*Littorina littorea*), known as Faoċóg at Cloghmore, bears the name, Faoċán in Clare Island. Yet, the Clare Island name, Gioloċaċ, connected with the definite species *Arundo Phragmites*, crops up again and again on the mainland, as in Kerry and Connemara, and the name Coirgeaṁaċ, which fills its place on Achillbeg, is met with in a variant form far south in Cork; and so on with the other examples of discontinuous distribution. In zoology and and botany discontinuous distribution is held to be a proof of antiquity, and it may well be that the same law holds good in popular Gaelic nomenclature.

As a consequence of this marked localization of folk-names of plants and animals any collection dealing with a fairly extensive area must include a large proportion of synonyms, using the word in its strict scientific sense; so that the names will far exceed in number the objects named. Each county, to say nothing of smaller divisions of the area, will contribute its peculiar forms or dialetic variants, and these brought together in one comprehensive lexicon cannot fail to give rise to false conceptions of the copiousness of folk-speech and of the discriminative capacity of the folk who develop and use it. Thus a full collection of the Gaelic plant names of all Ireland, arranged alphabetically without localities, might lead the unwary reader to imagine, for instance, that the Connemara peasant had 500 plant names at his command, while it would be nearer the truth to assume that the plant and animal nomenclature of an intelligent Connemara man or Clare Islander would rarely cover more than 100 species.

There seems to be as little reason to expect the occurrence of an endemic or peculiar plant name in Clare Island as there is to hope for the discovery there of an endemic plant species. Even if a truly endemic plant name should be current in the island, the day of its recognition as such is yet far distant; for our knowledge of the precise distribution in Ireland of the various Gaelic plant names and their numerous dialectic forms is still sadly defective. When our knowledge of these forms has been extended by the multiplication of local lists such as those here given, we shall find ourselves better equipped for excursions in etymology. A study of these variants may yield clues to guide us back along the tortuous path of phonetic corruption to the original form and the

true meaning of many names long since sunk to the position of arbitrary labels.

As for the distribution within Clare Island itself of the Gaelic names now current there, a few may be said to be in universal use. Almost all of the islanders, old and young, English speakers and bilinguists, speak of the common Ribwort Plantain as Slan Lus; of the Ragweed as Bodalán; of the Yellow Flag as Sellistuing; of the Silverweed as Bliogán; of the Purple Loosestrife as Creadtad; of the Periwinkle as Faodán. But many of the Gaelic names are used side by side with the English names, the adult islanders preferring the Gaelic, the younger the English. Some of the older people use indifferently a Gaelic or an English name. For instance, one man near the Abbey in speaking to me of the Common Elder hesitated between Trom and Bore-tree; and another, when asked the name of the Broad-leaved Dock, gave me both Copóg and Docken. A stranger to Clare Island who confines his inquiries to the neighbourhood of the quay or harbour is liable to fall into the error of supposing that Gaelic is a quite extinct language on the island. But a few days spent in collecting native plant names in the remoter parts, towards the north and west, will convince him that many of the islanders, and these not always the really aged people, still speak the old tongue.

Discussions on Gaelic language and folk-lore too often proceed on the mistaken assumption that all things Gaelic are necessarily of a hoary antiquity; that we must seek for Gaelic origins—say, for instance, the origin and meaning of plant and animal names—in the dim azure of the past. Implicit in this assumption is the notion that Gaelic is a dead and fixed language, whereas the fact is that it is still living, and displaying the usual signs of life and growth in the evolution of new words from its own resources and in the adoption with modification of words from other languages—above all from English. So it is quite possible that some of our more local Gaelic names of plants and animals may be inventions of recent date. It may be, for instance, that Máir Fada (Long Mary), the usual Gaelic name for the Heron on Clare Island and the mainland shores of Clew Bay, is a recent coinage of some local wit or playful *gossoon*, a coinage destined to perplex future philologers when some generations of currency have blurred its outlines. Still it remains undoubtedly true that the great mass of Gaelic plant and animal names, and perhaps all of them now current throughout Gaelic Ireland and Scotland, are of ancient origin.

The following list of plant names is peculiar in one respect, the almost complete absence from it of Clare Island names for our common indigenous trees and shrubs, such as the Alder, the Hawthorn, the Broom, the Spindle-tree, the Holly, the Ash, the Birch, the Quicken-tree, the Hazel, and the

Oak. The explanation is probably this. Some of the species, *i.e.*, the Alder, the Broom, and the Spindle-tree, are altogether wanting in the island flora; all the others are quite rare there, so much so that they enter but seldom, if at all, into the thoughts of the island population as a whole. The Hazel, the Birch, the Holly, and the Quicken-tree or Mountain Ash linger on in sheltered hollows, as on the north-east of the island; but there is reason to suppose that knowledge of their existence there is confined to the residents of the townland of Ballytoohy More, in which they grow, and is hidden from the "untravelled" population of those remote regions of the island lying some two to three miles distant around and beyond the abbey. What is seldom thought of is seldom spoken of: what is seldom spoken of tends to drop altogether out of speech. It may be that further inquiry would have shown me that the ancient and widespread Gaelic names for the Holly, the Hazel, the Birch, and the Quicken-tree are still in use among the Ballytoohy men, and that the absence of this group of names is, in part at least, rather apparent than real. However that may be, there can be small doubt but that the Gaelic names of trees are not generally current in the island.

In drawing up the lists, I have thought it advisable to touch briefly on dialectic variations of the Gaelic names, especially the plant names, the variants being drawn from desultory collections made in various parts of Ireland within the last twenty years, and I have added short notes on the uses now made of plants or animals in the Clew Bay area. I have also appended to each of the two sections, on plants and on animals, a very short list of some English names I found current in the area, enough perhaps to show that the study of such names is full of interest from a distributional point of view. For instance, the common use in Clare Island of the name *Bore-tree* for the Elder, of *Whin* for Furze, and of *outshot* as an English equivalent for the Gaelic Caillead, the bed alcove built out from the wall of the living room, would seem to point to a northern English or Border element in the island population. And finally, as a supplement to the whole, I have given as closely as possible in the words of the narrator, some scraps of legend connected with the native fauna which I chanced to meet with while collecting material for the lists. The collecting and recording of such naïve folk-stories may to some appear a work of extreme frivolity. Yet others, and I am convinced not a few, will prize these waifs and strays of Clare Island tradition as survivals of surpassing interest, since they carry us back to the primitive beliefs of a remote past, compared with which the thirteenth-century abbey of the O'Malleys is but a thing of yesterday.

As for the arrangement of the material embodied in the lists, three schemes suggested themselves; one purely scientific, where the botanical and zoological binomial names are placed first and arranged in the sequence of some recognized

natural system; another, in which the English popular names come first in alphabetical order; and a third, alphabetical like the second, but with the Irish Gaelic names set first. The third scheme has been adopted here as the most convenient for students of language and folk-lore, who are far more likely to consult the lists than professed botanists and zoologists. For the benefit of the more scientifically minded, an index of the Latin binomials has been appended, and to cure the defect inseparable from an alphabetic arrangement—the separation of different names or variants of names referring to the same object—frequent cross-references have been given. The individual entries are thus arranged :—(1) Irish Gaelic name; (2) meaning, if ascertained; (3) scientific name; (4) English popular name; (5) distribution of native name in Clew Bay area; (6) general remarks, including notes on the general distribution of the name and its variants. Throughout the lists but scanty reference has been made to the literature of the subject, so that the great bulk of the matter here given is from sources hitherto unpublished. For a revision of the Gaelic orthography of the names, and for some valuable suggestions as to their derivation, I am indebted to the Rev. William Colgan, of Ballinlough, Co. Roscommon.

II.—Gaelic Plant Names.

Airgead Luacha, Silver of Rushes? *Spiraea Ulmaria* Linné, Meadow-sweet.—On Clare Island and on the mainland shores of the bay, as at Belclare, Achill Sound, and Mulranny; also general in Ireland from Donegal to Kerry. In the island the root is used along with copperas to yield a black dye; at Cloghmore, Achill Sound, for scouring milk churns as a "sweetener."

Aiteann, *Ulex europæus* Linné, Whin, Gorse, Furze.—Clare Island, where the flowers are said to be used for producing a yellow dye. This name is general throughout Ireland, and its meaning is made clear by the Welsh form, *eithin* (aithin), prickly.

Bacaḟán. *Menyanthes trifoliata* Linné, Bog Bean.—The name is generally used in Clare Island, but I have no note of its occurrence elsewhere in Clew Bay, though I have it from Claremorris, Co. Mayo. Threlkeld gives the variant Pacaḟán for Connaught.

Bliorcán. *Potentilla Anserina* Linné, Silver-weed.—General on the island, also on the mainland, as at Roonah, Mulranny, and Achillbeg. This name in one or other of its dialectic forms is widespread in Ireland. In Kerry, in Connemara, and in Clare the form Briorglán is the prevalent one; this is shortened to Briorc in Louth (Omeath) and Dublin, and to Briorcán on Lough Ree, Co. Longford. In Roscommon

(Ballinlough) the Clare Island form is used, and in North Dublin the form bhuorlóg. The root is called blucán in Clare Island, where, as in many other parts of Ireland and in Scotland, it is roasted and eaten by boys.

bogluir, Soft Plant. *Senecio aquaticus* Hudson, Marsh Ragwort.—This name is applied in Clare Island and on Achillbeg to the early state of the Marsh Ragwort when it shows only the rosette of succulent base-leaves which are pounded and used as a poultice for sores. The plant in this stage of growth is held to be quite a distinct species from the flowering Marsh Ragwort, which along with the closely allied Common Ragwort (*S. Jacobaea*) is known as bocalán. According to one Clare Island authority, an Irish speaker, the word bogluir denotes merely the pounded leaves or poultice, and in this sense is often applied to the pounded leaves of slán lur as well as to the Marsh Ragwort,

bolgán wrack, } Bagged or Bladder Wrack,
boilgín wrack. } *Fucus vesiculosus* Linné.—Both names, suggested by the small pouches, pockets, or bladders borne by the plant, are applied at Belclare, Clew Bay, to the common seaweed known in English as the Bladder Wrack. "If you boil that boilgín wrack in strong sea-water, it's a grand thing for rheumatism in the legs." The English dialect word *wrack* for sea-weed is in common use in this part of Clew Bay. See feamain dub.

bocalán. } *Senecio Jacobaea* Linné and
b. buide. } *S. aquaticus* Huds. Common Ragwort and Marsh Ragwort.—This name bocalán, with or without the adjectival affix buide (yellow) is universal in Clare Island and on the greater part of the mainland shores of Clew Bay, and is widespread in Ireland in one or other of its variant forms. The form buacalán is used at Mulranny, and this with or without the affix buide is the prevalent form in Kerry, in Connemara, and in Donegal; in Louth (Omeath) I have found the variants bualtán and bualteirán. The form Bollan is used in the Isle of Man.

A well-known fairy plant, doing duty in Irish legend for the witches' broomstick and as a mark for buried gold. The name is perhaps connected with buacaill (cowboy), the plant being the commonest pasture weed in all Ireland. See bogluir.

bocalán bán, White Bohalawn. *Artemisia vulgaris* Linné, Mugwort, Wormwood.—A common name for this species in Clare Island, and apparently widespread in Ireland.

bráirte. *Brassica alba* Boissier and *B. campestris* Linné, White Mustard and Wild Turnip.—Clare Island; apparently a variant of fraireac, the name

commonly applied to these species almost throughout Ireland and closely related to the Latin *Brassica.*

Caillead giumaire. See Giumair.

Carra mir. *Lathyrus macrorrhizus* Wimmers, Heath Pea.—General in Clare Island. Sweet Knobs may be suggested as a rendering of the Gaelic name, taken from the knobby liquorice-flavoured roots or tubers, which are dug up and eaten by the children in Clare Island, as in many other parts of Ireland and in Scotland. The Scotch Gaelic name *Cormylie* or *Cormeille* (Honey-root) expresses the same idea as the Irish Gaelic name.

Carra mir dogs. *Vicia Cracca* Linné, Tufted Vetch.—Clare Island; applied as a contemptuous term to this common vetch as lacking the quality of the true Carra mir.

Ceanabán dub corad, Black-footed Canavawn. *Blechnum Spicant* Roth, Hard Fern.—At Cloghmore, Achill Sound. The second component of the name is obviously descriptive; the first, Ceanabán, which is widespread in Ireland as a name for the Cotton Sedge (Eriophorum), is probably connected with the Gaelic canáib, Latin cannabis, Arabic cannab, French *chanvre*, and English *canvas* and *hemp* (see De Candolle, "Origin of Cultivated Plants").

Ceathrama caorad, Sheep's Quarter. *Atriplex erecta* Hudson, Orache, Lamb's Quarters.—Used in Clare Island and in Achillbeg, as in Kerry and Connemara. Perhaps a translation into Irish of the English name.

Clúbán. *Spergula arvensis* Linné, Corn Spurrey.—Clare Island. Also used in Co. Dublin and at Maam, Co. Galway.

Corón gráire. Big Road Leaf. *Rumex obtusifolius* Linné and *R. crispus* Linné, Broad-leaved and Curled Dock.—Clare Island, Belclare, &c., general around Clew Bay, as it is almost throughout Ireland. In Clare Island, as in Kerry, Louth, and Connemara, the compound name Corón gráire (Road or Street Dock) is generally applied to *R. obtusifolius*, so commonly found growing in the neighbourhood of dwellings, especially in the "street" or open yard in front of Irish roadside homesteads.

Corógad woher, Leafy Ware or Seaweed. *Laminaria saccharina* Linné.—A compound Irish-English name used for the species at Cloghmore, Achill Sound, but perhaps generic for the Laminarias. The second component is apparently connected with the English *ware*, seaweed, and occurs also on the Dublin coast. In Kentish dialect seaweed is spoken of as *waur*.

Corón ṗáraig } *Plantago major* Linné, Way Bread,
Cró ṗáraig } Plantain.—In Clare Island the first of these names is

sometimes applied to the rosette of broad base-leaves of this common species, the second name being given to the mature plant with its long flowering or fruiting spike. The form of the first component in the second name varies much in different parts of Ireland. From Kerry and from Claremorris, Co. Mayo, I have the form Cruaċ Ṗáṫraiġ, which is simply Croaghpatrick, the famous "Reek" of Westport. In Glen Inagh, Connemara, I was given the name Ḃileóg Cruaċ Ṗáṫraiġ, meaning the Croaghpatrick Leaf or Plant, and from Maam, Co. Galway, I have got Copóg Cró Ṗáṫraiġ with the rendering, Leaf of St. Patrick's Hut. Threlkeld in his "Synopsis" (1735) gives Croḃa Ṗáṫraiġ, meaning apparently St Patrick's Palms (of the hand). Whatever may be the true rendering of this first component, Cró or Cruaċ, one thing is certain, that the plant is connected with St. Patrick.

In Clare Island the leaves are used as a poultice for sores.

Coillteaċ. *Himanthalia lorea* Lyngb., Sea-Thongs.—This name was given me at Louisburgh Quay by a Rinvyle curraċaḋóir or canoe-man.

Coirġearaċ. *Arundo Phragmites* Linné, Common Reed.—Landing on Achillbeg after crossing the Blind Sound from Cloghmore in August last, I noticed this handsome marsh grass growing as a cultivated plant in a fenced field. The owner of the crop told me it was Coirġearaċ, and that he manured it, and grew it for thatching. Threlkeld gives a variant, *cuisgirnah*, as used in Cork—see ġiolcaċ.

Coir ṙionnaiġ, Fox's Paw. *Fucus canaliculatus* Linné.—This name was given me at Louisburgh by the Rinvyle canoe-man already mentioned.

Craḋán. *Arctium Lappa* Linné, Burdock. General in Clare Island, also at Cloghmore, Achill Sound. This plant affords a good illustration of the peculiar sexual system which prevails in the folk botany of Gaelic Ireland. A male (Ṙireann) and a female (baineann, pronounced *bwinnan*) craḋán are well recognized both on Clare Island and on Achill Sound: "That one there that has the big leaves on it like rhubarb has a cure in it. That's the craḋán baineann," said my informant, pointing to a Burdock showing only the large root-leaves. "That other one that throws the long leg is no good at all. That's the craḋán ṙireann." The "long leg" of this male *crawdhaun* was the stiff fruiting stem. This sexual system of Irish folk botany owes nothing to Linnaeus, and I have never been able to grasp its abstruse principles.

Crann caoirṫeann, Berry Tree. *Pyrus Aucuparia* Ehrh., Quicken Tree, Mountain Ash.—Curraun Achill; general in Ireland, with or without the prefix Crann, and surviving even in Cornwall and Devonshire in the form *keer* or *care*. In Co. Dublin it becomes *quayreen*, and in the Isle of Man *cuirn*. A famous tree in Gaelic legend.

Crann fíomta, Twisted or Bent Tree. *Salix aurita* Linné, Round-leaved Willow.—Clare Island. See also Sailean.

Créactaċ, Wound (wort). *Lythrum Salicaria* Linné, Purple Loosestrife.—General on Clare Island, and on the mainland shores of the bay; also in Galway, Clare, and Kerry.

Cróbán ṁuire. *Erythraea Centaurium* Linné, Centaury.—Clare Island, where the usual name, Dréimire ṁuire (The Virgin Mary's Ladder), current in Donegal, Clare, and Galway, does not appear to be known.

Crocán. *Juncus acutiflorus* Ehrh., Jointed-leaved Rush.—Clare Island.

Duillúr Feiṫlean. *Lonicera Periclymenum* Linné, Woodbine, Honeysuckle.—Cloghmore, Achill Sound. See Feiṫleog.

Drúiseóg. *Rubus fruticosus* Linné, Blackberry, Bramble.—Clare Island, and widespread in Ireland—Donegal, Connemara, Louth, Kerry, &c., often in the shortened form Drúis (dhrish). The roots are used in Clare Island for producing a black dye.

Dubán ceann ċorać. *Prunella vulgaris* Linné, Self-heal.—General in Clare Island. "They make a drink out of it called Cailleach's Tay, that's very good for a weak heart." See Ténagaranti.

Feiṫleóg faoi crann, Sinew round the Tree? *Lonicera Periclymenum* Linné, Woodbine.—Clare Island. Precisely the same form is used in Clare-morris and in Galway; but the name is very frequently shortened to Feiṫleóg, in which form I found it in Inisheer, S. Isles of Aran. The name is very probably derived from Feiṫ, a withe or sinew, in allusion to the nature of the twining stems.

Fearbán. *Ranunculus repens* Linné, Creeping Buttercup.—Clare Island and Achill Sound. A widespread name in Gaelic Ireland, and suffering very little dialectic change.

Feamain.—A general term for the larger, leafy seaweeds, especially the Fuci and Laminariae. No doubt connected with Feam, a tail. Clare Island, Achill Sound, &c., and general in West Ireland.

Feamain deaig, Red Fammin. *Laminaria digitata* Linné, Tangle.—Clare Island, Achill Sound, &c. The chief material for kelp-making.

Feamain buiḋe, Yellow Fammin. *Fucus nodosus* Linné, Knotted Fucus.—Clare Island, Rinvyle, &c., an appropriate name for this species in the autumn, when the fruiting plants turn a bright yellow.

Feamainn dub, Black Fammin. *Fucus vesiculosus* Linné, Bladder Wrack.—Clare Island, Achill Sound, Rinvyle, &c. The names Feamainn buiḋe and F. dub are perhaps not fixed in their application to the species given above, but vary in application with seasonable colour-variation in the plants. *Fucus vesiculosus*, yellow in the fruiting season, turns black when wilted. See Bolgán, wrack.

Féitóg liaṫ. *Ramelina scopulorum* Ach.—Clare Island. I am indebted to Miss Knowles for this name of obscure meaning applied to a well-known lichen, which is used in the island to produce a yellow or rather saffron dye. See Sgia cloċ.

Fiḋeóg *Juncus effusus* Linné, Soft Rush.—General in Clare Island. Also used in Connemara.

Fliṫ or Flic. *Stellaria media* Vill., Chickweed.—Clare Island. General in Mayo and Galway. A name of very obscure sound in Gaelic. Given in Threlkeld as Fliuh, and in Cameron as *fliodh* or *fluth* for West Scotland. Perhaps connected with Fluiċ, moist or succulent.

Foṫannán. Thistles in general.—Applied in Clare Island to the three common species, *Cnicus lanceolatus*, *C. arvensis*, and *C. palustris*. A widespread name in Ireland, occurring with little or no change in Mayo, Galway, and Kerry. The names Feoċaḋán and Ḋeóraḋán, also widely used in Ireland, are perhaps variants of Foṫanán.

Fraoċ. *Calluna vulgaris* Linné and *Erica cinerea* Linné, Heath.—General in Clare Island and round Clew Bay, as it is throughout West Ireland. No attempt appears to be made in Gaelic Ireland to distinguish these two species by name. The term Mínfraoċ, Kind or Soft Heath, in common use in Clare Island, seemed to me at first to apply to a distinct species, but further inquiry showed that it denotes merely the tender young shoots of the heather which are eaten by cattle.

Fraoċóg. *Empetrum nigrum* Linné, Crowberry.—This name or its variant, Fraoċán, is the common Irish Gaelic for the Bilberry (*Vaccinium Myrtillus*); but this species is rare and probably seldom fruits in Clare Island, and the name is applied to the Crowberry, the fruit of *Empetrum nigrum*, which is found on the higher slopes of Croaghmore and elsewhere. In Tyrone the Crowberry plant bears the name Fraoċ na Fraoċóg, or Frocken Heath, as it may be rendered, using the Co. Dublin word for the Bilberry.

Fuarán. *Heracleum Sphondylium* Linné, Cow-Parsnep.—Clare Island, Belclare, and Roonah. The same form occurs in Roscommon; Siurán in Dublin and Uaran in Kerry. See Pléargán.

Gall raiṫneaċ, Foreign Fern? *Osmunda regalis* Linné, Royal Fern.—General in Clare Island. It is not easy to account for the use of the adjective gall, foreign, in connexion with so distinctly native a species as this is in Ireland. In Iar Connaught the plant is called Raiṫneaċ gallda, also meaning Foreign Fern.

Giolcaċ. *Arundo Phragmites* Linné, Common Reed.—General in Clare Island, as it is in Kerry and in Connemara. See Coirgearaċ.

Giúmaṡ. } *Pinus sylvestris* Linné, Scotch Fir.—In general use in Clare Island,
Giúṡ. } not for the living tree, which is not found there, but for the bog-deal or relics of old forest, which are plentiful in cut-away bogs in several places. The large stump of bog-deal is known in the island as Caillеаć giúmaṡe or Fir Hag. It is a curious fact that the Spruce Fir (*Pinus Abies*) bears in Lapland the native Lapp name *güesa*, very closely similar in sound to the Gaelic name for the allied Scotch Fir. (See Linnaeus, "Flora Lapponica," 2nd ed., p. 285.)

Gliogaṡ. *Equisetum maximum* Lamarck, Great Horsetail.—General in Clare Island, where the species is common. The name is perhaps connected with the Gaelic for prattle or jingling sound in allusion to the rustle made by the Horsetails as they are stirred by the breeze, or as one walks through them.

Glúmeаć deaṡg, Red Kneed-Plant. *Polygonum Persicaria* Linné.—Clare Island, precisely as in Connemara and in Kerry.

Gronnluṡ. *Senecio vulgaris* Linné, Groundsel.—Clare Island. General in Gaelic Ireland. Perhaps an Irish modification of the English *groundsel*.

Gruanać } *Lithothamnion calcareum* Aresch. and *Lithophyllum fasciculatum*
Gruanaće. } Fosl.—The common name for the "Coral" about Inishlyre and the Westport channel generally, where beds of both species occur. It is used as a Heath-killer, lime being deficient in most of the drift islands of Clew Bay, so that heather grows freely if permitted. Speaking of the "coral" as it came up in our dredge off Inishlyre, a Rossmindle fisherman said: "It cuts the heath to pieces and clears it off the land."

Liaṫ. *Pinguicula vulgaris* Linné, Butterwort.—Clare Island, where it is said to poison geese. Perhaps connected with Léiṫe or liaṫaú, sheep rot, the plant growing in marshy ground, which induces the disease in sheep. In Kerry I have found the form Leiṫ uiṡge in use.

Liać. Laminaria frond.—At Cloghmore, Achill Sound, 1910. A name of very obscure sound, and perhaps generic for broad-leaved water-plants. It is used as a component in Gaelic names for the Pondweed and the Water-lily.

Luṡ mór, Great Plant. *Digitalis purpurea* Linné, Foxglove. See Méaṡaćán.

Maide Méaṡaćán, Thimble Stick or Staff. *Digitalis purpurea* Linné, Foxglove.—This is the prevailing name in Clare Island for the flowering plant of the Foxglove. The name Luṡ mór, so commonly given to the plant in other parts of Ireland (I have found it in use in Donegal, Galway, Clare, and Kerry), appears in the island to be applied only to the immature state, with its conspicuous tuft of broad base-leaves. In this

state it seems to be considered a distinct species. "It has a nature of its own," I was informed. A famous fairy plant in Ireland, as is shown by many of its Gaelic names, as Meiṁiġe ṗúca (the Pooka's Fingers) in Kerry, Meaṗacán ṗróe (Fairy Thimble) at Omeath, Siṫean, &c.

Méaṗacán, Thimble.—The Clare Island name for the Foxglove flower; the name for the whole plant at Cloghmore as in other parts of Ireland.

Miliuṗać. *Zostera marina* Linné, Grass Wrack.—Used at Bartra and Belclare, Clew Bay. Dinneen ("Irish Dictionary," p. 483) gives the name Milṗéaṗać, sweet grazing or grass, as used in Achill for a "marine weed with a sweet root." The Clew Bay Miliuṗać is no doubt a variant of this.

Mín ṁaṗa. *Conium maculatum* Linné, Hemlock.—General in Clare Island, also used in Achillbeg. From Iar Connaught I have the form Muing ṁaṗa, apparently meaning Sea Mane. Threlkeld gives Muinṁeaṗ and Cameron *muinmhear*. The meaning is obscure, but the second component is probably the Gaelic word for sea. In Ireland, at least, the plant has a strong affection for seaside stations.

Miṗṁín ṫeaṗg. *Mentha hirsuta* Hudson, Water Mint.—Clare Island. General in Kerry.

Neantóg. *Urtica dioica* Linné, Nettle.—General in Clare Island and on the mainland shores of the bay. as it is almost throughout Gaelic Ireland in one or other of its forms. In some parts of Kerry it becomes Lanntóg.

Neantóg caoć, Blind Nyanthogue. *Lamium purpureum* Linné, Red Dead Nettle.—Clare Island and Achill Sound; also in Connemara.

Nóinín. *Bellis perennis* Linné, Daisy.—Clare Island, Bartra, Achill Sound, Achillbeg, &c. Throughout Ireland, with little variation. No doubt connected with Nóin, noonday, and analogous in its origin to the common English name Daisy (Day's-eye).

Pléaṗgán. *Heracleum Sphondylium* Linné, Cow Parsnep.—Achill Sound. A contraction of Gunna pléaṗgán, pop-gun, for which the hollow stems are used by boys.

Raiṫneać. *Pteris aquilina* Linné, Bracken.—A generic name for the ferns, but applied in Clare Island and round Clew Bay, as throughout Gaelic Ireland, to the Fern *par excellence*, the ubiquitous Bracken.

Raiṫneać ṁaṫa ruaḋ, Fox's Fern. *Athyrium Filix-foemina* Roth, Lady Fern.—At Cloghmore. In Kerry this fern is known by the name Raiṫneać ṁaṫra, Dog Fern.

Rileóg. *Myrica Gale* Linné, Bog Myrtle.—General in Clare Island and on Achill Sound. Widespread in Gaelic Ireland in varying dialectic forms, Releog (Raylogue) in Kerry, Rideóg (Ridyogue) in Roscommon, &c.

Ríreaċ. *Himanthalia lorea* Lyngb., and *Chorda filum* Linné.—Applied to both species in Clare Island, to *Chorda filum* at Rossmindle and to *Himanthalia lorea* at Cloghmore. See Scaoileaċ.

Sal cuaċ. *Viola sylvatica* Fries, Wood Violet.—Clare Island. My informant at Ballytoohy, Clare Island, believed this Gaelic name to mean the Cuckoo's [Stocking] Heel, and said he had heard it so interpreted by old people in the island. A correspondent from Co. Mayo suggests that the name may mean the Heel of the Drinking-Horn, the shape of the spur of the Violet resembling the base of the old Irish Cuaċ or drinking-cup.

Saileán. *Salix aurita* Linné, Round-leaved Willow.—Clare Island; also used in Iar Connaught. See Crann ṁiomṫa.

Sáṁa bo, Cow Sorrel. *Rumex Acetosa* Linné, Common Sorrel.—Clare Island. I have from Kerry and Galway the name Sáṁa, simply, for this species.

Sáṁa caorać, Sheep's Sorrel. *Rumex Acetosella* Linné.—General in Clare Island as it is in Connemara.

Scaoileaċ. *Himanthalia lorea* Lyngb.—The name is applied to Laminaria at Cloghmore, to Himanthalia at Rinvyle. The word is derived from the verb Scaoilim, to scatter or spread loosely, in allusion to the waving fronds.

Scra cloċ, Stone Scurf. *Parmelia saxatilis* Ach.—General in Clare Island as the name of this lichen, which is still used there to give a yellow dye of better quality than Féitóg liaċ, which is also used for the same purpose. In the Carna district, Galway, the name Scra cloċ is given to another Lichen, *Ramalina scopulorum* Ach., there also used as a yellow dye (Brown, "Ethnography of Carna and Mweenish," R.I.A. Proc., 3rd Ser., vol. ii., p. 523). See Féitóg liaċ.

Sellirtrinn. *Iris Pseud-Acorus* Linné, Yellow Iris, Flag.—General in Clare Island, and on the mainland shores of the bay, as at Roonah, Murrisk, Belclare, and Mulranny. Perhaps no Gaelic plant-name is so widely spread or suffers so many dialectic changes as this does. In Kerry it appears as Illirtrum, Selirtrum, or Oileartrum; in Louth (Omeath) it becomes Soilartrum. Threlkeld gives Sillirtar, Wade the digammated form Fealartar and Fealartrum, and it turns up in Cornwall in the contracted form *Laister*. The root is used in Clare Island to produce a black dye.

Sellirtrinn wild, The Wild Shellistring. *Sparganium ramosum* Hudson, Bur-reed.—Clare Island. In the Clew Bay area it is customary to distinguish plants or animals of uncommon size and vigour by the adjective "wild." The Bur-reed, resembling a very luxuriant and lofty Sellirtrinn (Yellow Iris), was so distinguished for me by an old resident of the island.

Sellirtroċ. *Iris Pseud-Acorus* Linné. This variant is used at Cloghmore, Achill Sound.

Slán lur, Health or Healing Plant. *Plantago lanceolata*, Ribwort Plantain.—General in Clare Island and all round the mainland shores of the bay; almost universal in Ireland. A well-known remedy for cuts and sores in Ireland and Scotland as in the Sikkhim Himalayas, where the plant occurs. Hooker thus refers to it in his "Himalayan Journals":—"At Tallum [in the Tanga Valley, Sikkhim] I attended an old woman who dressed her sores with Plantago (Plantain) leaves, a very common Scotch remedy, the ribs being drawn out from the leaf which is applied fresh; it is a rather strong application." In Clare Island the leaves are pounded up to make a poultice, and, according to one informant, the leaves of this species are for the purpose mixed with those of Copóg ṙáoraig, the root-leaves of *Plantago major*. See Note D.

Slat ṁara, Sea Rod. *Laminaria digitata* Linné.—Applied to the thick stems of the Tangle in Clare Island and on Achill Sound as it is in Donegal, in the South Isles of Aran, and even in Co. Dublin, where the shortened form *Slots* or *Slocks* is in use: one of the chief materials for kelp-making.

Téagarantaí. *Prunella vulgaris* Linné, Self-Heal.—This name was given me for Prunella at Cloghmore, where the use of the plant in making a *tisane* is well known. I cannot venture to suggest any rendering of the Gaelic name; but "Garden tea" was proposed by my informant.

Tráitnín. *Cynosurus cristatus* Linné, Dog's-tail.—Often used as a generic term for a dry grass stem; but in Clare Island the tráitnín *par excellence* is Dog's-tail, whose wiry, leafless stems stand out so prominently in the pastures at the approach of autumn. In Co. Dublin the Dog's-tail is called "Thrahneen grass."

Trom. *Sambucus nigra* Linné, Elder.—Clare Island and almost throughout Ireland in one or other of its forms. In Louth and Longford it is Tromán, in Iar Connaught Trom, in Kerry Troum, and in the Scotch Highlands *Druman*.

An ṡleiḃe *Teucrium Scorodonia* Linné, Wood Sage.—Clare Island and at Cloghmore, Achill Sound, where I found it grown in a garden as a cure for coughs. The name is also used in Connemara and in Inishiar, Aran Islands. In Inishiar the name was translated for me by an Irish speaker as "Fresh of the Mountain." In some authorities the first component of the name is written luḃar, Yew, but no doubt erroneously, as "Mountain Yew" is a singularly inappropriate name for the plant.

III. Some English Plant Names.

Bent or **Bint.**—*Psamma arenaria* R. & S., Marram Grass. At Bartra, Clew Bay ; also used for the same species in Co. Dublin. In English dialect applied to this and to many other species.

Bore-tree.—*Sambucus nigra* Linné, Elder. In general use in Clare Island. A common name in North English and Border dialect in Yorkshire, Cumberland, Ayr, &c.

Brier.—*Rubus fruticosus* Linné, Blackberry, Bramble. General on the island and round Clew Bay, as it is in Kerry, Sligo, and Dublin, in all of which counties it appears to supplant the word Bramble in folk-speech.

Burdock.—*Arctium Lappa* Linné. Clare Island; but used there quite rarely in comparison with the Gaelic ɡlóʼóán.

Coral.—In general use round Westport Bay as a name for *Lithothamnion calcareum.*

Docken.—*Rumex obtusifolius* and *R. crispus.* Clare Island and Clew Bay generally, the old plural form being used in the singular and a new plural, Dockens, formed from it.

Fifes, Flutes.—Applied in Clare Island to the hollow stems of *Angelica sylvestris.*

Juniper.—The Crowberry, *Empetrum nigrum,* is known by this name in Clare Island.

May Flower.—*Primula vulgaris* Hudson, Primrose. This is the only name I could find in use for the Common Primrose at Belclare and Murrisk on Clew Bay.

Millgrass.—The Grass Wrack, *Zostera marina.* Used at Belclare. A compound Irish-English name meaning 'Sweet Grass.'

Rush.—In use on Clare Island and Clew Bay for the Soft Rush (*Juncus effusus*). At Mulranny I heard the old plural, *rushen,* used.

Thorn.—Applied to the Spear Thistle (*Cnicus lanceolatus*) near the abbey, Clare Island.

Thristle.—This variant for thistle I heard used at Annagh Island, Clew Bay. It is also used in Co. Dublin and in the Scotch Border counties.

Whin.—In frequent use in Clare Island and round Clew Bay for *Ulex europaeus,* the word Furze, so common in East Ireland, being apparently unknown in the Clew Bay area.

Wild Coral.—Used in the Rossmindle district, southern Clew Bay, as a distinctive name for *Lithophyllum fasciculatum,* the large roughly globular form of "Coral." See Wild Shellistring (p. 14) and Wild Bornyack (p. 19).

Yellow Wrack.—Used at Belclare, Clew Bay, as a name for *Fucus nodosus*, the Knotted Fucus. Wrack is a common English dialect word for seaweed.

IV. Gaelic Animal Names.

(a) *Sea Animals (Fish, Molluscs, Crustaceans, &c.).*

Ballaċ, The Speckled (Fish). *Labrus maculatus* Bl., Ballan Wrasse.—In general use in Clare Island, where the fish is very common and as well known by the name Gunner as by its appropriate Gaelic name. Much fished for amongst the Laminaria off the rocks at low water, the lines being provided with a crab-shell guard to prevent the hooks fouling in the weed. The islanders speak of the fish as a good "kitchen" for use with potatoes. See Note A.

Báirneaċ. *Patella vulgata* Linné, Limpet.—General in Clare Island and round the shores of Clew Bay; also used in Co. Dublin in precisely the same form. See Fiaḋ Báirneaċ, and Note B.

Briaileaċ. *Tapes virgineus* Linné.—Used at Belclare, Clew Bay.

Bran. *Pagellus centrodontus* de la Roche, Common Sea Bream.—Used in Clare Island.

Cluairín, Little Ear. *Pecten maximus* and *P. varius* Linné, Scollop.—At Rossmindle, Clew Bay, where it is applied to both species of Pecten, and at Belclare, where it is used for *P. varius* only. See Muirineaċ.

Corr. *Ammodytes lanceolatus* Les., Sand Eel.—Clare Island and Mulranny. The word occurs as a component in place-names in both districts. The remarkable shingle promontory, so conspicuous a feature in the island shores about half a mile north of the quay, is named Kinacorra, the Sand Eels' Head, probably from its shape; and a deep sea hollow off the pier at Mulranny is known as Poll na gcorr, or the Hole of the Sand Eels.

Corrawine. *Syngnathus acus* Linné, Greater Pipe-fish.—Used at Belclare by English-speaking boatmen and pronounced *corrawine*. Perhaps a corruption of Corr fiaḋain, Wild Sand Eel. There is no sound in Gaelic corresponding to the *i* in wine, but the Gaelic Fiaḋ is in Clare Island corrupted to *Fye* by English-speaking islanders, *e.g.* in Fiaḋ Báirneaċ (Wild Bornyack), and possibly a similar corruption has occurred with fiaḋain in the present case.

Crirpóg.—A peculiar variant or corruption of Crubóg, applied to the Edible Crab at Belclare.

Cruaḋán. } *Trigla gurnardus* Linné, Grey Gurnard.—In general use in Clare
C. glas. } Island.

Cruaḋán ḋearg. *Trigla cuculus* Linné, Red Gurnard.—Clare Island.

Cṙubóg. *Cancer pagurus* Linné, The Edible or Great Crab.—Clare Island, Achill Sound, Cloghmore, &c. See Note A.

Cuan ṁara. *Echinus esculentus* Linné. Common Sea-Urchin.—Clare Island; a name of very obscure meaning.

Donnánaċ. *Motella mustela* Linné. Five-bearded Rockling.—Clare Island. The name is perhaps connected with donn, brown, in allusion to the colour of this common shore fish, often found between tide-marks on the island.

Duillicín. } *Mytilus edulis* Linné, Common Mussel.—General in Clare
Dublicín. } Island. The name is applied especially to the dwarf form *incurva* of the Common Mussel, which often covers flat half-tide reefs with large sheets of densely packed blue-black shells. The name is no doubt compounded of dub (black) and leac (genitive lice) a flat stone, and may be rendered, Little Black Rock [shell].

Eaṙcon. *Conger vulgaris* Cuvier, Conger Eel.—A general term for eel, often applied to the Conger in Clare Island.

Faoċán. *Littorina littorea* Linné, Common Periwinkle.—In general use in Clare Island not only for this species, but as a generic term in the widest sense, including several scientific genera of Testaceous Gasteropods, such as Purpura, Buccinum, Trochus, and Littorina. At Lake Tacumsin in Wexford I met with the variant péaċán—see Faoċóg.

Faoċán dub, Black Fweecawn. *Littorina littorea* Linné. Applied to the Common Periwinkle by a Rinvyle man at Louisburgh.

Faoċán ċapaill, Horse Fweecawn. *Purpura lapillus* Linné, Dog Winkle.—Used at Clare Island and at Rinvyle.

Faoċán iarann, Iron Fweecawn. *Buccinum undatum* Linné, Whelk.—Used at Rossmindle, Clew Bay, the name being suggested no doubt by the hardness of the shell—see Faoċóg iarann.

Faoċán Ṁuire, Virgin Mary's Fweecawn. *Trochus umbilicatus* Montagu.—Clare Island and Rinvyle. See Note C.

Faoċóg. *Littorina littorea* Linné.—At Cloghmore near the southern opening of Achill Sound this name takes the place of the Clare Island Faoċán, and, like it, is applied both specifically to the Common Periwinkle and generically to other univalves.

Faoċóg ṁaoid, Dog Fweecoge. *Purpura lapillus* Linné, Dog Winkle.—This is the Cloghmore substitute for the Clare Island Faoċán ċapaill.

Faoċóg iarann, Iron Fweecoge. *Buccinum undatum* Linné, Whelk.—Cloghmore, equivalent there to the Rossmindle Faoċán iarann.

Fiogaċ. *Acanthias vulgaris* Risso, Piked Dog-fish.—Clare Island and Cloghmore. In Clare Island I was told that this fish was sometimes eaten, and that oil was formerly made of it for use with rush-lights and lamps.

Fiaḋ bárṁneaċ, Wild Bornyack. *Patella vulgata* Linné, Limpet.—In Clare Island this name, corrupted by English-speaking natives to Fye Bornyack, is applied to the large, smooth form of the Common Limpet which inhabits rocks near low water where the heavy surf breaks. The word "wild" here, like "dog" or "horse" in English popular names, is used to denote something coarse or strong. See Note B.

Fleangaċ. *Scyllium canicula* Linné, Lesser Spotted Dog-fish.—Clare Island and Cloghmore.

Gliomaċ. *Homarus vulgaris* Edw. Common Lobster.—General in Clare Island; also at Cloghmore, Achill Sound.

Gliomaċ ṁara, Sea Lobster. *Palinurus vulgaris* Latr., Spiny Lobster.—General amongst the Clare Island fishermen.

Laḋar na mban, Lady's Fingers? *Asterias rubens* Linné, Common Star-fish.—Clare Island; general amongst the fishermen.

Madaḋ mór, The Great Dog. *Scyllium catulus* Turton, Large Spotted Dog-fish.—Used in Clare Island.

Maoiṫearcán (an).—In Clare Island this name is given to the Great or Edible Crab (*Cancer pagurus*), when it has exuviated or cast its shell. In this soft state it is held to be an excellent bait for fish. "You'll catch three with a wheescawn for every one you'll catch with a common crab," I was told by a fisherman. In Dinneen ("Irish Dictionary," p. 465), the name is entered as Fuirceán; but the sound of the spoken word in Clare Island is certainly ṁaoiṫearcán, as here given, the word being perhaps a derivative from maoiṫe, softness. If this derivation and spelling be correct, the name may be englished "Softy," which is certainly appropriate to the object named.

Milreán, Dainty or Sweet Bit. *Anomia ephippium* Linné.—At Belclare, Clew Bay. In spite of its name, I could not find that this mollusc was ever eaten in the Clew Bay area; indeed it is set down as deleterious by good authorities. The name is possibly ironical.

Mongaċ. } In Clare Island I found these names applied to *Gadus pollachius*
Monaċ. } Linné, the Pollock. At Cloghmore they were applied to the Coal Fish, *Gadus virens* Linné.

Muirníneaċ. *Pecten maximus* Linné, Great Scallop.—Used at Rossmindle, Clew Bay. See Cluairín.

Pairtán. *Cancer pagurus* Linné, Great Crab, Edible Crab.—Applied to this species in Clare Island; but also used there and throughout the Clew Bay area as a generic term for the crabs.

Pairtán ṁaoileann. *Maia squinado* Latr.—Clare Island, Cloghmore, and Rinvyle. I was at first inclined to adopt for this name the spelling

Partán ḟaoileann, which precisely represents the sound of the name as spoken. The meaning, Seagull Crab, is, however, singularly inappropriate, and I am convinced that the spelling here adopted is the correct one, the rendering being Mweelans Crab. The Mweelans are prominent naked rocks or sea-stacks, lying some two miles south of Clare Island, and a likely haunt for this deep-water crab.

Partán glas, Green Crab. *Carcinas maenas* Pennant, Common Shore or Green Crab.—Clare Island, Cloghmore, and Rinvyle.

Partán iarann, Iron Crab. *Xantho florida* Leach.—Clare Island; an appropriate name for this very hard-shelled crab, which is common under stones at low water throughout the Clew Bay area.

Partán síle. *Portunus depurator* Leach, Swimmer Crab.—General amongst the Clare Island fishermen and probably applied to the Swimmer Crabs generally. The second component of the name sounds precisely as Síle (Sheila), a woman's name, and may possibly have originated in the island from some trivial circumstance, as popular names not infrequently do.

Ribe punán. *Palaemon serratus* Fabr. or *P. squilla* Fabr., The Prawn.—Clare Island. "It's the Shrimp that lives in flashes by the sea," a Clare islander told me, "flash" here meaning pool, and "shrimp" being applied, as it is generally in Ireland, to what is usually called prawn in England, prawn in Ireland being applied to the Norway Lobster (*Nephrops norvegicus* Leach). The name may perhaps be rendered Seal's Whisker, in allusion to the long, slender antennae of the shrimp.

Ruc. *Raia batis* Linné, The Skate.—General in Clare Island.

Runnaċ. *Scomber scomber* Linné. The Mackerel.—General in Clare Island.

Rón. *Halichaerus grypus* Fab., The Grey Seal.—Clare Island, Achill Sound, &c., and general in West Ireland.

A favourite alliterative saw amongst the Clare Island fishermen is the following, which includes the three species just mentioned. I could find no Gaelic version of it. "The three swiftest things that swim in the sea are the Ruc, the Rone, and the Runnock." The Skate when it comes to the surface, as it does at times, is said by the fishermen to "travel along the top of the water like a shot from a gun," and the mackerel "is that swift that it catches hold of a bait from a hooker doing its 8 miles an hour."

Smugairlíde póm. Seal's Spit.—*Aurelia aurita* Linné. Jelly-fish.—A very widespread name in Clare Island and round Clew Bay for this jelly-fish, which at times appears there in vast numbers. The name is no doubt generic for several common species of jelly-fish.

Staigín. *Buccinum undatum* Linné, Common Whelk.—Used at Belclare, Clew Bay. See Faoćán iarann.

Teinne Ġealáin. *Noctiluca miliaris.*—Clare Island. This expression, which perhaps may be a general term for phosphorescence rather than a definite name for the animal producing it, Mr. Praeger found in use amongst the Clare Island fishermen for the brilliant light-flashes in the wake of a boat, usually due to the animalcule, Noctiluca. In that wonderful farrago of imaginative medicine. Keogh's "Zoologia Medicinalis Hibernica," "Tinny Gallane," is entered as the Gaelic name for the Glow-worm. The true Glow-worm is not Irish, but we have in Ireland a luminous centipede, *Linotaenia crassipes*, C. Koch, and this is probably Keogh's Glow-worm.

(*b.*) *Land Animals*: *Birds, Insects, and Mammals.*

Buiḋeóg Léana. Yellow Meadow [Bird]. *Emberiza citrinella* Linné, Yellow-hammer.—Clare Island.

Ciarróg. *Calathus cisteloides* and its allies.—A general name in Clare Island and round Clew Bay for this narrow black beetle, which is common under stones.—See Notes C. and D.

Cárróg. *Pyrrhocorax graculus* Linné, The Chough.—Clare Island, where the bird breeds in many places. Probably what is known to philologers as an onomatopaeic word, imitative of the note of the bird.

Cárróg bán. White Caurogue. *Corvus cornix* Linné, Hooded Crow.—Clare Island.

Cuaċ. *Cuculus canorus* Linné, Cuckoo.—Clare Island.

Darra daol. } Applied in Clare Island to two species, *Ocypus olens*, a common
Deairg daol. } black beetle or chafer, and *Lithobius forficatus*, a red-brown centipede. The black darra daol, known in English dialect as the Devil's Coach-horse, is an object of superstitious aversion in Clare Island, as it is in Ireland generally. It is supposed to carry a virulent poison in its pointed tail, which it erects in a threatening manner when molested. "There's a black one and a red one too, because it's just the same moral," I was told by an islander who identified the centipede as the "red one," which was the same "moral" (model) as the black one, though to the uninitiated scientific observer they are utterly different in character. The beetle and the centipede, in fact, agree in nothing but their generally uncanny and vicious aspect. It is difficult to fix the precise form of the first part of the Gaelic name as current in the Clew Bay area. It appears to fluctuate between dar, darra, and dearg.—See Note D.

Deairg gabróg, Red Fork? *Forficula auricularia*, Earwig.—Clare Island. The second component of the name appeared to be sounded as *dhowlogue*

rather than *gowloguc*; but it seems probable that the latter is the correct form, the name being suggested by the conspicuous forked tail.

Dreoilín. *Troglodytes parvulus* K. C. Koch, The Wren.—Clare Island.

Faoileann, Sea-gull.—General in Clare Island, on Achill Sound, &c., as a generic name for the gulls. I could not find current in the area any distinctive Gaelic names for the different species of sea-gulls.

Fiaċ dub. *Corvus corax* Linné, The Raven.—Clare Island.

Glaróg, *Motacilla melanope* Pallas, Grey Wagtail, and *M. lugubris* Temminck, Pied Wagtail.—Used for the wagtails in Clare Island apparently as a generic term.

Luċ. *Mus musculus* Linné, Common Mouse.—Clare Island.

Luċ féir, Grass Mouse. *Mus sylvaticus* Linné, Long-tailed Field Mouse.—Clare Island.

Luċ mór, Great Mouse. *Mus decumanus* Linné, Rat.—Clare Island, where I did not hear the commoner name Luċ Fhranncaċ or French Mouse used, though it is probably known in the island.

Madaḋ uisge, Water Dog. *Lutra vulgaris*, Otter.—Clare Island.

Máir' fada, Long Mary. *Ardea cinerea* Linné, Heron.—Clare Island, Belclare, and Rossmindle.

Préacán liaṫ, Grey Crow. *Corvus cornix* Linné, Hooded Crow.—Clare Island. See Caróg bán.

Prumpeallán. *Geotrupes stercorarius*, Dung Beetle.—Clare Island. See Note C.

Spreóg. *Erithacus rubecula* Linné, Robin.—Clare Island.

V. Some English Animal Names.

Bream bird.—Applied to the Terns in Clare Island.

Cobbler.—At Belclare used for *Cottus bubalis*, a common shore fish.

Gunner.—Frequently applied to the Ballan Wrasse, *Labrus maculatus*, in Clare Island.

Limpet.—In Clare Island sometimes used by the children, though the Gaelic bárneaċ is much more frequently heard.

Nine Eyes.—Applied to the Gunnel or Butter-fish, *Centronotus gunnellus* Linné, at Belclare, as it is in Co. Dublin.

Otter.—Used in Clare Island as well as the Gaelic name.

Scollop.—At Belclare for *Pecten maximus*.

Twelve Eyes.—This name is given to the Gunnel in Clare Island in lieu of the more widespread but less appropriate name, Nine Eyes.

Willy Wagtail.—Applied in Clare Island to the Grey Wagtail.

Wild Bornyack.—The Clare Island name for the large form of Limpet inhabiting exposed stations. See Fiaḋ bárneaċ.

VI. Supplementary Notes.

(A.) *The Crab Shell as a hook-guard.*

One of the difficulties to be overcome in fishing for the Gunner from the rocks on the Clare Island coast is the tendency of the hook to foul amongst the Laminaria or tangle fronds. A simple and effective remedy is found in an ingenious application of the carapace of *Cancer pagurus*, the common Edible Crab. The empty shell is cut into two across its shorter diameter, leaving the dorsal and ventral plates united, and forming in front a smooth-sided wedge. Then a hole is pierced in the centre of this wedge, and the half-shell is strung on the fishing-line (with its wedge-shaped edge towards the fisherman), and is fixed there about a foot above the hook. The baited line with its sinkers is then slung out well beyond the fringe of swaying tangles, with the hollow of the crab-shell turned seawards, and its wedge end landwards. When a fresh cast has to be made, the line is drawn rapidly through the weeds, the sharp, smooth-sided edge of the shell clears a passage for the hooks, and these slip through before the opening has time to close.

There is probably a Gaelic name for this simple contrivance which is used by all the Clare Island rock-fishers; but I failed to find it, or any English name more distinctive than the "shell."

(B.) *The* Fiaḋ Ḃáirneaċ *as a Rat-catcher.*

The "Wild Bornyack" is well known to catch rats in Clare Island, not, of course, by out-running them, but in the following manner, as explained to me by an old islander:—

"Of a soft evening them bornyacks do rise up and go travelling a bit over the rocks, and the rat'll come up and slip in her tongue to lick the meat, and the bornyack'll clap down its shell and catch her by the tongue. And I tell you the power of man couldn't loose the hold of the bornyack, and the rat is caught there till the tide comes up and drowns her. I seen them myself hanging there by the tongue and they dead."

This account was confirmed by several Clare Island men. The capture of a rat by a Limpet is also on record from the Scotch island of Dunstaffnage ("Cambridge Nat. Hist.," vol. iii, p. 57).

(C.) *The Origin of the Operculum.*

While collecting names of animals and plants in Clare Island I several times came across a legend connecting St. Patrick with the Faoćán Ṁuire (Fweecawn Wirré). It appeared in many forms, all with a strong family likeness, and though some of the narrators were inclined to associate the legend with the common Faoćán (Fweecawn) or Periwinkle, the best authorities

agreed that the true Fweecawn Wirré was *Trochus umbilicatus.* Amongst the variants I found current I select the following as the most circumstantial. It was given me by a native islander, a boatman under forty years of age, and I reproduce it here as closely as possible in his own words, without attempting to modernize his grammar or to represent phonetically his western pronunciation. Though an Irish speaker, he gave me the legend in English :—

"One time the Jews were chasing St. Patrick all over Ireland to kill him, and at last they caught him and buried him deep in the ground. And then the Jews went off with themselves and came into a house to get their supper. It was a cock they put into the pot, and, as they were sitting there waiting for it to be cooked, says one of them :—'I don't know is there any fear of the saint rising up again on us?' And another of them made answer with a laugh :—'Ay is there, just as much fear as there is of that cock there in the pot rising up and crowing twelve times.' And lo and behold you, the words were hardly out of his mouth when up the cock rose in the pot and let twelve crows out of him. And when the Jews heard that, it was real mad they got, for well they knew by it that the saint had made a miracle and rose up on them. So away they went to hunt for him; and the first thing they met on the road was the Ꝑꝛumpeallán (Primpellawn), and says the Jews to the Primpellawn, 'Did you see Patrick passing this way?' 'Ay did I,' says the Primpellawn; 'I seen him inoé' (in-yai), meaning yesterday, for you see the Primpellawn wasn't wishing to give them Jews any help at all, at all. So away they went; and the next thing they met was the Ciaróg (Keerogue) and he walking along the road; and they up and axed the Keerogue if he seen the saint. And the Keerogue made answer that he seen the saint sure enough, and that it's hiding himself in behind a Fweecawn he was that was creeping over the rocks and putting a cap on the Fweecawn when it drew back into its shell with him. So off them Jews set hot foot down to the seashore to hunt for that Fweecawn with the saint in in it and the cap on it. But it's well St. Patrick knew what they were after; so what does he do but put a cap on every one of them Fweecawns, and so sorrow bit of them Jews could ever find the one he was hid in. And that's how them Fweecawns came to have caps on them, for ne'er a one of them had a cap on it before that."

A Rinvyle man I met at Louisburgh Quay gave me another version of the legend, and illustrated his story by taking up a living specimen of *Trochus umbilicatus*, and pointing out the operculum as the "cap." This Fweecawn he told me, never had a cap on it before, and it's had one ever since. He went further and told me that "ne'er another one of them Fweecawns" (using the word here in its wide generic sense) "has a cap on it at all."

(D.) *The Infamous* Dapa dail.

Although the Dapa dail (Darra dheel) is a creature of ill fame throughout the Clew Bay region, as it is, I believe, all over Ireland, I was unable to find current in the district any legend accounting for its bad reputation. It is generally held there to be highly poisonous; and in illustration of this, as well as of the wonderful healing powers of Slan lur (Slawnloos), a Murrisk man told me the following child's tale well known in his neighbourhood:—

"One day the Keerogue and the Darra dheel had a great fight, and at last the Darra dheel got a grip of the Keerogue and turned up its tail and stung the Keerogue and poisoned him, and left him for dead. But what does the Keerogue do but crawl away till he comes across a Slawn-loos was growing in the grass, and he bit a piece out of the Slawn-loos and chewed it up and swallowed it, and he was cured on the spot."

While collecting plant and animal names on Clare Island I was accustomed to lay my difficulties of identification, etymology, and pronunciation before a small council of islanders assembled at night in the inn kitchen at the harbour. The men of light and leading here gathered together were usually able to come to agreement on the problems presented to them; so one night I brought in alive in a glass tube a specimen of what I considered to be the true Darra dheel (*Ocypus olens*), and proposed to lay it on the table as an exhibit for examination and discussion. The proposal caused a flutter; anxious eyes were turned towards the door as if in contemplation of retreat, and when the harmless beetle was gently shaken out of the tube on to the table one bearded man, losing all control of his feelings, retired to the farthest corner of the kitchen, crying out, "Oh, put it in the fire! Put it in the fire, I tell you. That'll bring you a great advantage." The more reckless spirits having cautiously inspected the beetle from a safe distance pronounced it to be the true Darra dheel. Only one *esprit fort* ventured to laugh at the fears of his brother islanders, and when I returned the beetle to its glass tube a sigh of relief passed round the kitchen.

For many interesting details as to the Darra dheel in Irish literature see Note 9 of R. J. O'Duffy's edition of Oiże Ċloinne Tuireann (Soc. Pres. Ir. Lang.), and also Dr. Hyde's "Beside the Fire," p. 184.

(E.) *Seal Metamorphosis.*

Of the Clan Coneely seal legend, so well known in Connemara, I failed to find any clear traces in Clare Island; but two other interesting stories of seal metamorphosis weregiven me by the islander whose version of the Fweecawn Wirré legend is reproduced here in Note C. I give these seal legends as closely as possible in the narrator's words.

"A great many years ago, long before my time, the Clare Island men used to go hunting the seals to make oil out of them. So one day four men went off in a canoe beyond Achill Head there to look for seals in the caves. And when they came to a good cave, one of them landed with a heavy stick, the butt-end of an oar it was, to see would there be any seals in in it. And he hadn't been long there when a big seal comes flopping down the stones from the top of the cave, and made for the water. But before he got in the man with the stick gave him three terrible blows on the back, thinking to kill him. But he didn't, and the seal swam away. And then another seal came down from the top of the cave, and the man gave him three welts of the stick, too, but he didn't kill that seal either, and away it swam after the first one. And then another one came flopping down, and he got three terrible welts of the stick like the other two, but no more was he killed, so the whole three got away on the man.

"Then he got back into the canoe, very angry with himself, and they pulled away for another good cave, where they thought to find more seals. But they hadn't got far when a terrible storm rose up all of a sudden, and no matter how hard they pulled they couldn't make head against it, and it's far out to sea they was blown where they had never been before that. And then the night came on on them and they far out there in the sea and killed with the hard rowing, and they'd almost given up all hopes of seeing home again when one of them seen a small light shining out far ahead of them. And they pulled for it like mad, and at long last they got under the shelter of a little island they never seen nor heard of before, and there sure enough was the light shining in the window of a house.

"So they made the canoe fast and landed and went up and rapped at the door, and a woman opened it and axed them to come in and sit by the fire. And it was making plasters the woman was when she let them in, and they seen three men lying on the floor by the fire and their backs stripped. And when the canoe men came over to the fire to warm themselves three terrible wounds it was they seen on the backs of the three men was lying there. And one of the canoe men, the one that landed with the big stick to kill the seals in the cave, got a turn when he seen the wounds, and he called out: 'The Lord be praised! and who done that on yous?' And one of the men on the floor made answer: ''Twas you yourself done it not three hours ago in the cave over there beyond Achill Head.' And by that the canoe men knew it was the three seals was lying there with the cruel welts of the stick on their backs, and they got afeard, as well they might. But the seal man said: 'Let this be a lesson to yous for all your lives; so go away home with yourselves now, and let you not be laying hands on a seal any more.' So

they made a promise to him. and the storm went down, and he gave them the bearings for Clare Island, for sorrow one of them knew where they were at all, and they made off in the canoe and got safe home. And I can tell you ne'er a one o' them four ever laid hands on a seal again."

Along with this legend I was given a very complete version of the Legend of the Seal Wife, so well known in the Hebrides and in West Ireland. As the Clare Island version appears to be fuller than any I have seen on record, I venture to set it down here as closely as may be in the diction of the narrator.

"Three Clare Island men went out seal-hunting in a canoe one day, and when they'd got out to the island they were making for, one of them landed in a cave to see would any seals be in in it, and the other three pulled away to another cave to look for more seals. But by the time the canoe came back to pick up the first man, the wind had rose up, and the sea was that coarse they didn't dare venture in with the canoe to take him off. They tied a balk of wood to a rope to see would it float in the way he'd catch hold of it and let himself be dragged out through the waves. But sorrow a bit of good it was; for the water was that cross and contràry the balk wouldn't go in half far enough. So the end of it was the man in the cave roared out: 'Go away home with yous before the storm gets real bad and leave me here for the night. For it's not afeard I am at all to stay here till yous come back for me.'

"So away they went and left him there all alone by himself, and he climbed up into a skelp [cleft] of the rocks the way the high tide couldn't catch him. But it wasn't long he'd been there when a big herd of seals came swimming and splashing into the cave and got up and lay down on the round stones on the floor, and he could see them without they seeing him, for it's well hid he was in in the skelp of the rock above them. And he kept watching them; and when the night began to fall what does he see but all the seals taking off their cuculs (Coċall) and hanging them up on the rocks. And the minute they took off the cuculs they all turned into men and women and began to talk to each other, the way you and me is talking at this present. And when they got tired talking they all lay down to sleep, the women seals lying up at the top of the cave by themselves where the stones were dry, and the men seals lower down near the water.

"And they slept there all night; and as soon as the light of morning came creeping into the cave, the canoe man rose up softly in the skelp he was hiding in, and put down his hand and pulled up one of the women's cuculs and hid it under him in the skelp. It wasn't long till all the men and women woke up and went putting on their cuculs and swimming off into the sea as good seals

as ever they were when they came in. But one of the women couldn't find her cucul at all, and she went up and down the cave in a terrible state, crying and calling to the others not to leave her there. But they wouldn't wait, and so they went off with themselves and left her there all alone by herself.

"By this time the sea had gone down, and the canoe came out again to take the man away from the cave; so he got down out of the skelp with the cucul hid close under his *bawneen* [white flannel vest], for well he knew the seal-woman once she got hold of the cucul would slip it on and turn back into a seal and swim off with herself. A real handsome woman she was, and after speaking her fair and kindly, he took her into the canoe and brought her home to the island, and they were married there by the priest. And they lived very happy there, and had two children, and the husband took care to keep the cucul hid in the thatch the way the wife wouldn't see it.

"But one day he was out fishing, and the wife was drying flax by the fire—for at that time there was flax grown in the island—when the flax caught fire and before she knew where she was the house was all in a blaze. So she ran out with the children, and the thatch caught fire in a few minutes and she got a queer smell coming from the thatch and she looked up and what did she see there but her cucul, and it singeing with the fire. With that she made a leap at the cucul and caught it, and ran down to the shore with it, and slipped it on and made a seal of herself, and away she swam off with herself, leaving the two children behind her.

"So the husband was left forlorn there with the children till one day a neighbour came and told him how he'd seen his wife come up out of the sea and throw off her cucul and walk up on the rocks and hug and kiss the children were playing there, and cry as if her heart were breaking. 'And,' says he, 'if you go your way down now to the shore and hide till she comes up again you've nothing to do only dart out and snap up the cucul, and you'll have her back again with you.' With that the husband goes down to the shore and hides behind a rock nigh-hand where the children were sitting, and sure enough a seal comes swimming up and throws off its cucul and he seen at once 'twas his wife that was in it, and she takes to hugging and kissing the children as if she'd like to eat them. Then out he leaps and grabs at the cucul; but he wasn't smart enough, for she caught it up before he came near it and on she claps it, and away with her into the sea. And the poor man never seen sight or light of her after that. He was a man that lived over there at the other end of the island, but I disremember his name."

I was unable to discover the precise meaning attached by the Clare Islanders to the word Coćall, which so often recurs in these seal legends. All the

authorities agreed that the word had dropped out of the ordinary colloquial Gaelic of the island, and survived there only in the seal legends. One man believed the cucul was a cap, another thought it might be a cape, a third preferred to english it hood, and a fourth was inclined to extend its meaning to the whole skin or vesture of the seal. Larminie, in his "West Irish Folk Tales, translates it "transforming cap"; and both MacDougall ("Argyleshire Folk and Hero Tales") and Campbell of Islay ("Popular Tales of the West Highlands") render it "husk." It is, no doubt, connected with the infant's caul to which sailors attach a superstitious value as a safeguard against drowning.

VII. Index of Scientific Names of Plants and Animals.

INDEX OF SCIENTIFIC NAMES OF PLANTS AND ANIMALS—*continued.*

5.

AGRICULTURE AND ITS HISTORY.

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No account of the agriculture of any small or even of any large island could be written without discussing that of the other places with which it may have been in contact. English agriculture, for instance, although it is largely the outcome of the system the English people brought with them to Britain, cannot be fully described without reference to ancient Rome, to early Scandinavia and France, and to the Low Countries in the times of Elizabeth and the Stuarts. The following paper will be found to contain less about Clare Island and more about the mainlands of Ireland and Great Britain than might ordinarily have been expected. But the circumstances here are not ordinary. Clare Island could not have been treated as the Survey scheme intended it should be, without reference to the mainlands; and, as no systematic and searching history of Irish or British Agriculture has yet been written, it became necessary to deal with this part of the inquiry at some length. What appears here must be regarded, therefore, as pioneer work in a field which is largely unexplored; and some of the views brought forward may have to be modified by further research. For instance: since this paper was read, discussions with students of philology and archæology have brought out divergent views as to the dates when certain crops may have been cultivated by the Irish Celts; and so that these views may stand alongside those expressed in the paper they are put in as notes.

From the historical point of view, Clare Island by itself is well-nigh sterile. The live stock of the island have been so changed by the importations of the Congested Districts Board that the signs which would indicate those of even five-and-twenty years ago are very few. And, such as they are, these indicate that the stock of that time were themselves the descendants of stock brought to the island after the sixteenth century to sweep out a still earlier stock. In the same way, the system of farming has been changed in

some degree by the Congested Districts Board, and most signs of the earlier systems have been obliterated. Thus, we are forced to depend very largely upon what can be inferred from other places to which we believe Clare Island may be comparable.

And at the very beginning we run into a crucial problem: How far were the older Clare islanders true Celts, and how far were they modified in blood and in economy and custom by the Norsemen? If we could eliminate the Norsemen, which, on the west coast of Ireland, is very difficult to do, our problem would be simplified in some degree. For then we could say that the old Clare islanders had no other cow than the little black cow of Western Europe and no other horse than the old Celtic pony till a few hundred years ago. And we could also say that the probability of their ever having cultivated their fields on the two-field or three-field system typical of Teutonic and old English agriculture was highly improbable.

Being unable to solve the problem as between Norseman and Celt, we can only begin by giving a very incomplete account of the agriculture of the Celts, and then indicate how far it might have been modified by contact with the Norsemen and with other people who may have influenced the Clare islanders since the Norsemen's times.

Far enough back in the history of any nation, we come to a time when that nation took to tilling the soil. That time, for the Celts in Britain, is placed as far back as the fourth century before the Christian era by Pytheas, who sailed the North Sea as far as Orkney in the time of Alexander the Great. At one time many of Pytheas's stories were deemed incredible; but so many of them have turned out to be true that he is now treated with a higher degree of respect. Strabo was one of the early unbelievers; but he admits that Pytheas "appears to have reasoned correctly, that people bordering on the frozen zone would be destitute of cultivated fruits, almost deprived of domestic animals; that their food would consist of millet, herbs, fruits and roots; and that where there was corn and honey they would make drink of these."[1] The construction of the original Greek indicates that, while the herbs, fruits and roots were wild, the millet was cultivated.[2]

At the first attempt we should not guess millet to have been the first grain cultivated by the Celts; but we have only to consider how great were the facilities for isolation in those ancient times. Besides, Herodotus tells us it was grown by the Callipidae, a tribe of Greek-Scythians, and by the Alazones; Maurikios tells that the Slavs were rich in products of the soil, especially in millet; Hehn shows it to have been grown by the Aquitanians,

[1] Bohn's translation, book iv, chap. v, § 5.

[2] *κέγχρῳ δὲ καὶ ἀγρίοις λαχάνοις καὶ καρποῖς καὶ ῥίζαις τρέφεσθαι.*—Strabo, book iv, 201.

the Gauls, Thracians, and other northern races; and Schrader, remarking upon its use in Switzerland and Scandinavia in the Stone Age, says it is one of the oldest cultivated plants in Europe if not actually the first grain cultivated.[1]

With the advent of the Romans in Western Europe, a change begins to creep over the agriculture of the nations with which they come in contact. Yet it would not be safe to assume either that this change was entirely due to the Romans or that the whole of any nation was equally affected. It must not be forgotten, for instance, that congestion may have been equally potent with the introduction of new grain-crops in causing the Germans to abandon the nomadic habit for their settled village and its peculiar system of agriculture. Nor must it be imagined that the remote Northern Germans were as far advanced in Caesar's day as those immediately beyond the Rhine; or that the rest of the Celtic inhabitants of Britain were in as high a state of civilization as the Iceni or the other maritime tribes which had crossed over from the country of the Belgae for plunder and war and, when the war was over, had remained and begun to cultivate the land. The parts of a nation farther from more highly civilized nations are usually more backward than those that are nearer.

Bearing these considerations in mind, let us note first what we are told of the Celts in Britain during the Roman occupation. From Caesar we learn that "corn" was grown by the maritime Britons. On his first expedition he found all the corn cut excepting in one place;[2] and on his second he demanded forty hostages from the Trinobantes and corn for his army.[3] After his second expedition, in which he marched from near Deal to St. Albans and presumably knew the country he had passed through, Caesar says that the Britons were innumerable, that they had houses much like those in Gaul and a large number of cattle.[4] The people of the interior, however, for the most part, did not sow corn, but lived upon flesh and milk, and clothed themselves with skins.[5] Unfortunately, Caesar gives no indication of the kind of "corn" cultivated; but the important inference can be drawn that, as yet, the Britons of the interior at any rate were strangers to the use of flax and wool.

Strabo's account, written about half a century later, is in close agreement with Caesar's. The products of Britain were "corn, cattle, gold, silver, and iron, which things are brought thence, and also skins, and slaves, and dogs" well adapted to hunting.[6] The manners of the people "were in part like

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[1] See Schrader's Reallexicon der indogermanischen Altertumskunde, 1901, pp. 11 and 374.
[2] Omni ex reliquis partibus demesso frumento pars una erat reliqua (Caesar, book iv, chap. 32).
[3] His Caesar imperat obsides quadraginta frumentumque exercitui (book v, chap. 20).
[4] Book v, chap. 12. [5] Book v, chap. 14. [6] Strabo, book v, chap. iv, § 2, Bohn's translation

those of the Celts[1] insomuch that some of them, though possessing plenty of milk, have not skill enough to make cheese, and are probably unacquainted with horticulture and other matters of husbandry. . . . Forests are their cities, for having enclosed an ample space with felled trees, they make themselves huts therein, and lodge their cattle, though not for long continuance."[2]

Caesar's two expeditions were but the preliminaries to the Roman conquest of Britain, which was not completed till Agricola won the battle of Mons Grampius, A.D. 84. In the hundred and forty years after Caesar's first landing, much of Roman civilization had been introduced to Britain: if not to the country as a whole, certainly to the southern end of the island and more especially to those parts within reach of the Roman network of cities and garrisons with roadways to connect them. But how much of their system of agriculture and how many of their crops were introduced by the Romans cannot now be told with accuracy.

A passage in Tacitus may be read to mean that vines and even olives were tried in Britain; but that, while they failed, the other usual farm-crops grown by the Romans were successful: "With the exception of the olive and vine, and plants which usually grow in warmer climates, the soil will yield, and even abundantly all ordinary produce. It ripens indeed slowly, but is of rapid growth, the cause in each case being the same, namely, the excessive moisture of the soil and of the atmosphere."[3]

Some of the chief "ordinary produce" of the Romans were wheat, of which they had several kinds, barley, beans, millet, and flax; while other crops were lupines, lucerne, fenugreek, vetches, turnips, and radish.[4] Whether all these crops—excepting millet, of course—were introduced by the Romans cannot now be told. We can only tell the crops grown in Britain after the Romans had left it; but, before we can name with some approach to what might be called approximate certainty the crops which the Celts took over from the Romans, we must give some consideration to the agriculture of the nations who came to Britain after the Romans had left.

These other nations lived beyond the Rhine in Caesar's time, and, according to him, their civilization was at a stage very similar to that of the Celts in Britain. Referring to the Suevi, "by far the largest and most warlike tribe among the Germans," he says that among them there was no private ownership of land; that they did not stay in one place longer than a year; that they did not live much upon corn but mostly upon milk and flesh; that they were much engaged in hunting; and that, even in the coldest

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[1] i.e. in Gaul. [2] Strabo, book iv, chap. v, § 2, Bohn's translation.
[3] Agricola, chapter xii, Church and Brodribb's translation.
[4] See Dickson's Agriculture of the Ancients.

parts, they wore no clothing but skins which were so scant that a great part of their bodies was exposed.[1] And referring later to the Germans as a whole he reiterates the same statement: "They do not care to till the land; and the larger part of their food consists of milk, cheese and flesh. Nor has anyone a determinate piece of land or boundaries of his own; but the counsellors and headmen annually assign land in a position chosen by them to the tribes and families living together for the time being, whom they compel to move elsewhere next year."[2]

A hundred and fifty years later the Germans had made a very considerable advance, due chiefly to two main causes, congestion and contact with the Romans. At this later date they were seen by Tacitus, from whom we shall make two quotations which refer doubtless to the more western tribes and which, because their interpretation is disputed, we shall quote first of all in the original Latin, and then translate freely for ourselves:—

Nullas Germanorum populis urbes habitari satis notum est, ne pati quidem inter se iunctas sedes. Colunt discreti ac diversi, ut fons, ut campus, ut nemus placuit. Vicos locant non in nostrum morem connexis et cohaerentibus aedificiis; suam quisque domum spatio circumdat, sive adversus casus ignis remedium, sive inscitia aedificandi. Ne caementorum quidem apud illos aut tegularum usus; materia ad omnia utuntur informi et citra speciem aut delectationem.[3]

. . . . . .

Agri pro numero cultorum ab universis in vices occupantur, quos mox inter se secundum dignationem partiuntur. Facilitatem partiendi camporum spatia praestant. Arva per annos mutant, et superest ager.[4]

In the first of these passages the crucial word is "sedes" in the first sentence, which is usually interpreted to mean "houses" or "dwellings." But this interpretation makes no clear distinction between "sedes" in this sentence and "domus" in the third, and assumes that Tacitus was repeating himself—a most unlikely thing for him—in saying that each house stood apart by itself. We must therefore look for some other interpretation of "sedes"; and, from the fact that in Caesar's day the Germans lived in companies or communities while, many years later, both in Germany and England, they lived very much in the same way in separate villages dotted all over the country, we come to the conclusion that Tacitus used "sedes" here to mean a collection of houses—a settlement—a meaning it carried in the plural.

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[1] Gallic War, Bk. iv, chapter i.
[2] *Ibid.*, vi, chapter xxii.
[3] Germania, chapter xvi.
[4] *Ibid.*, chapter xxvi,

Thus the first passage becomes intelligible, and the two may be translated as follows:—

It is well known the Germans have no cities. Nor can they bear even to have their settlements close together, but establish them separately and apart, as a spring, or a plain, or a wood has induced them. Nor do they build their villages as we do, with the houses joined together; but everybody has an open space round his house, either as a precaution against fire or because they know not how to build. The use of even unhewn stones or tiles is unknown among them; and, for all purposes, timber, undressed and without beauty or attractiveness is used.

. . . . . .

Fields proportionate to the size of the community are occupied in turn and divided up among the inhabitants according to their worth. The extent of the plains facilitates division. The tilled land is changed from year to year, and abundance of untilled land is still left over.

These two disputed passages interpreted as above, chiefly in the light of earlier and later history, show that the Germans—some of them at any rate—of Tacitus's time had ceased to be nomads, that they lived in villages which preferably were well apart from each other, and that the houses in a village were built separately. They also show that the land was divided up among the members of a community and that the same piece of land was not yet tilled year after year.

From other passages in Tacitus we learn other facts about the Germans. Their food was still plain: wild fruit, fresh game and curdled milk; but the women were now wearing linen,[1] from which we may infer the introduction of flax; and we infer the manufacture of wool and therefore the keeping of sheep from the statements that the men wore woollen cloaks[2] and that homicide was expiated by payments of cattle and sheep.[3] Already the germ of feudalism can be discerned in the bands of warriors which grew up within the tribes to make their living by warfare[4] and eventually to become supreme over those who were not warriors.

But more interesting from our present point of view was the consumption of a liquor which was made, according to Tacitus, from barley or corn—*ex hordeo aut frumento.* From this it may not be absolutely safe to say that the Germans were now growing barley; for Tacitus may have put it in as most likely to account for the liquor they brewed, not knowing that millet

[1] Germania, xvii.
[2] Tegumen omnibus sagum. *Ibid.*, xvii.
[3] Luitur enim etiam homicidium certo armentorum ac pecorum numero. *Ibid.*, xxi.
[4] *Ibid.*, xiii and xiv.

might have been used for the purpose.[1] At the same time there is a possibility that, if the Germans had any other grain than millet, it may have been oats; for, after saying that the oat is the lowest of all kinds of 'corn' and that barley degenerates into it, Pliny adds further that it takes the place of 'corn' among the Germans since they sow it and have nothing else from which to make porridge.[2]

In support of Pliny's statement, it might be pointed out that the oat was not an Aegypto-Semitic or Roman crop—at any rate no Roman agricultural writer mentions it as such[3]—and, so, was unlikely to have reached Britain through the Romans. But, since it was grown in Britain—especially towards the north—in the Middle Ages, it was more likely to have come in either through the Anglo-Saxons or the Norsemen, and therefore may have been grown by the Germans in Pliny's time.

This excursion into the early history of agriculture in Germany has been necessary in order to get a clear view of that of England, and thence to get some notion of its probable course in Ireland.

For many hundred years after Tacitus, Teutonic agriculture leaves no written records; and such as are first met with are so meagre and scant that they can be read only in the light of researches and literature dealing with much more recent times. The long gap must be filled in from both ends.

It is impossible to read English agricultural literature of the seventeenth and eighteenth centuries without being impressed with the fact that at that time there were two concurrent systems in England, viz. the "Inclosed" and the "Open Field" systems: the former comparatively new, and increasing; the latter uneconomic, wasteful, and old. All through the eighteenth century and well into the nineteenth there was agitation against the old system, and between "1710 when the first Inclosure Bill was passed in England" and 1849 over seven million acres of "Open Field" land were "inclosed" by statute.[4]

A typical example of the open field system might be described as follows:—The population lived all together in a village. Their houses stood separately each in the midst of a small piece of ground, frequently called the "yard," in which were grown flax, cabbages, carrots, and sometimes a few other vegetables. The land around the village was divided into three great tillage fields of nearly

[1] Meyer's Conversationslexikon says that the Crimean Tartars brew a beer from millet (Hirse); and Sienkewicz, in one of his works, writes of people who lived north of the Caspian Sea two hundred and fifty years ago drinking spirits distilled from millet.

[2] Primum omnium frumenti vitium avena est, et hordeum in eam degenerat sic ut ipsa frumenti sit instar, quippe cum Germaniae populi serant eam, neque alia pulte vivant (Nat. Hist., Book xviii.)

[3] See Professor John Wilson's Farm Crops.

[4] Porter's Progress of the Nation, 1815, p. 157.

equal proportions, and these were subdivided again into acre, half-acre, quarter-acre and even smaller plots. If a villager had altogether, say, twelve acres of tillage land, he had approximately four acres in each of these great fields. The villager's acres did not lie side by side, but were scattered up and down each field here and there in acre, half-acre and quarter-acre patches. Every free villager, large and small, held all his tillage land in this "mingle-mangle" fashion; but he did not hold the same patches year after year; for there was a reallotment at definite intervals, so that no man might hold a good patch—or a bad patch—too long and that others might have a chance of it.

There being no fences. and the stubble being open to every villager for grazing after harvest, it was necessary that every one should grow the same kind of crop in the same field at the same time and that all should be ploughing, sowing, reaping and harvesting together. The crops grown were therefore such as were most suitable for the majority.

But although the villagers had three fields, they could crop only two of them at a time. Their implements were so primitive that the land became foul when two crops had been taken and, so, had to be ploughed again and again the third year to get rid of the weeds. In this third or cleaning year, which was called the fallow year, the land was ploughed usually four times —in March, June, August, and September—and at the last ploughing was sown with wheat. In the spring following the harvest the wheat stubble was ploughed up, and beans or some other crop was sown. These other crops were peas, barley and oats. Thus the general rotation was wheat the first year, beans or other grain the second, and fallow the third; and, in any one year, one of the great village fields was the "wheat"-field, another the "bean"-field, and another the "fallow"-field.

In addition to the three great tillage fields, there were other fields lying beyond them which were never ploughed. There was the meadow, in which every free villager had his allotted stripes, and there were usually the cow-pasture. the bullock-pasture, and always the "common" pasture, on each of which he had the right to graze a definite number of stock in proportion to his acres in the tillage fields. Farther away was the "forest" in which each villager had his share of timber and firewood and in which his allotted number of swine were tended by the common herd. The village flock of sheep was herded on the stubbles in winter and on the "common" pasture in summer.

Inferences may be drawn from the departures from type. The departures were of two kinds, namely as to the number of tillage fields and as to the crops that were grown. All over England, as far north as Yorkshire and Durham at least, the three-field type was common, and the

main crops were wheat and beans; but barley was also sown in the "bean"-field and less frequently oats. But there was a much smaller number of villages having only two fields, which were cropped one year and fallowed the next. These villages, therefore, in any one year had only one "corn" field and the fallow field. Evidence of the three-field system is found certainly as far north as Aberdeenshire;[1] but it is not clear that it was so prevalent in the east of Scotland as in England. Besides, the kinds of crop grown in the north were not the same as in the south. Wheat and beans dropped out towards the north, and barley or bere, oats, and peas took their place. Judging from the Aberdeenshire example, bere was the first crop after the fallow, and oats and peas the next.

It is not clear which crops, if any, were peculiar to the two-field villages either in England or Scotland.[2]

From the foregoing it is possible to make some suggestions as to when the English adopted the three-field system and also as to when they took over such crops as wheat, beans and peas from the Romans. It scarcely needs pointing out that the English village with its three fields is a development from the village of Tacitus. Take away from the later villages the lordship and the somewhat unequal areas occupied by villagers, both of which were a concomitant of feudalism, and we get back to a village which held an area of land equal to the requirements of its people, among whom it was reallotted periodically in about equal portions. Take away the denser population of the Middle Ages, and we restore the possibility of choosing new land every year and some being still left over. But why the third field? Had the English in Germany been as confined as to space as they were afterwards in England, and had they still grown only such crops as millet and oats or barley, they would have required two fields: one in which their crop of the year was growing and another which was being tilled and cleaned for the next year's crop. But wheat when it was introduced could not be worked in with those other crops. It had to be sown in autumn; its cultivation was different; and, since all stubbles were grazed, it must be separated from the field in which the other "summer corns," as they were called, were grown. Hence, if wheat and one or more of the other crops were grown, a third field was necessary.

Seebohm was able to trace the three-field system back to the seventh century, to the Laws of King Ine, "re-published by King Alfred as 'The Dooms of Ine' who came to the throne A.D. 688."[3] Can we take the

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[1] See Keith's Agriculture of Aberdeenshire.

[2] The above description of the early agricultural systems is gathered from old agricultural books and from such writers as Seebohm, Maine, Gomme, Maitland, and Vinogradoff.

[3] English Village Community, p. 109.

system further back? Had the English come over from Germany with the two-field system, there would have been more of it in later times, because every change of system required a revolution from the previous—by no means an easy matter, as was shown by the way the three-field system survived till the eighteenth and nineteenth centuries, when it finally gave way at the introduction of two new crops, namely, the turnip and red clover. Moreover, the same three-field system lives on in Germany to the present day, and there, under similar difficulties as to the lack of records, it has been traced back by Hanssen to the year 771.[1] It is not improbable, therefore, that the three-field systems in Germany and England have the same origin: that is that it was adopted in Germany before the English left. It might be argued of course, that, given the same crops in England and Germany as a result of contact with the Romans, two peoples so closely allied would probably grow them in the same fashion. But the likeness is too close for that explanation. Nor will this argument explain such coincidences as the German calling the two crops of the three-field system "wintergetreide" and "sommergetreide," while the Englishman called them "winter-corn" and summer-corn"; some Englishmen speaking of the first three ploughings of the fallow as "een fallow," "twy fallow," and "try fallow";[2] and the German calling the fallow the "brach" while the Scot in Scotland and in the North of Ireland speaks of the light stubble furrow drawn in autumn as the "brack-fur."

In any case we have no more mention of millet in Britain in the Middle Ages. We have oats and barley or bere, which may have come in from the north of Europe, grown in the Germanic and Scandinavian parts of Scotland and in England; and we have wheat, beans, peas and flax, which were brought west by the Romans, grown in England and some of them at least in the east of Scotland.

Before going on to consider the agriculture of the Celts, it will be well to say how English agriculture branched off from the three-field system and how it developed afterwards.

The change had begun before the Norman conquest: how long it would be impossible to say. It was due to the assumption of lordship by the military leaders, who, in the first instance, forced the non-combatant villagers to supply them and their thanes and other military attendants with produce from the village fields and to work such land as they seized for themselves.

In the early days it is probable the lords and their thanes were still members of the village community and shared the village land plot about

[1] See Von der Goltz's Geschichte der deutschen Landwirtschaft, 1902, p. 77.
[2] See Mortimer's Art of Husbandry, Bk. ii. ch. 3.

with the other villagers; but eventually they built themselves castles and keeps outside the village and laid hold upon the unoccupied land around them. Still the villagers worked their land for them and brought them some part of the produce of their own fields; but gradually the lords gathered additional labourers around them, chiefly captives in war and their descendants, and with these they worked their lands.

Originally the lords or landowners as they came to be called worked their tillage land like the villagers, in three fields[1]—a wheat-field, a bean-field, and a fallow-field—but, later on, when more tillage produce was required, a piece of land was broken up, cropped for five or six or even more years in succession till it was exhausted, and then left alone to nature to be clothed again gradually in weeds and pasture. When one piece was exhausted another took its place.

Even before the Norman conquest, and much more afterwards, the religious houses became landowners and worked their land like other land-owners.

With the rise of commerce in the Middle Ages and the consequent discovery that gold was more powerful than men, the landowners took in more and more of the waste land round their demesnes and either cultivated it themselves or let it to farmers, who worked it on the system of cropping it till it was exhausted and leaving it alone to recover in pasture. Ways of improving its fertility were discovered, such as marling, sanding, and enclosing sheep and cattle upon it, by which the period of cropping could be prolonged and the pasture hastened forward.

Disputes with the villagers as to infringement of their rights and boundaries, and frequent trespass by village and other stock, led to the land reclaimed and worked in this way being fenced in, or, as it was called, "inclosed," in contradistinction to the village lands which were still unfenced and were called "open."

Thus, at the beginning of the Stuart period, there were two main systems of agriculture in England: the village with its "open" fields and its three-field system of tillage, and the landowners and farmers with their "inclosed" fields and their smaller crops, perhaps, but less awkward and therefore less wasteful system of farming. If improvements were possible at all, there was more chance of their being adopted by the landowners and farmers than by the villagers: hence the great demand for "inclosing," which began at latest in the seventeenth century and was carried by law early in the eighteenth.

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[1] Land round the homestead was worked in this way in Aberdeenshire, in the eighteenth century. It was called the "infield," the rest being called the "outfield." See Keith's Agriculture of Aberdeenshire.

Although the first great step in the advancement of English agriculture was not taken till near the end of the third decade of the eighteenth century, the incidents which led up to it took place in the middle of the seventeenth. These were the introduction from Flanders of two new crops, turnips[1] and red clover, by Sir Richard Weston, in 1644 or 1645.[2] Their cultivation did not spread, however, till a century later. Sainfoin and lucerne were introduced from France[3] about the same time; but they also made small progress. Rye-grass, which was introduced probably a few years later, made somewhat better progress. In Plot's *Oxfordshire*, published in 1677, we are told: "They have lately sown ray-grass, or the *Gramen loliaceum*, by which they improve any cold, sour, clay-weeping ground, for which it is best, but good also for dry upland grounds, especially light, stony, or sandy land, which is unfit for sainfoin. It was first sown in the Chiltern parts of Oxfordshire, and since brought nearer Oxford by one Eustace, an ingenious husbandman of Islip, who, though at first laughed at, has since been followed even by those very persons who scorned his experiments."[4] Rye-grass eventually found its place in being sown down with the last grain-crop taken by "inclosed" farmers before the land was left to nature.

The great step, however, was taken by Tull and Lord Townshend. Tull showed that the yield of a crop could be increased greatly by thorough and persistent cultivation: that is by cultivation not only before the crop was sown but also while it was growing. But, in Tull's day, field crops could not be cultivated while growing, because they were sown broadcast; and cultivation would kill many plants. Tull then invented two machines: one to sow the seed in drills or rows, and another to cultivate between them—the drill-sowing machine and the horse-hoe.[5]

Since its introduction by Weston the turnip had been no great success, chiefly because it had to be sown broadcast; but now the way to grow it was seen to be in drills, like Jethro Tull's wheat; and the first to demonstrate this on a large scale, about 1730,[6] was Lord Townshend who had been Prime Minister to King George the First. The turnip and the other crop introduced eighty years before by Weston were now readily adopted as field crops by the farmers of Norfolk, who in those days were the most advanced in England.

The two new crops had far-reaching consequences, first upon the "inclosed"

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[1] That is as a field crop. Turnips had been previously grown in gardens.

[2] Weston's Discourse of the Husbandrie used in Brabant and Flanders, edited by Hartlib, 1645.

[3] Blith's English Improver Improved, 1653.

[4] See Wilson's Farm Crops, vol. ii., p. 203.

[5] See Tull's Works, especially The Horse-Hoeing Husbandry, 1730.

[6] Wilson's Farm Crop, vol. i., p. 268.

and next upon the three-field or "open" systems. Hitherto the practice on "inclosed" farms was to crop a field continuously for six or eight years till it was exhausted. Now was adopted the four-course rotation, wheat, turnips, barley, and clover, which had the advantage of producing plenty of winter-food for stock, from which followed plenty of manure, and from which followed the elimination of the old exhaustion and the need for leaving the land to nature for a term of years. This four-course rotation, modified to suit local conditions and lengthened by sowing down longer-lived grasses with the clover, has been the groundwork of British tillage farming down to the present day.

But the two new crops were disastrous to the three-field system. The turnip seemed an ideal crop for the fallow, because the land could be cleaned and tilled and a crop grown at the same time. But the turnip could not be got out of the ground in time to prepare for and sow the winter wheat. Nor could red clover be grown on the fallow, for then the land could not be cleaned at all. So, as the "inclosed" farming grew better and better, while the three-field farming stood still, the agitation for "inclosing" the village fields grew stronger and stronger. At the present day the old English villages and their three fields have all disappeared excepting a very few, the most notable of which is perhaps Laxton in Nottingham.

It need scarcely be stated that, although the three-field system was an advance upon the earlier semi-nomadic system in which, while the people lived in settled villages a new piece of land was tilled every year, it was a very effective barrier to further progress. But it had one momentous result in this that it made the Englishman a tillage farmer rather than a grazier. For the very reason that his home was surrounded by tillage-fields, through which he must pass before reaching the pastures and forest beyond, he acquired, so to speak, the faculty "to plough and to sow and to reap and to mow," as if by a kind of hereditary instinct. But because of its rigid framework and the inflexibility of its rules, the three-field system barred any radical change in agricultural methods. Improvements, therefore, were confined to the "inclosed" farmers—a circumstance which led eventually, as already stated, to the downfall of the three-field village system.

Only a few of the more important changes in British agriculture, subsequent to those already mentioned, need be noted before passing on to that of the Celts. The earliest improvements we read of were such as were likely to have had their origin in the reclamation of waste and untilled lands. These were draining, the application of marl and liming. In Walter Blith's "English Improver Improved," published in 1653,

"Drayning," which was "taking away Superfluous and Venomous Water which lieth in the Earth and much occasioneth Bogginess, Miriness, Rushes, Flags, and other filth, and is indeed the cause of Barrenness in any Land of this nature," was very fully explained. It was to be done by tapping the sources of the superfluous water with trenches which were then to be filled in as follows:—"Then thou must take good green Faggots, Willow, Alder, Elm, or Thorn, and lay in the bottom of thy works, and then take the Turf thou tookest up in the top of thy Trench, and Plant upon them with the green Soard downwards, and then fill up thy works levell again." Or "Take great Pibble stones or Flint stones, and so fill up the bottom of thy Trench about fifteen inches high, and take thy turf and plant it as aforesaid, being very fit for the Trench, as it may joyn close as it is laid down."

The inclosed system of farming made possible a great improvement in the live stock of the country. The good could now be kept separate from the bad, and good herds and flocks could be established. This led to a great importation of larger and better farm stock of all kinds from the continent of Europe, but especially from the Low Countries, in which, till well on in the eighteenth century, the best agriculture was to be found. The invention of gunpowder and the eventual disappearance of soldiers in armour led to the old war-horse—the 'great' horse—being employed instead of cattle in ploughing and other farm-work. Towards the end of the eighteenth century several new crops were introduced; but these induced no great change. They were swedes, mangels, and improved varieties of oats and barley. One crop, however, must be mentioned, not because it was so new, but because it had become a field crop and was eventually of great importance in Ireland. The potato was introduced to Europe in the sixteenth century;[1] but in England it was cultivated only in gardens till early in the seventeenth century, at which time it became a field crop first of all in Lancashire.

We are now in a position to approach the agriculture of the Celts. But we must first of all consider the framework in which they had to work; for just as the agriculture of the English village community was conditioned by its peculiar constitution so also was that of the Celts by their tribal polity which, for the lack of a modern example, is not easily reconstructed.

From Caesar's description of the Celts we may extract so much as bears upon our present problem. There were already two great classes in Gaul, the ruling and the ruled, the gentle and the simple; and the rulers treated the ruled like slaves: "Among the Gauls there are two kinds of people enjoying

[1] See Wilson's Farm Crops.

any rank and position. For the common people are treated almost like slaves, who may make no venture of their own and who are not taken into consultation. Most of them, when pressed by debt or heavy tribute or injustice from the stronger, give themselves up in servitude to the chiefs, to whom they stand just as slaves do to their masters."[1]

The rulers were subdivided in two sections, a military and a learned. The power of the former varied with their wealth and pedigree, for the greater these the greater the number of vassals and dependents at their command.[2] They corresponded with the kings and chiefs and their cousins of later days. The learned class were also noble—*equites*—but they were exempt from military service and tribute. Their chief functions were to be lawyers and law-makers, judges and teachers. Maine identifies them with the Irish Brehons.[3]

Among the British Celts of later times we find a development from a state of affairs similar to that described by Caesar as existing among the Gauls. There are still chiefs and kings, learned men and common people, and fugitive and broken men little better than slaves to the chiefs they serve.

Whether in Ireland, Wales or Scotland, the outstanding features of their civilization were based upon the tie of blood, and they entertained a preference for grazing, scattered dwellings, and an itinerant and casual tillage. The clan system and its bearing upon the land has been very thoroughly investigated for Wales, where perhaps it suffered least from external interference and, so, attained its highest complication.[4] There were three grades of Welshmen: the true-bred Welshmen, "strangers" who were aspiring to that position, and the servile class. The power lay with the true-bred Welsh, that is with the princes, chiefs, and men of family; but most of all with the princes and chiefs. Indeed, long before the English conquest of Wales, the chiefs had attained a power over their clans that was in some ways perhaps equal with that of the Norman lords over the English people; for not only did they command the tribesmen in war but they also received some part of the produce of their fields and pastures. Each tribe had a larger or smaller area of country in its possession. Portions of the nature of home farms were reserved by the chiefs, and the rest was distributed among the tribesmen and the aspirant tribesmen. Each tribesman was entitled to four free acre strips of land (erwi),[5] to use of the waste in common, and to the right of hunting. When a tribesman took up land, he did so

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[1] Gallic War, vi. 13. [2] *Ibid.*, vi. 15. [3] Early History of Institutions, vol. ii.
[4] See especially Seebohm's English Village Community and Welsh Tribal System.
[5] In earlier times five.

alongside his father; and thus a number of relatives held contiguous holdings. When congestion arose tribesmen could not get holdings alongside their relatives without other tribesmen changing their holdings; but changes and such movements as would rearrange the holdings of relatives beside each other seem to have taken place frequently. Each tribesman's homestead was erected beside his land; and, so, the homesteads of a family and therefore of a tribe were stretched out in more or less regular rows along the countryside in all probability four or five acres' breadth away from each other.

The "strangers," that is descendants of men who had come into the country but who could not be tribesmen till their mothers had been Welsh for nine (sometimes four) generations, held land like the tribesmen; but in their case there were no patriarchs or heads of families. Any stranger, once he was grown to manhood, was equal to any other, much as the English villagers were; but he was by no means equal to a Cymro. He could not bear a soldier's weapons, and hunting and horsemanship were forbidden him. Nor could he be a scholar, a chief, or a bard till the chief of the tribe he was attached to consented. The strangers as well as the tribesman contributed to the chiefs from their land, and they were liable to more onerous demands in the way of labour and service. On military expeditions they were the camp-followers to supply horses, make encampments, and see to the commissariat. "They are to furnish pack-horses to the king for the hosts, and they are to present the queen once every year with meat and drink, and they are to support the dogs, the huntsmen, the falconers, and the youths, all of them once every year."[1] According to the Venedotian code of laws, a body of about sixteen strangers (a maenol) had to contribute in produce to their chief:—

"In Winter.

"A three-year-old swine, a vessel of butter 3 handbreadths in depth and three in breadth, a vat full of bragot nine handbreadths in depth diagonally, a thrave of oats of one band for provender, 26 loaves of the best bread grown on the land. . . .

"In Summer.

"A three-year-old wether, a dish of butter, 26 loaves, and a cheese of one milking of all the cows in the trev"[2] ($\frac{1}{4}$ a maenol).

On the other hand, a contribution from a similar number of tribesmen was

"A horse load of the best flour that shall grow on the land, the carcase of

[1] Quoted in Seebohm from Ancient Laws of Wales, i, 193.

[2] Quoted in Seebohm's Tribal System in Wales from Ancient Laws of Wales, i, 199.

a cow or ox, a full vat of mead 9 handbreadths in its depth diagonally and as much in breadth, seven thraves of oats of one band for provender, a three-year-old swine, a salted flitch of 3 fingerbreadths in thickness, a vessel of butter 3 handbreadths in depth, not heaped, and 3 in breadth."[1]

Of the servile class little is known excepting that they consisted chiefly of deserters from other tribes, criminals, and their descendants. They were people with no pedigree and therefore unlikely to get much mention in any document. They were the property of the chiefs and higher tribesmen and lived in huts or cubicles about their masters' houses. They performed the most menial services: they were horse-boys, errand-boys, messengers, swine-herds, and so on; and, in the case of a chief with a home-farm, they were his farm-labourers. Many of them had a garden in which to grow food and vegetables.

It need scarcely be pointed out that, as each full tribesman and aspirant had only about four acres of arable land, of which it is unlikely that more than two were under crop at one time, and, as the average crop, reckoned in wheat, could scarcely have been more than ten or twelve bushels to the acre,[2] the tribesmen must have depended very largely upon the produce of their flocks and herds. Nor is it likely that their farming was good enough to make wheat their chief crop; while oats and, in some cases, barley, with less trouble and care, would have yielded them an equivalent grain-supply. Judging by the data collected in Seebohm's books, oats were the chief grain-crop. One or two quotations from Giraldus Cambrensis, a relative of some of the men that came over to Ireland with Strongbow, who wrote in the twelfth century, will show the case to have been as suggested:—

"In the months of May and April only the soil is once ploughed for oats, and again in the summer a third time, and in winter for wheat. Almost all the people live upon the produce of their herds, with oats, milk, cheese and butter; eating flesh in larger proportions than bread.[3] . . ."

"The higher class go to battle mounted on swift and generous steeds, which their country produces; but the greater part of the people fight on foot, on account of the marshy nature and unevenness of the soil.[4]

"They neither inhabit towns, villages, nor castles, but lead a solitary life in the woods, on the borders of which they do not erect sumptuous palaces, nor lofty stone buildings, but content themselves with small huts made of the boughs of trees twisted together, constructed with little labour and expense, and sufficient to endure throughout the year. They have

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[1] Quoted in Seebohm's Tribal System in Wales from Ancient Laws of Wales, i, 197.
[2] See article "Agriculture" in Science in Modern Life, vol. v, p. 8.
[3] Giraldus Cambrensis, Bohn's edn., p. 490. [4] *Ibid.*, p. 491.

neither orchards nor gardens, but gladly eat the fruit of both when given to them. The greater part of their land is laid down in pasture; little is cultivated, a very small quantity is ornamented with flowers, and a still smaller is sown. They seldom yoke less than four oxen to their ploughs; the driver walks before, but backwards, and when he falls down, is frequently exposed to danger from the refractory oxen.[1]

"The nation is, above all others, addicted to the digging up of boundary ditches, removing the limits, transferring landmarks, and extending their territory by every possible means. So great is their disposition towards this common violence, that they scruple not to claim as their hereditary right, those lands which are held under lease, or at will, on condition of planting, or by any other title, even although indemnity had been publicly secured on oath to the tenant by the lord proprietor of the soil."[2]

At this stage it may be remarked that it is doubtful how far improvements in agricultural methods were possible under the Welsh or any other tribal system. The Welsh were not indeed forced by congestion from pasture to tillage before the Conquest forced individual ownership upon them; and to that extent therefore a chance of showing whether their farming would have improved was not given them. But, even if they had got the chance, the conditions under which they lived rendered great agricultural developments impossible. Each tribe was ready to fly at every other, unless when a number combined against a common enemy. Thus, security of tenure, one of the first essentials to improvement, did not exist for many tribes. Nor, because of frequent removals to fit in with the family system of inheritance, did security of tenure and temptation to improvement exist for the individual tribesmen. It may be remarked also that, at the present day, where tribal systems or even village systems exist, agriculture is usually in a comparatively backward condition.

As a mere matter of curiosity, let us quote a few random passages from Leland's Itinerary, written about 1536–39, to show how the old inclination for pasture and the tribal setting out of holdings lingered on in Wales long after the tribal system was broken down:—In Ventland "The country is also sumwhat montayneus, and welle replenished with woodes, also very fertyle of corne, but men there study more to pastures the which be wel inclosed.

"Cairarvonshire about the shore hath reasonable good corne, as abouth a myle upland from the shore on to Cairavon. Then more upwarde be Eryri Hills, and in them is very little corne, except otes in sum places, and a little barle, but scantly rye.

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[1] Giraldus Cambrensis, p. 505. [2] *Ibid.*, p. 512.

"Ise Dulesse is good for corne as whete, rye, peason and benes.

"There is no place yn al these commotes where the people dwelle vicatim but al sparsim."[1]

The polity of the Celts in Ireland had its origin in the same source as that of the Celts in Wales. It was just another branch of the same tree, only it lived till it was four or five centuries older, and probably, in consequence, was somewhat different in the end of its days. From the point of view of our present inquiry it may be suggested that time seems to have increased the power of the Celtic chiefs in Ireland. Many of them armed their servile class—fuidhirs as they were called—and through them not only attained a greater ascendancy over the free tribesmen, but also acquired private ownership in land. It was thus possible for agriculture to have made some advance on the lands in the absolute possession of the chiefs, provided always that there were no other circumstances to retard it.

But before coming closer to the Irish tribal system, it may be observed that it had already survived at least two disintegrating attacks before it finally succumbed to those of Elizabeth and James. The earlier was that of the Norsemen.[2] While the first of these were filibusters and plunderers who were eager, as has been said frequently, to avenge upon Christianity the terrible wrongs done to themselves and their religion by Charlemagne, the later Norsemen came in with the intention of settling and holding the land, just as they did in England and Scotland. But, although they raided and ravaged it, divided it up into sections for purposes of government and taxation,[3] and even gave Norse endings to the names of the four provinces—Leighin*ster*, Mumha*ster*, Ulad*ster*, and Kunnak*ster*[4]—they were unable to hold the interior permanently. Their interests lay in too many lands, and their strength was dissipated in too many conquests at the same time. In Ireland the power of the Norsemen was eventually confined to the cities they had built and to the districts around them—Dublin, Wexford, Waterford, Limerick, and so on—and their energies were eventually turned to trade and commerce, by which they became the intermediaries between the tribes of the interior and the inhabitants of Britain and Europe. But it must not be forgotten that, just as in the Highlands of Scotland, while only fragments of their language and civili-

[1] These quotations are from Toulmin Smith's edition, published 1906.

[2] Meaning roughly Ostmen, Danes, Norsemen, and Swedes, and the Saxons driven into Denmark by Charlemagne.

[3] "Imar (and his sons) ordained kings and chiefs, stewards and bailiffs in every territory, and in every chieftanry after that, and he levied the royal rent. And such was the oppressiveness of the tribute and rent of the foreigners over all Erinn at large, and generally, that there was a king from them over every territory, and a chief over chieftainry, and an abbot over every church, and a steward over every village, and a soldier in every house."—Wars of the Gaedhil with the Gaill, p. 49.

[4] Halliday's Scandinavian Antiquities of Dublin, p. 135.

zation remain, the Norsemen left a very large share of their bone and sinew to be mingled with the Celtic population. In evidence thereof we might cite the physiognomy and build of the population in many parts of Ireland, particularly on the "fingers" of Kerry and Cork; the presence until recent years, especially near the Shannon and towards the north, and in spite of severe competition, of many of the hornless breed of cattle which were introduced by the Norsemen[1]; the presence of a very unusual number of dun-coloured horses (still exceedingly common in Norway) in the West of Ireland as well as in the Highlands of Scotland; and the peculiar arrangement of some villages to be seen, again, more especially in Kerry and west Cork. To these might be added the likeness of the folk-tunes of Ireland to those of the Highlands of Scotland and Scandinavia.[2]

The other disintegrating element affecting the Irish tribal system was the Anglo-Norman invasion, the chief effect of which, from our present point of view, was to divide Ireland into three parts for four hundred years. The smallest part was the English Pale, whose boundaries were somewhat uncertain and inconstant, but which was inhabited for the most part by English settlers, who spoke English, who lived under English law, and whose feudal lord was the King of England himself. After the invasion it was agreed between King Henry II and Strongbow that while "Dublin and all the other port towns, with the lands adjoining, should be handed over to the king . . . the earl and his heirs should hold all other conquests of him and his heirs."[3]

The largest part was that over which the Normans were made the feudal lords under the king, namely the southern half of Ireland from Louth to Galway, with the exception of the Pale. English settlers were introduced to this part of the country, but never at once in very large numbers; and, in time, they and their feudal lords adopted the speech and some part of the customs and laws of the Irish. The third part was all that was left to the north, which was always inhabited by people of Irish race and speech, who lived under Irish laws and customs, with the occasional exception of narrow strips of English and Scotch settlers on the coasts of Antrim and Down.

It will be most convenient to consider the purely Celtic position first. Just as in Wales, there were two main classes of people, the free and the non-free, the tribesmen and the non-tribesmen, the landed and the landless. Of the tribesmen there were many grades; but for our purpose they may be

[1] See "The Scandinavian Origin of the Hornless Cattle of the British Isles," Scient. Proc. Royal Dublin Society, 1909.

[2] In the summer of 1910 Professor Marstrander heard Irish songs sung to tunes like those of Norway on the Blaskets.

[3] Bagwell's Ireland under the Tudors, vol. i, p. 46.

divided into two, the nobles and the commons. From the nobles were drawn the kings, princes, chiefs and leaders generally; while the commons were the farmers. There were tribes and families, just as in Wales, and each tribe, so long as it was not subject to another, controlled the land in its own country. The land was of two kinds, tribal and non-tribal. Of the tribal land a part was set aside for the chief,[1] another for his successor (the tanist) and the rest was divided among the tribesmen. These were grouped together in families, whose binding and controlling functionary was the oldest member, theoretically the great-grandfather of the youngest generation of tribesmen. When a young tribesman became entitled to a farm, this had to be found for him alongside his father's and his brothers'. If all the land beside his father's and his brothers' farms were already occupied by uncles and cousins, then either the uncles and cousins or the fathers and brothers had to move along a little so as to let the young tribesman into his proper position. The same kind of movement took place when tribesmen died. So, the family land was constantly expanding and contracting, the tribesmen were frequently moving from one place to another, and no man was sure to hold the same land for more than two or three years. Outside the farm land, there was a common grazing in which all had their share.

The non-tribal land was all in the possession of the nobility. At what stage or time private ownership in land arose it would be difficult to say; but it was a natural development of the tribal system in Celtic Ireland and Britain, just as feudalism was a natural development of the village or 'mark' system in northern Europe. Congestion and the desire to possess other land produced warfare; warfare produced military leaders and their "companions"; and the military leaders made themselves private landowners. In time ownership was not confined to the military, but was extended to others who had done signal service of one kind or another. Joyce thus describes the private landowners in Ireland: "Most of these were *flaiths*, or nobles, of the several ranks; and some were professional men, such as physicians, judges, poets, historians, artificers, &c., who had got their lands as stipends for their professional services to the chief, and in whose families it often remained for generations."[2]

The non-tribal land was worked in two ways. Either the owner retained it in his own hands and worked it by the non-free men who had come under his power, or he let it to another kind of man, the bo-aire (cattle chief) who

[1] The Irish chiefs did not succeed each other in strict heredity, but were chosen by the clan from their nobility. When a chief died, the tanist stepped into his shoes, and a new tanist was chosen.

[2] Social History of Ancient Ireland, vol. i, p. 187.

was a commoner of somewhat better standing than the farmer tribesman. 'The non-free people were of three classes, . . . the Bothach[1], the Sencleithe, and the Fudir.[1] The persons belonging to the first two were herdsmen, labourers, squatters on waste lands, horse-boys, hangers on, and jobbers of various kinds—all poor and dependent."[2] . . . "A fudir was commonly a stranger, a fugitive from some other territory, who had by some misdeed, or for any other reason, broken with his tribe—who had become 'kinwrecked,' as they expressed it in Wales—and fled from his own chief to another who permitted him to settle on a portion of the unappropriated commons land."[3]

The fudirs were of two kinds, a higher and a lower, a *saer* or free fudir and a *daer* or bond fudir. The former were those who were "free from crime, and who, coming voluntarily into the district, were able to get moderately favourable terms when taking land from the chief."[4] Some of them, therefore, grew wealthy. But the latter—the daer fudirs—"were escaped criminals, captives taken in battle or raids from other districts or other countries, convicts respited from death, persons sentenced to fine and unable to pay, purchased slaves, &c."[5]

It was through the fudirs that the nobles enhanced and maintained their position as landowners, and curtailed the powers of the ordinary tribesmen. "The settlement of fudirs was disliked by the community and discouraged by the Brehon law: for it curtailed the commons land; and while it tended to lower the status of the tribe, it raised the power of the chief, who in cases of dispute could bring all his fudirs into the field. Any social disturbance, such as rebellion, civil war, &c., in which many were driven from their homes and beggared, tended to increase the number of the fudirs."[6]

The bo-aires who rented non-tribal land were, like the farmers of tribal land, the non-noble members of the tribe who, in one way or another, had accumulated some wealth in cattle. They may also have held a share of tribal land—whether they did so is not clear—but, if they did, they drew their chief livelihood from pasturing cattle on privately owned land rented from the nobles, as well as by lending out stock to the poorer farmers.[7]

But although we can now get some conception of the Brehon land system, thanks chiefly to the patience and perseverance of O'Donovan and O'Curry, it is not possible to descend to what might be called the finer agricultural

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[1] These names are still used in the north-east of Scotland to describe men of indifferent stature and character in the one case and efficiency in the other.

[2] Joyce, vol. i, p. 162. [3] *Ibid.*, vol. i, p. 163. [4] *Ibid.*, vol. i, p. 163.

[5] *Ibid.*, vol. i, p. 164. [6] *Ibid.*, vol. i, p. 164.

[7] The above statement as to the system of land-tenure is drawn chiefly from O'Donovan and O'Curry's introduction and notes to the Brehon Laws, and from Maine, Seebohm, and Joyce, as well as from Spenser and Davies.

details. That part of the work has not yet been subjected to close research; and so we are limited to general statements, some of which can carry no more than inferential value. We cannot say, with even approximate accuracy what proportion of the land, tribal or non-tribal, was tilled; how much the spade was used and how much the plough; how many stones of grain were sown and how many harvested; how many stock were kept or how many stones of beef or gallons of milk were produced to the acre. We can only state what the times were likely to have allowed and how much it was possible for the Brehon framework to contain, and then check our statements by such contemporary references as can be found to the point.

At the time the Brehon laws were still operative in the northern half of Ireland—say, till 1600—the following field-crops were common in western Europe:—wheat, oats, barley and bere, rye, beans, and peas; while flax was grown widely in small patches.* Beans and peas are not mentioned in Brehon Ireland. But, if we assume that the translators have got the true English equivalents, and that the dates at which the old Irish words were in use are truly fixed, then, judging from "The Vision of Mac Conglinne," the rest of the crops mentioned above were known in Ireland in the twelfth

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* Note by Mr. E. C. R. Armstrong, National Museum, Dublin:—

The Royal Irish Academy's collection contains a number of bronze sickles found in various parts of Ireland. In shape they vary from a short angular implement with a slightly curved blade $6\frac{3}{4}$ inches long, and a socket an inch and a half high to a curved diminutive bronze representation of the modern iron reaping-hook 7 inches round the convex edge. All the sickles in the R.I.A. collection have a socket for the insertion of the handle, but recently a mould for a sickle has been found in Co. Antrim, which is not socketed, and resembles the examples found on the Continent. It may certainly be dated at 1000 B.C. The other *might* be two centuries later. Sir John Evans ("Ancient Bronze Implements," 1881, p. 194) says:—"Sickles are the only undoubtedly agricultural implements in bronze with which we are acquainted in this country. Already in the Stone Period the cultivation of cereals for food appears to have been practised." In "Ancient Stone Implements," 2nd edition, 1897, p. 358, the same author says: "I am inclined to think that these curved flint knives may not impossibly have supplied the place of sickles or reaping-hooks, whether for cutting grass to serve as provender or bedding, or for removing the ears of corn from the straw. We know that amongst the inhabitants o the Swiss Lake-dwellings some who were unacquainted with the use of metals had already several domesticated animals, and cultivated more than one kind of cereal; and it is not unfair to infer the same was the case in Britain."

* Note by Professor Carl Marstrander:—

The question as to the kinds of grains cultivated by the Celtic race in the British Isles in early times, can only be settled on linguistic and archaeological grounds, where there is a lack of literary tradition. Celtic archaeology is still in its infancy, still awaiting the master-mind capable of comprehending and utilizing the many branches necessary to one who would investigate the history of West and Middle Europe in prehistoric times. And as to the literary tradition, it takes us, here as elsewhere, back to comparatively recent times only. Nor does philology invariably provide a reliable base for investigation, partly owing to the scarcity of the material, and partly because of its unreliability or lack of verification, as for instance where the name of a grain has merely the support of a grammarian. Moreover almost all Gaelic names of grains are unconnected not only with Britannic, but with all the related Indo-European tongues.

Comparatively Old-Irish sources furnish the following names of barley, rye, and various kinds of wheat and oats:—

century, together with several others, including one for which the English equivalent is unknown:—"The eight kinds of grain thou must not spare, O Mac Conglinne, wheresoever they are offered thee, viz., rye (*secul*), wild-oats (*seruān*), beare (*maelān*) buckwheat (*rūadān*), wheat (*cruithnecht*), barley

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WHEAT: *cruthnecht*, the name extant to the present day.
tuirenn.
dag .i. cruthnecht, Cormac (an old grammarian).
A special sort of wheat is called *ruadān* (*-ān*, not *-ăn* as proved by the Book of Leinster, 150 a 2), glossed by *cruithnecht ruadh* "red wheat" by the grammarian O'Davoren (cp. with the same meaning *derg-chruithnecht* in the Félire Oengusso), and identified by him with *maol-chruithnecht*, which latter certainly expresses the same as *cruithnecht maol*, Brehon Laws, v, 222, 223.

OATS: *corce*, still extant.
máilān uilchi (sic leg.), Thesaurus Palæohibernicus, ii, 48, 26 (Philargyrus), which is probably identical with Middle-Irish *mǽlān*, which Kuno Meyer in his edition of Aislinge Meic Conglinne—I do not know on what authority—renders by 'beare.'
serbhan. For the meaning of this rare word we have to depend on the scholia of the grammarians. O'Clery assigns to it the meaning *coirce* 'oats,' whilst the grammarian of H. 3. 18 throws out the suggestion 'a certain kind of grain, probably oats' (p. 637 d). *serban* disappeared early from the spoken language.

BARLEY: *eorna*, the usual word from earliest times and still extant.

RYE: *secal*, mod. *seagal*, still in use.

The meaning of *fidbach* is quite uncertain. Originally it probably indicated a wild plant, for it cannot be disassociated from the u-stem *fidu* 'a wood.'

Of all these names *corce* only seems common throughout Celtic, corresponding to Welsh *ceirch*, Corn. *keirch Cruthnecht* and *dag* are quite unaccounted for; the similarity in sound between *cruthnecht* and *Cruthne* 'Pictland,' *Cruthnech* 'Pictish, a Pict' is remarkable, and the possibility of an original meaning 'Pictish grain' must receive consideration. Connexion between *eorna* and Sanskrit *yava* 'grain, esp. barley,' Gr. ζειά, horsefodder, in Homer, is extremely doubtful. Neither is the comparison of *tuirenn* with Armenian *coreun* convincing. Somewhat sounder is the comparison of *corce* with the synonymous North-Germanic *hagran-* (Finnish loanword *kakra*): the former points to **korkio*, the latter to **kokron-*. *Secal* originates from Lat. *secale*, usually regarded as a Gaulish loanword. Of the remaining names, *ruadan* and *maelan* (both *-ān*) are derivatives of the adjectives *ruad* 'red' and *mǽl* 'bald.' Likewise *serban* is in some way relative to *serb* 'bitter, acrid, sour,' although I am not clear as to its precise bearing. The final *an* is probably long as in *ruadán*. I should lay no stress on the doubtful occurrence in the Annals of Ulster, anno 650.

From the above we may conclude that wheat, oats, barley, and rye were familiar to the inhabitants of ancient Ireland as is further proved by numerous references in earlier and later texts. For the question in hand it is of the utmost importance that we should fix definitely the age of the recognized names of grains. The undoubted connection of Irish *corce*: Welsh *ceirch*, proves the familiarity of the Celts with the cultivation of oats before crossing the Channel at the beginning of the Iron Age. Similarly such words as *cruthnecht*, *tuirenn*, *eorna* must date back to prehistoric times, as they are quite isolated in Irish—had they been borrowed in the historic period their source would have been traceable. I consider it highly probable that the Celts when leaving the Continent were familiar not only with oats, but also with at least wheat and barley. It is quite unlikely that the advanced Celtic race in Middle and West Europe should have been ignorant of these cereals, grown by neighbouring tribes all around them. Wheat and barley are well known from the Swiss lake-dwellings, dating from the Stone Age; the latter is also known from Italian and Scandinavian finds of the same period. Rye was, according to Pliny, cultivated by the Taurini in the Alps, and the common Germanic-Slavonic name for it proves its high antiquity in North, Middle, and East Europe. The Germans, according to the same author, also cultivated oats, and archæological finds date from the bronze age. We have too long entertained the idea of prehistoric Europe as portioned off by insurmountable barriers permitting of no communication. Later research reveals more and more how multitudinous were the streams of culture which inundated Europe from the east and south.

(*eōrna*) *fidbach,* oats (*corca*)."[1] Flax is not mentioned directly, but someone is described as "putting a linen apron about him,"[2] and there is a reference to rye: "I advanced vehemently . . . like . . a deer to the cropping of winter-rye (*gemshecoil*) in the month of June."[3]

Before the evidence from "MacConglinne" can be accepted, however, a number of points have to be considered, of which these might be mentioned as suggestive:—

(i) Is the mention of buckwheat by the author of such a work as "MacConglinne" proof that buckwheat was grown in Ireland in the twelfth century? Or is even the circumstantial reference to rye proof that rye was grown? Buckwheat is grown in western Europe, most of all, perhaps, in Brittany, whence, if it had been grown there long, it might have come to Ireland. But does any other early author mention it in Ireland? Rye was not grown by the early Egyptians, Greeks, or Romans. It spread from eastern Europe, and is first mentioned among the Latins by Pliny[4] as having been grown by the Taurini. They called it *asia,* but Pliny called it *secale.* Do the Latin name *secale* and the Celtic names, *segul* in Irish, *secal* in Breton, and *cekela* or *zekhalea* in Basque indicate (*a*) that the Celts brought rye westward with them from Central Europe, (*b*) that they got it through Roman channels in later times, or (*c*) that they got it in medieval times and gave it the Latin name?[5]

(ii) Is the translator justified in identifying *seruān,* a sourish grain, with wild oats; *maelān,* a sweetish grain, with bere; and *rūadān,* a reddish grain, with buckwheat? What is usually known as the wild oat, *Avena fatua,* is not worth gathering. Another inferior oat, *Avena strigosa,* was cultivated till the eighteenth century in Scotland and the north of Ireland, and is still found in some parts as a cornfield weed. This oat may be meant; but it is not sour. Buckwheat is not reddish: it is rather brownish.

(iii) Did *cruithnecht,* wheat, mean the same grain ten or fifteen hundred years ago that it means now? The word originally meant 'the Picts,' whence it came to mean the Pictish corn.[6] If Pytheas is to be trusted at all, the Pictish corn was millet (κέγχρος). Can *cruithnecht* have been transferred at some time from the one grain to the other? 'Corn' to a southern Englishman is wheat, to a Scotsman oats, to an American maize. In view of the fact that there is frequent reference to "red wheat" in Irish, it ought to be mentioned that one variety of millet, *Panicum sanguineum,* has reddish grain: much redder than the grain of the modern "red" wheat.

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[1] Dr. Kuno Meyer's translation, p. 98. [2] *Ibid.*, p. 62. [3] *Ibid.*, p. 84.
[4] xviii, 141. [5] See De Candolle's Origin of Cultivated Plants.
[6] This is on the authority of Professor Marstrander.

The settlement of such questions as these and others they may suggest must be left in the combined hands of future philologists, historians, archæologists, botanists, and agriculturists. Meantime we can at least say which were the chief crops and products under the Brehon system.

One of the features of the Brehon system was the farmer's insecurity of tenure of the cultivable land. He was sure of such land; but, because of the changes arising through accessions and deaths, he was not sure how long he would hold the same piece. He was in similar uncertainty as to the site of his dwelling which, in consequence, was built with a view to temporary occupation. Some tribes seem to have arranged for a biennial or triennial re-allotment; but even this is a short tenure. Add to this the frequent inter-tribal aggressions and contests, and it can be seen that the conditions necessary for wide and careful tillage did not exist. Land naturally dry and suitable might have been tilled and sown with grain; but the essentials necessary to the increase of such land, viz., drainage and reclamation, could not be undertaken with great hope. At the same time, the possibility of having to move frequently from one farm to another was all in favour of crops using the ground for a short time only and against such a crop as wheat which had to be ploughed for and sown the one year and harvested the next. Consequently, where crops were grown at all, we can look only for oats and barley, but especially for oats, since that crop can thrive better in land indifferently drained and tilled. But, above all, we must look for grazing and herding as the mainstay of the people's existence.

And so we find it. Indeed, it is very doubtful whether the northern or Brehon half of Ireland had made much material advance since Strongbow's invasion. This we find on the authority of Sir John Davies, James the First's Attorney-General for Ireland, who lived in the country from 1603 till 1616, was elected Member of Parliament for Fermanagh in 1612, and was Speaker of the Irish House of Commons from 1613 to 1615. Carrying out his duties, he "visited all the provinces of that kingdom in sundry journeys and circuits"; and it fell to him to take part in ending the Brehon customs and settling on the spot which lands were to be given to the Irish in Ulster and which to James's "planters" from England and Scotland.

For a description of Ireland in Strongbow's time we are indebted to Giraldus Cambrensis, whom we have already quoted as to Wales. He came to Ireland with Henry's son John, afterwards King John; and from his description we may make such quotation as is necessary to give some idea of the agriculture of the country as he saw it:—"The Irish are a rude people, subsisting on the produce of their cattle only. . . . This nation . . . lead the same life their fathers did in the woods and open pastures, neither

willing to abandon their old habits or learn anything new. They, therefore, only make patches of tillage; their pastures are short of herbage; cultivation is very rare, and there is scarcely any land sown."[1]

Four hundred years later, in his longest tract, dealing with the country as a whole, Davies tells us that he had considered, among other things, "what were the true causes . . . why the manners of the mere (*i.e.* unmixed) Irish are so little altered since the days of King Henry the Second, as appeareth by the description made by Giraldus Cambrensis."[2] In his letter to Salisbury on the plantation of Ulster he justifies the "planting" of Englishmen and Scotsmen alongside the Irish by saying of these last: "If themselves were suffered to possess the whole country, as their septs have done for many hundred of years past, they would never, to the end of the world, build houses, make townships or villages, or manure[3] or improve the land as it ought to be";[4] and he also says that in Cavan "the habitations of the people are so wild and transitory as there is not one fixed village in all this county."[5]

No doubt there were variations in different parts of the country; but, on the whole, the proportion of tilled land to grass was very small.[6] In the Brehon laws, we find oats and barley indicated with some frequency, but wheat seldom; and, more than likely, it was grown only in the south. The Brehon laws ran in the south as well as in the north, although intermittently. The plough and the spade were both in use; and, while we read of farmers combining[7] to supply oxen to haul a plough,[8] we also find that "all over the north, at the beginning of the seventeenth century, the plough was tied to the horse's tail."[9] Fynes Moryson tells us "the wild Irish do not thresh their oats, but burn them from the straw."[10] The quern was in common use for grinding grain.

With regard to stock, a few points only need be mentioned. Many of the wealthier men—chiefs and rich bo-aires—were in the habit of letting out cattle to the poorer. The cattle were grazed chiefly on the commons; but a farmer might graze them on his cultivable land if he pleased, so long as he kept them away from his neighbours' corn. There were tribesmen who wandered about with their stock, renting land from landowners for short periods.[11] There were also tribes who had grazings to which they migrated in early summer and returned to their winter quarters in autumn.[12]

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[1] Bohn's edition, p. 124. [2] Ireland under Elizabeth and James the First, ed. Morley, p. 218.
[3] i.e. cultivate. [4] Ireland under Elizabeth and James, p. 387.
[5] *Ibid.*, p. 374. [6] Bonn's englische Kolonisation in Irland, vol. i, p. 82.
[7] Ancient Laws of Ireland, ii, 359. [8] Four oxen usually hauled the plough.
[9] Quoted by Bonn from Barnaby Rich. The same practice is spoken to not only by Arthur Young (1775–78), but also by Wakefield (1812).
[10] Ireland under Elizabeth and James, p. 427.
[11] Ancient Laws, iii, p. 131, and Bonn i, 47. [12] *Ibid.*, i, p. 133.

Such having been the state of affairs in the north till the beginning of the seventeenth century, we can now turn to the south; and in dealing with the south, as indeed with the whole country, one fact above all others must be kept well in mind, namely, that the Norman "conquest" was not really a conquest,[1] but an invasion. It was the beginning of a long contest between Normans and English united with feudal law and custom on the one hand and Irish united with Brehon law and custom on the other.

Dermot MacMurrough, the Brehon King of Leinster, having been deposed by his own people, asked Henry the Second's help to bring about his restoration. Henry himself could not take part, but he gave Dermot leave to contract for help within his English dominions: in return for which Dermot "did homage and took an oath of fealty":[2] a transaction which probably had not the same meaning to Henry as to Dermot. Dermot received the co-operation of Richard de Clare, afterwards called Strongbow, who, in turn, enlisted in the venture a number of Normans, mostly descendants of a Welsh princess, Nesta, some of them descendants of Henry the First and therefore cousins in some degree to Henry the Second. Strongbow's reward was to be "the hand of Dermot's only daughter and the succession to his kingdom."[3] Here, again, it is possible Dermot and Strongbow had different ideas in their minds, for Dermot's kingship was not hereditary but elective according to Brehon law.

In two years, 1169–70, the Normans had captured Wexford, Dublin and Waterford, overrun the surrounding country, and restored Dermot; and Strongbow had been married to Dermot's daughter. Their success was so great that Henry saw the possibility of the Normans forestalling him by setting up another Norman kingdom in Ireland; and he requested Strongbow to come back and meet him in England. Strongbow "succeeded, after much altercation, by the address and mediation of Hervey, in appeasing the king's displeasure."[4] But "the earl made his peace with the king upon the terms of renewing his oath of fealty, surrendering to him Dublin and the adjacent cantred, with the towns on the sea-coast and all the fortresses; and submitting to hold the rest of his conquests to him and his heirs of the king and his heirs."[5]

Thus was feudal law first set up in Ireland. The king became the immediate lord of the cities and the country round Dublin, that is of the people best able to pay him tribute, chiefly Ostmen or Danes, and overlord of Strongbow and the other Normans, while they became lords of all they

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[1] The "conquest of Ireland in the twelfth century" is an utter misnomer: Richey's Short History of the Irish People, p. 143.

[2] Richey, p. 144. [3] *Ibid.*, p. 145. [4] Giraldus Cambrensis. [5] Richey, p. 153.

might conquer and hold. That meant that the king became first owner of all the land; and, while he let that over which he was immediate lord either for knight-service or for payments in money or in kind, he let the rest to the Norman lords upon their oath of fealty; and they in turn were expected to sublet the land they held for knight-service or for direct payment. Primogeniture and the usual incidents of feudal law, such as wardship, escheat, fines and relief followed in consequence; and the Brehon law was annulled.

But in Ireland feudalism lacked one essential feature which elsewhere was its mainstay. When the conqueror divided up England among his Norman lords and knights, he retained a number of manors as his own, and, in after-days, the knights and soldiers living on those manors were used effectively in keeping the lords and barons true to their overlord, the king. In Ireland, on the other hand, the king retained only the Dublin district, which was altogether too small to keep the Norman lords in check; and, if he had to use force, he "had to rely upon such of the great feudal vassals as might remain loyal. . . . The invariable result of this policy was to kindle a civil war and excite personal feuds in the attempt to maintain order."[1] Another Irish feature was that the Norman lords themselves, partly because their original feudal retainers were too few, partly because they found Irish soldiers cheaper, and partly for other reasons, fell away from feudalism and adopted such of the Brehon laws and customs as were to their interest. At the same time their retainers and their descendants who remained in Ireland were absorbed in the Irish population.

Thus it was that only the country under the immediate eye of the king's deputy, the Pale, whose boundaries fluctuated considerably but were never confined to an area much less than that represented by the present counties of Dublin, Louth, Kildare and Meath, was the only part of Ireland in which feudal laws and customs continued to prevail.

It is not easy now to say for certain how the English worked the land within the pale, because the problem has not yet been fully investigated, but, from circumstances which will now be quoted, it can be inferred that the system was approximately that of England during the Middle Ages.

Sir John Davies tells us that "when the English Pale was first planted all the natives were clearly expelled, so as not one Irish family had so much as an acre of freehold in all the five counties of the Pale."[2] The incomers were English, knowing the English system of agriculture only and likely to establish no other. That system had originated and grown from the old English village as a nucleus, but separate farms, demesne farms, manor

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[1] Richey, p. 171. [2] Letter to Salisbury in Ireland under Elizabeth and James, p. 389.

farms, had been set up near the castle or the priory outside the village land even before the conquest.

In Ireland, in the twelfth and thirteenth centuries, the castle of the lord or the knight was the apparent and necessary nucleus, with the cottages of the lower retainers and workmen in the vicinity and the homesteads of the rent-paying tenants each in the midst of its own farm of land. Some of these collections of houses and homesteads would naturally become villages. At any rate, "the English pale was planted with towns and villages."[1] Gomme cites the case of Kells and inclines to the opinion that the Danes turned six tribal homesteads with their land into a Danish village which the English afterwards took over.[2] It is difficult to believe, however, that the early Celtic homesteads were sufficiently definite to have been so adopted by the Danes.

In any case the essential point for us is to know which crops were grown by the English. No definite references to the crops grown within the Pale can be found; but Bonn cites several to show that some of the Normans without the restricted Pale cropped their land on the three-field system and, therefore, grew wheat, as well as barley or oats. "Agriculture had improved and the three-field system had taken the place of the Celtic grass system in many places."[3]

For instance, the Earl of Gloucester had 4 carucates of land, that is from 400 to 480 acres, at Callan, of which 154½ were wheat, 142 oats, the rest fallow; and at Dunfert there were 6½ carucates, of which 4 were in wheat and oats, while the rest was fallow.[4] But to judge from its prevalence in Arthur Young's time, and remembering that, if it had not taken root before the seventeenth century, it was unlikely to have been planted at all, the three-field system was common within the Pale. Bonn points out that in Young's time Louth, Meath, Kildare, Carlow, King's County, Queen's County and Kilkenny were the centres of grain-growing, and that in these counties the three-field system was frequent.[5] For Edward the First's wars, grain was requisitioned from Ireland. In 1296-97 sixteen grain ships carried 4,500 quarters of grain from Drogheda, Dublin, Waterford and Youghal to Gascony, and for Edward's Scotch wars 8000 quarters of wheat, 10,000 of oats, and 2,000 of malt, and 500 head of oxen, 1,000 fat swine, and 20,000 fish were furnished by Ireland.[6] In addition, it should be noted that, for the Scotch wars, a considerable quantity of grain was brought over from England to be milled within the Pale.[7]

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[1] Carew MSS., iii, p. xcvi. [2] The Village Community, p. 153.

[3] Englische Kolonisation in Irland, i, p. 144.

[4] *Ibid.*, i, p. 118. [5] *Ibid.*, ii, p. 248. [6] *Ibid.*, i, p. 144.

[7] The Wardrobe Accounts of Edward I (Liber Garderobe), pub. Soc. Antiquaries, 1787, pp. 271 et seq.

Outside the Pale in the South of Ireland were the two races, separate at first but eventually amalgamated. Southward from the Pale "the colonists occupied, in a narrow line, portions of the King's and Queen's Counties, and Carlow; they held the counties of Kilkenny and Wexford, and the eastern part of Munster; they occupied Limerick and the adjoining districts, and their castles extended to the mouth of the Shannon. In Connaught, the territories of the De Burgos stretched from Galway northward and eastward over the plain portion of Connaught."[1] The colonists were few, and, with their settlements flanked by the Celtic population on several sides, sometimes well nigh surrounded, and an entire lack of sustained support from the English headquarters, they were frequently hard pushed to maintain their position. Left to themselves as they were, the colonists struggled for a while; but Edward Bruce's invasion early in the fourteenth century crippled the English power in Ireland and hastened the amalgamation of the Normans and their adherents with the Irish people. Naturally there resulted some kind of compromise between the Feudal and the Brehon laws and customs. The Normans retained primogeniture, so far, at any rate, as they themselves were concerned, and it is probable they also retained the hold of feudal lords upon the descendants of the original English and their land, if not also upon the Irish, excepting that, in their case, the letting of farms among the common tribesmen may still have been regulated by the Brehon laws.

All this, however, has been neglected by historians; and we can only say, from our present point of view, that the English introduced the cultivation of wheat on some scale to the south of Ireland, and that, although the reversion to tribal customs and the inter-tribal fighting which naturally followed may have hindered its extension, it is unlikely that so valuable a crop would be subject to anything approaching complete decline. We are not astonished, therefore, to find an export of wheat and other grain in addition to such things as hides and skins, cheese and butter, salt beef and fish, which were exported from the south of Ireland during the Middle Ages.[2]

The foundations for the modern development of Irish agriculture were laid in the sixteenth and seventeenth centuries by the planters and undertakers of Elizabeth and James the First. The advance made since those days could not be represented diagrammatically by a continuous straight line. Social and political differences, and the great catastrophe of the nineteenth century, have caused the line to bend and sag again and again; but, on the whole, lost ground has usually been regained and the general direction of the line has been upward in the main. It might be asserted that,

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[1] Richey, p. 173. [2] For details see Mrs. Green's Making of Ireland and its Undoing.

had the Norman-English and the Irish been left alone, they might have laid a surer foundation; but before they could have done so, some of them would have had to set up a strong central government, which would have put an end to intertribal rivalry and strife, and the Brehon laws would have had to be modified. So far as we know no tribal system in the world's history, Aryan or other, has been conducive to agricultural advance.

The planters of the sixteenth and seventeenth centuries generally followed the direction taken by the Normans. They sat down in the flat lands in the north and in the south, and estates were granted all over the central plain from the Pale to Galway. For example, in the south: "The estate of the Southern Geraldines having been confiscated, and the population almost destroyed, an English plantation in Munster followed, as of course. In Munster 574,628 acres were forfeited to the Crown. . . . This tract of land was portioned out into seigniories of 12,000, 8,000, 6,000, and 4,000 acres each. The undertakers, that is, the grantees who should undertake the planting of a territory, were to have estates in fee-farm, at a rent of £33 6*s.* 8*d.* for estates of 12,000 acres, to be doubled after the expiration of three years. Every undertaker of 12,000 acres was bound to plant 86 families; to retain for his own family 1,500 acres; for one chief farmer, 400 acres; for two good farmers, 600 acres; for two other farmers, 400 acres; for fourteen freeholders (300 each), 4,200 acres; for forty copyholders (100 each), 4,000 acres; for twenty cottages and labourers, 800 acres.

"Some undertakers obtained more than one seignory. Sir Walter Raleigh secured 42,000 acres in Cork and Waterford."[1]

Later, in the north, "the lands to be planted were divided into three proportions, the greatest, of 2,000 English acres, the middle, of 1,500, and the least, of 1,000 each."[2] . . . "The King granted estates to all, to be held by them and their heirs. The undertakers of 2,000 acres held of him *in capite*; those of 1,500, by knight's service, as of the Castle of Dublin; and those of 1,000 in common socage. The first were, in four years, obliged to build a castle and a bawn; the second, in two years, a strong stone and brick house and bawn; and the last a bawn; timber for that purpose, as well as for their tenants' houses, being assigned them out of the King's woods. The first were obliged to plant on their lands, within three years, forty-eight able men eighteen years old or upwards, born in England, or the inland parts of Scotland, to be reduced to twenty families; to keep a demesne of 600 acres on their hands; to have four fee-farmers on a hundred and twenty acres each; six

[1] Richey's Short History, p. 543.
[2] Quoted in Richey, p. 602, from Carte's Life of Ormond.

leaseholders on a hundred acres each; and on the rest eight families of husbandmen, artificers, and cottagers."[1]

The incomers were English and Scotch, chiefly of the landowning and farming classes. They had left a country which had already made considerable advance in agriculture—England had done so, at any rate. They had been accustomed to the three-field system or to the more modern system of inclosed fields, on which various crops were grown for shorter or longer periods and were then left down to pasture. They knew about reclamation and draining and some of the methods then in vogue to improve or keep up the fertility of the land. Their first move, therefore, was to apply their previous knowledge and experience to Irish land. How they did this and how necessary it was can be shown by some quotations from Gerard Boate's "Ireland's Natural History," published by Hartlib in 1652.[2] Boate himself had not been in Ireland, but he "got information from his brother Arnold who lived in Ireland and from other English in Ireland."[3]

Describing the soils of Ireland and their fertility, Boate says: "There be indeed some countries in Ireland, where the ground underneath being nothing but stones, and the good mold upon it but very thin, it is nevertheless fruitful in corn and bringeth sweet grass in great plenty, so as sheep and other cattell do wonderfull wel thrive there; which kind of land is very common in the County of Galloway, and in some other Counties of Connaught, as also in sundry parts of other Provinces. But the reason thereof is in those parts, because the stone whereon the mould doth lye so thinly, is not Free-stone, or any such cold material, but Lime-stone, which doth so warm the ground, and giveth it so much strength that what it wants in depth, is thereby recompensed."[4]

Yet draining was necessary; for, "except in the case now by us declared, neither corn nor grass will grow kindly, where the ground, though otherwise good, is not deep enough, as also where it hath a bad crust underneath. From whence it commeth that in many places, where the grass doth grow very thick and high, the same nevertheless is so unfit for the food of beasts, that cows and sheep will hardly touch it (especially if they have been kept in better pastures first) except that by extreme famine they be compelled thereto; and that by reason of the coarseness and sowerness of the grass caused by the standing still of the water, the which through the unfitness of the neather crust, finding not a free passage downwards, maketh cold the good mold, and the crop and grass degenerate from its naturall goodness.

[1] Quoted in Richey, p. 603, from Carte.

[2] This book was republished in Dublin in "A Collection of Tracts and Treatises," 1860.

[3] Dictionary of National Biography.

[4] Ireland's Natural History, original edition, p. 85.

"For the same reason the land in many parts, where otherwise the soil in it self would be fit enough to produce good Wheat or Barley, will hardly bear anything else but Oats or Rye, and that none of the best."

He tells that draining of the bogs was first begun by the English: "So that it may easily be comprehended, that whoso could drain the water, and for the future prevent the gathering thereof, might reduce most of the Bogs in Ireland to firm land, and preserve them in that condition. But this hath never been known to the Irish, or if it was, they never went about it, but to the contrarie let more and more of their good land grow boggy.[1]

"But as the Irish have been extreme careless in this, so the English . . . . have set their industry at work for to remedy it, and having considered the nature of the Bogs, and how possible it was to reduce many of them unto good land, did some yeares since begin to goe about it all over the land, and that with very good success."[2]

Then, having remarked that, but for the rebellion, many more bogs would have been drained, he describes the process: "This draining of the Bogs was performed in the manner following. On that side of the Bog where the ground was somewhat sloaping, they cut a broad deep Trench, beginning it in the firm ground, and advancing it unto the entrance of the Bog, into which Trench the water would sink out of the next parts of the Bogs in great abundance and that many times so suddenly, as if a great sluice had been opened, so as the labourers were constrained to run out of it with all speed lest the force of the water should overwhelm and carry them away. Some part of the Bog being by this meanes grown reasonable dry within a short space of time, opportunity thereby was ministred to advance the Trench further into the Bog: and so by little and little they went on with it untill at last they carryed it quite across the Bog, from the one side to the other: And having done this, they made a great many lesser Trenches out of the main one, on both sides of the same: the which bringing the water from all the parts of the Bog unto the main Trench, did in a little while empty the Bog of all its superfluous moysture, and turn it into good and firm ground."[3]

With regard to lining and marling, two new things, he says: "The English living in Queens-county in Leinster having seen that in sundry parts of England and Wales, especially in Pembrokeshire, Lime was used by the inhabitants for the manuring and inriching of their grounds, began some years since to practise the same, and found themselves so well thereby, that in a short time the use thereof grew very common amongst them, so as many of them ever after used no other kind of dung.[4]" . . .

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[1] Ireland's Natural History, original edition, p. 113.
[2] *Ibid.*, p. 114. [3] *Ibid.*, p. 116. [4] *Ibid.*, p. 96.

"Lime is much used in the province of Munster, as in other parts of Ireland, so far to manure the ground withall, where the sea-sand likewise is greatly used to the same end, not only in places lying on the seaside, but even ten, twelve, and fifteen miles into the land, whether it is carried in some places by boats, and in others upon carts, the charges being sufficiently recompensed by the profit comming from it. For they used it for the most part only upon very poor land, consisting of cold clay, and that above half a foot deep: which land having been three or four times plowed and harrowed (in the same manner as is usual to be done with fallow) the sand is strawed all over very thinly, a little before the sowing time: the which being done, that land bringeth very good corn of all sorts, not only Rye and Oates, but even Barley and Wheat, three yeares one after another; and having lyen the fourth year fallow, for many years after it produceth very clean and sweet grass; whereas formerly, and before it was thus manured, it produceth nothing but moss, heath, and short low furze: which herbs are fired upon the ground, and the ground stubbed, before it is plowed the first time."[1]

Still more interesting is Boate's reference to marl and marling, a practice at its height towards the end of the eighteenth century and still in vogue in some parts of Ireland. Of marl, Boate says:—

"It hath from antient times been greatly used for manuring of land both in France and England. . . . The same also is stil very usual in sundry parts of England, being of an incomparable Goodness: The which caused the English, who, out of some of those places where Marle was used were come to live in Ireland, to make diligent search for it, and that with good success at last; it having been found out by them within these few years, in severall places; first in the Kings-county, not far from the Shanon, where being of a gray colour, it is digged out of the Bog: And in the County of Wexford, where the use of it was grown very common before this Rebellion, especially in the parts lying near the sea; where it stood them in very good steed, the land of itself being nothing fruitfull. For although the ground (for the most part) is a good black earth, yet the same being but one foot deep, and having underneath a crust of stiff yellow clay of half a foot, is thereby greatly impaired in its own goodness. In this depth of a foot and a half next under the clay, lyeth the Marle, the which reacheth so far downwards, that yet no where they are come to the bottom of it. It is of a blew colour, and very fat (which as in other ground, so in this, is chiefly perceived when it is wet), but brittle and dusty when it is dry:[2]

"The marle is layed upon the land, in heaps by some before it is plowed, by others after, many letting it lye several moneths ere they plow it again,

[1] Ireland's Natural History, original edition, p. 99.

[2] *Ibid.*, p. 101.

that the Rain may divide and mixe it; the Sun, Moon, and Air mellow and incorporate it with the earth. One thousand Cart-loads goeth to one English acre of ground.[1] . . .

"The good usage of the Marled-land, to keep it in heart for ever after, doth consist, in the opinion and practise of some, in letting it ly Fallow at convenient times, but the ordinary manner, commonly practised by the inhabitants of the County Wexford, and counted the best by them, is, that having sowed it five or six years together, with the richest sorts of Corn, to wit Wheat and Barley (especially that sort which in some parts of England, and generally in Ireland, is peculiarly called Bear, being a much richer grain than the ordinary Barley) it being afterwards turned to pasture, whereunto it is very fit, for as much as it bringeth very sweet grass in great abundance: For the Marle is also used on Meddows at the first, with very good success, improving the same wonderfully. If the Marled-land be thus used, and by turns kept under Corn, and Grass, it keeps its fruitfulness for ever."[2] . . .

"Where the land of it self is better and richer, there after Marling, Wheat and other Corn may be sowed, not only for ten years together, but longer.[3] . . .

"The Province of Connaught (by what hath been discovered) is much more plentifull in Marle, than is Leinster, as in other Counties, so in those of Roscoman, Slego, and Galloway, almost in every part of it. It is there of three several colours, some being white as chalk, other gray, and some black; but none blew, as that in the County of Wexford. It lyeth nothing deep under the upper-ground, or surface of the earth, commonly not above half a foot; but its own depth is so great, that never any body digged to the bottom of it.

"The land which they intend to Marle in this Province, is commonly plowed in the beginning of May, and lying five or six weeks (untill it be sufficiently dryed and mellowed by the Sun and Wind) they harrow it, and then having brought the Marle upon it, five or six weeks after it is plowed again and a third time about September: After which third plowing they sow it with Wheat or Barley, whereof they have a very rich crop the next year.[4]

"Land marled in that manner as we have said, may be sowed ten or twelve yeares together; the first eight or nine with Wheat, and Bear, or Barley, and the remaining three or four years with Oates, afterwards the land is turned to pasture, and having served some years in that kind, it may be Marled anew, and made as good for corn as at first.[5] . . .

"In Connaught they scarce lay the fourth part of the quantity of Marle on the ground of what they doe in the County of Wexford."[6]

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[1] Ireland's Natural History, original edition, p. 101. [2] *Ibid.*, p. 102. [3] *Ibid.*, p. 103.
[4] *Ibid.*, p. 103. [5] *Ibid.*, p. 104. [6] *Ibid.*, p. 105.

These quotations show not only how the English planters set about reclaiming and improving the land; but also that they adopted generally the system of farming that was common upon "inclosed" farms in Britain. But it must not be assumed that, although they introduced many improvements, the planters turned Ireland from a grazing to a tillage country. Tillage was increased very considerably, but it was only on the original Norman line of route down from the Pale through Carlow, Wexford, Kilkenny, and Queen's County, and on to Tipperary and parts of Limerick and Cork that it became outstanding. Improved methods were eventually introduced beyond the Shannon; but the main industry of that part of the country has always been the raising and grazing of sheep and cattle.

The plantations in the north were different in one or two essential points. Reclamation there was harder, for it had to be begun at the beginning; the planters, who were chiefly from Scotland and the north of England, got smaller estates;[1] and oats were the crop by far most widely grown. Barley and bere were grown, but very little wheat, if any at all.

Having begun by reclaiming and improving the land, the planters next imported stock from England. If they were going to farm as they had been accustomed, bigger and stronger cattle to breed bullocks for the plough, for one thing, were a pressing necessity. The cattle in Ireland up to the time of the plantations were nearly all of the little black Celtic race now represented by the Kerries. There was a hornless ingredient, brought in by the Norsemen; but there is no strong proof that there were others. The Normans were not the men to introduce cattle. The early colonists may have brought some over; but, in their day, there was no special inducement, because the cattle in England and Wales were not, as a rule, larger than those in Ireland. England herself had begun to import the larger kinds of cattle from Holland and Flanders not so very long before the times of the Irish plantations; and it was only about that time that the value of the larger-sized bullocks for ploughs and waggons became known. Of the planters' importations there are now no details to be found. That they had begun before 1580 might be inferred from a letter of that date, in which Sir Nicholas White, the Master of the Rolls, says: "The native cattle were black";[2] and that some numbers were being brought in by 1611 may be inferred from a Government regulation of that date: "For 2000 acres, and so rateably the undertaker for the first year may carry 20 cows, 2 bulls, and 20 young store cattle; 100 ewes and 6 rams; 20 mares, horses, and colts; and as many

[1] Did the comparative poverty of the northern landowners throw a larger share of the work of reclamation upon the tenants, and did this lead eventually to the Ulster tenant right custom?

[2] Housman and Sinclair's History of the Devon Breed of Cattle, 1st edn., p. 21.

swine as he will (not exceeding 10)."[1] But so many were brought in, or so many of the kind brought in were bred from, that, by the middle of the eighteenth century, nearly all the cattle in the low-lying and more fertile parts of the country were Longhorns or Longhorn crosses—the breed of the English midlands and north-west. Cattle were brought to the south from the south of England, and perhaps also to the north from Scotland; but these were in no great number.[2]

In the same way a new race of sheep was brought into Ireland, and these spread over practically the same area as the Longhorn cattle. Their descendants, the Roscommons, unlike the Longhorn cattle, still survive in the country, although their territory is now smaller than it once was.[3]

The history of the horse in Ireland is, so far, only conjectural. The Celtic pony was in the island in very early times. There is high probability that the Norsemen brought in horses as well as cattle. The Norman horses were larger and stronger than those in the country before them, and, to judge from the Bayeux tapestry, contained many of the features of the Suffolk Punch and the older Hackneys of the east of England.[4] The horses brought in by the planters would approximate to the Norman horse, excepting that they would have a cross of the "Great War Horse" of the Middle Ages. In the eighteenth century, probably also in the seventeenth, the kind of horse that produced the modern thoroughbred came to Ireland in considerable numbers.

The next changes in Irish agriculture might be expected to have crept in about the middle of the eighteenth century, shortly after Tull's and Townshend's work had begun to tell in England. But the general result of that work was scarcely the same in Ireland as in Britain. The two new crops, turnips and red clover, arrived in the eighteenth century; but "the new husbandry," as it was called, was not adopted widely for many years. It meant not only the abandonment of the fallow and the "inclosed" system of cropping, and the growing of two new crops, but it meant also the adoption of drill cultivation, new and more complicated machinery, and greater care and attention to the details of cultivation. The four-course system, modified frequently to suit local conditions—as, for instance, by sowing grass-seeds along with the clover and leaving that crop down for several years—spread widely and quickly in Britain and had reached as far north as Morayshire by the time

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[1] Irish State Papers, 1611–14, p. 43.

[2] See "The Origin of the Dexter-Kerry Breed of Cattle" and "The Scandinavian Origin of the Hornless Cattle of the British Isles," Sci. Proc., Royal Dublin Society.

[3] The data on this question have already been collected by the writer of this paper, but have not yet been published.

[4] Question: Is what is now called the 'Old Irish Draught'-horse related to the Norman horse?

Arthur Young came to Ireland; but that writer saw it only in one or two places in Ireland. He mentions that Lord Shelbourne, at Rathan, in Queen's County, had a Norfolk bailiff "who brought with him a plowman, plough, harrow and tackle";[1] he describes Mr. Bushe's farming at Kilfaine, in Kilkenny, and says "this is the Norfolk husbandry":[2] and at Castle Martyr, in Cork, he found a man who had adopted it only to give it up again: "Lord Shannon's expression of this mode to me was excellent, *I read myself into it and worked myself out of it.* He tried it with wheat, horse and hand-hoeing it perfectly, and got a very fine crop; an unexceptionable one for the mode, but the practice was not equal to the common way, while the expense, trouble, and attention, were endless, so that he was convinced, even by his success, that it could not be a beneficial mode of culture. For turneps also he prefers very much the broad-cast mode, and never began the drill method but as an ease of hoeing."[3]

But all over Ireland, in Young's time, and even in Wakefield's time, the rotations were generally copies or modifications either of the old three-field system or of the "inclosed" systems of cropping in England or Scotland. A few samples from Young will indicate this. Let us take the Pale counties first:—

At Luttrell's Town,[4] *Co. Dublin,* the rotation was fallow, wheat, oats; but "sometimes 1 Fallow. 2 Wheat. 3 Oats. 4 Clover. 5 Wheat. 6 Oats. They plough four times for wheat,[5] on clover but once, feed their clover the year through. No sain-foine. Many potatoes in the ridgeway 7 feet broad, and the furrows 3½."[6]

At Celbridge, Co. Kildare: Fallow, wheat, oats, oats. "A little barley is cultivated. They plough three or four times for wheat. Turneps were sown in fields 30 years ago, but left off on account of the poor stealing them."[7]

At Slane, Co. Meath: Fallow, wheat, barley or oats, oats. "Also 1 Fallow, 2 wheat, 3 barley, 4 oats, 5 clover, for Two years, 6 Barley."[8]

At Athy, Co. Kildare, "the common course of crops" was "1 Fallow. 2 Wheat, yielding 7 to 9 barrels. 3 Barley, 15 barrels. 4 Oats, 15 to 20. 5 Left for grass."[9]

From Athy to Carlow, "the courses are: 1 Fallow. 2 Wheat, yielding 5 or 6 barrels. Also 1 Fallow. 2 Wheat. 3 Oats, and grass seeds, or left to turf itself."[10]

In Louth: 1 Fallow, 2 Wheat, 3 Oats, 4 Barley, 5 Oats, 6 "Grass seeds sown, or left waste to turf itself."[11]

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[1] Tour in Ireland, Hutton's edition, vol. i, p. 65. [2] *Ibid.*, p. 79. [3] *Ibid.*, p. 323.
[4] Now called Woodlands. [5] i.e. they plough the fallow four times.
[6] Young, Hutton's edition, vol. i, p. 22. [7] *Ibid.*, vol. i, p. 27. [8] *Ibid.*, vol. i, p. 37.
[9] *Ibid.*, i, p. 71. [10] *Ibid.*, i, p. 71. [11] *Ibid.*, i, p. 113.

In these counties the more advanced farmers were growing turnips, sometimes sown broadcast, sometimes in drills. The width between the drills varied from 12 inches to 3 feet. Some of the land was being hollow- or underdrained. Beans and peas were grown here and there, especially in Wexford. Flax was grown everywhere: "Every farmer has a little flax from a rood to an acre, and all the cottages a spot, if they have any land, they go through the whole process themselves, and spin and weave it."[1] Potatoes were equally common, and were the chief food of the poorer people. They generally cultivated them in ridges or beds; but some farmers had begun to cultivate them in drills.

Outside the Pale less wheat was grown, and there was a greater tendency to growing the same kind of crop year after year till the land was exhausted. Fallows were less common, and so also were turnips and clover.

Armagh: "Within 4 miles of Market-hill, the course: 1. Oats. 2. Oats. 3. Oats. 4 Oats. 5 Oats, and then leave it to the rubbish, which comes up for 3 or 4 years: some potatoes, and after it flax."[2] Among the "manufacturers," as Young called them, that is farmers of 10 to 15 acres who made the best part of their living by growing flax and working it into yarn and cloth, the rotations were such as these: Potatoes, flax, oats, "and let it then lay for pasture,"[3] or Potatoes, bere, flax, oats[4] or "Potatoes, flax, oats, oats, "and then leave it to grass itself."[5]

About Lesly Hill, Co. Antrim: Potatoes, flax or barley, oats, oats, and "weeds for 2 years called a lay."[6]

At Newtown-Limmavaddy, Co. Derry: Potatoes, barley, oats, oats, flax, "lay 2 or 3 years, some sow grasses, clover &c.," oats, oats.[7]

At Castle Caldwell, Co. Fermanagh: Potatoes, potatoes, barley or flax, oats, oats, oats, "lay out for grass."[8]

At Ballynoch in Cavan, "The course of crops is: 1 Potatoes. 2 Potatoes 3 Bere. 4 Barley or Oats. 5 Oats. 6 Lay out for weeds, four or five years."[9]

Strokestown, Co. Roscommon: Potatoes, potatoes, flax, barley, oats, "Lay out for 6 or 7 years. None of them sow grass seeds."[10]

Drummoland, Co. Clare: Potatoes, bere, wheat, oats, oats, oats and "lay it out for grass" and Beans, bere, barley, wheat, oats, oats, oats "lay it out, or beans again."[11]

Tipperary: Turnips, fallow, wheat, oats, oats, oats, oats, oats, oats, "lay it out."[12]

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[1] This quotation refers to Slane; but Young refers similarly to flax in many places.
[2] Young, i, p. 116. [3] *Ibid.*, i, p. 120. [4] *Ibid.*, i, p. 124. [5] *Ibid.*, i, p. 126.
[6] *Ibid.*, i, p. 159. [7] *Ibid.*, i, p. 165. [8] *Ibid.*, i, p. 188. [9] *Ibid.*, i, p. 213.
[10] *Ibid.*, i, p. 216. [11] *Ibid.*, i, p. 285. [12] *Ibid.*, i, p. 390.

Annesgrove, Co. Cork: Potatoes, wheat or bere, oats, oats, oats, "leave it for three or four years."[1]

Arbella, Co. Kerry: Potatoes, potatoes, wheat or barley, oats, oats, oats, oats, "lay it out, and not a blade of grass comes for three or four years."[2]

There are occasional references to hollow draining, turnips and clover. At Annsgrove "neither pease, beans, nor rape in the country, but turneps and clover are creeping in among gentlemen."[3] Rundale and changedale were common. At Annsgrove "The poor people in general occupy from 10 to 15 acres; but the most common way is hiring in partnership in rundale; and they have changedale also."[4] In some parts rape was grown, and there is a reference to the seed being pressed for oil: "It is pressed for oil at the mills of Six Mile Bridge and Scariff, near Killaloe; but the greatest part is bought up by the merchants of Limerick for exportation for Holland. . . . The rape cakes are all exported to England for manure."[5]

Perhaps the most fateful of all the crops ever brought into Ireland is the potato. Sir Walter Raleigh is generally credited with having introduced it about the end of the sixteenth century, and the circumstantial story of his gardener who sent in the fruit instead of the tubers to be cooked is well known. But Raleigh has rivals. The Spanish Armada, for a wonder, was not one; but tradition supplied him with others, "one of the most probable of which" was "a trading vessel on her return from a transatlantic voyage . . . wrecked on the Galway coast," while more reliable authorities mention "a sea captain, John Hawkins, who had brought it[6] with him from Santa Fé" in 1545.[7]

There is no great need, however, to decide exactly when the potato came to Ireland or by whom it was brought; but, if Raleigh was its original introducer, then its cultivation must have spread through the country with marvellous rapidity; for by the middle of the seventeenth century it had taken a very important place in the national food-supply.

Indeed, it might be said that the introduction of the potato was one o the many turning points in Irish history. It came in early in the Plantation times and its value was discovered by those who had been transplanted before the transplantings were well over. Without this discovery the people would have been coerced into the employment of the planters. But, with the run of some rough grazing and an acre of hillside or bog on the outskirts of the planter's farm, that is with the cow in summer and the potato in winter, they could so far maintain themselves and their families that, until

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[1] Young, i, p. 297. [2] *Ibid.*, i, p. 367. [3] *Ibid.*, i, p. 297. [4] *Ibid.*, i, p. 299. [5] *Ibid.*, i, p. 286.
[6] This may have been the sweet potato. [7] Wilson's Farm Crops, ii, p. 18.

the days of congestion at any rate, employment with the planter was by no means an absolute, or, at any rate, a constant necessity. At the same time it forced, or, at any rate, accustomed, the farmer to that casual and uncertain labour living outside his boundaries and beyond his control which has had, and still has, so much to say to the inefficiency of Irish agriculture.

A few quotations set down in chronological order will show how widely and how quickly the potato came into cultivation in the seventeenth century, while a glance back at the rotations quoted from Arthur Young will show that, in his day, the potato was a comparatively unimportant crop with the larger farmers. It had not yet become an article of commerce. It was the crop of the people: the anchor that held them to the soil.

1649–53. *Cole*: In England potatoes "have been planted in many of our gardens, where they decay rather than increase; but the soyle of Ireland doth so well agree with them, that they grow there so plentifully that there be whole fields overrun with them, as I have been informed by divers souldiers which come from thence."[1]

1654. *General Fleetwood*, in a letter to Secretary Thurloe, speaks of "The condition of Ireland being to live much upon their potatoe-gardens."[2]

1672. *A Writer* (*Dr. Beale ?*) in the "Philosophical Transactions" of 1672, after referring to a dearth in London in 1629–30, says: "But potadoes were a relief to Ireland in their last famine; they did yield meat and drink."[3]

1672. *Sir William Petty*: "Six out of every eight of the Irish feed chiefly on milk and potatoes."[4] "The diet of these people is Milk, sweet and sower, thick and thin, which also is their drink in Summer-time; in Winter, Small-Beer or Water. But Tobacco taken in short Pipes, seldom burnt, seems the pleasure of their Lives, together with Sneezing, inasmuch that $\frac{2}{7}$ of their Expence in Food, is Tobacco. Their Food is Bread in Cakes, whereof a Penny serves a Week for each; Potatoes from *August* till *May*, Muscles, Cockles, and Oysters, nere the Sea; Eggs, and Butter made very rancid by keeping in Bogs."[5]

Referring to their "lazing," Petty says:—

"For what need they to Work, who can content themselves with Potato's, whereof the Labour of one Man can feed forty."[6]

"There being every where store of Fish and Fowle; the ground yielding excellent Roots (and particularly that bread-like root Potatoes)."[7]

1699. *Haughton*: The potato "has thrived very well and to good purpose,

[1] Quoted in a paper by Sir William Wilde in the Proceedings of the Royal Irish Academy, vol. vi, from Cole's "Adam out of Eden," published 1657.

[2] Thurloe Papers, ii, p. 602. [3] Quoted from Wilde's paper.

[4] Political Anatomy, in Hull's edition of Petty's Economic Writings, page 156.

[5] *Ibid.*, p. 191. [6] *Ibid.*, p. 201. [7] *Ibid.*, p. 273.

for in their succeeding wars, when all the corn above ground was destroyed, this supported them; for the soldiers unless they dug up all the ground where they grew, and almost sifted it, could not extirpate it."[1]

1699. *John Dunton*: "Behind one of their cabins lies the garden, a piece of ground sometimes of half an acre, or an acre; and in this is the turf-stack, their corn, perhaps two or three hundred sheaves of oats, and as much pease; the rest of the ground is full of their dearly beloved potatoes, and a few cabbages, which the solitary calf of the family, that is here pent from its dam, never suffers to come to perfection."[2]

Having brought this rough sketch down to comparatively recent times, we may now return to Clare Island. Unfortunately, the island itself affords very few data from which a history could be written. Practically the oldest sure and reliable foundation is to be found in the early Ordnance Survey maps, published about 1840. On the six-inch map the island is dotted with fifteen or twenty little hamlets lying round the eastern and southern slopes near the junction of the mountain and the arable land at a considerable distance from the sea. What were these hamlets, and why were they so placed? The scattered clustering of the houses and the irregularity of the small fields near the hamlets, with no sign of any attempt to set-off the land in rundale or stripes or squares, carries one back to early Celtic times, in which the plough was not thought of. But it may be that Clare Island is a comparatively modern settlement, in which the need for a plough did not arise in the minds of the settlers. If they had been pushed out from somewhere on the mainland even as late as the first plantations, it must not be assumed they would have carried ploughs along with them.

The story of Queen Granuaile, however, prescribes an earlier date than the one just suggested, although the peculiar inland position of the hamlets becomes a disturbing element. Had the settlement taken place long before Elizabeth's time, the people must have relied to some extent upon the sea for a food-supply; or, if they were not originally a fishing people, their natural increase must have driven them downwards towards the shore. To explain the case, it might even be suggested either that the people were driven inwards as a protection against the Norsemen or other sea-rovers, or that the chiefs had appropriated the land near the shore and driven the people up towards the mountains. Still more plausible it might be that a planter had acquired the low-lying land and allowed the people to exist along his boundary, or that, on the advent of the potato, the people had deserted the sea and built their hamlets on spots that would be equally convenient to the

[1] Quoted by Wilde from Haughton's "Husbandry and Trade Improved."
[2] Errors and Life of John Dunton, vol. ii, p. 606.

arable and the mountain land: but we have no criteria by which any one of these suggestions may be tested.

And no assistance can be got from the people themselves. There they are, an English-speaking population, with little knowledge of their own history further back than the famine and none as to their ancestors of two or three hundred or even a hundred years ago. That they must have spun and woven their own wool for many and many a year cannot be doubted. They do so still, for there are two weavers on the island; and carding, spinning, thickening, and finishing are done at home. But there is now no sign of growing flax and manufacturing linen. They must have lived to some extent on their cattle, sheep, and swine; they must have carried stuff up and down the hill-sides upon their ponies' backs; they must have grown patches of potatoes and oats and barley; and they must have ground their own grain, and perhaps even made some malt, before the American "yellow meal"[1] came in just after the famine. There are traces of a water-mill on the stream that runs into the sea at Portlea; and Mr. McCabe, the hotel-keeper on the island, writes that "the people used their own hand-mills and ground their own corn up to 1870."

Reduced in numbers by the famine and by the emigration to which agricultural and pastoral land has been subject since the invention of the railway and the steamboat and the introduction of machinery into agricultural production, the people have each now a larger share of the island. Having a market on the mainland they now find it convenient to raise stock and to exchange these for manufactured goods in return. At the same time they add to their income by taking part in the autumn herring and mackerel fishing, by lobster fishing, in which about three-fourths of the islanders engage, and by burning kelp, of which about thirty tons[2] are exported annually. For kelp-burning as well as for manuring the land, sea-weed is collected in the coves and bays from November to February and cut from the rocks during March, April, and May.

Twenty years ago the Congested Districts Board rearranged the holdings on a large part of the island. The mountain land was fenced in by a stone wall: and the low-lying land was split up so that each farmer had all his land together. In some parts, especially along the southern side, a farm strip runs from the mountain down to the sea. Each farmer has from fifteen to twenty acres of arable ground down below and a right of grazing for so many cattle or sheep upon the mountain.

If we take one farm with seventeen acres below, we shall see how the farmer works. Of these seventeen acres he tills about three. This area is

[1] Indian meal. [2] Formerly, when kelp was dearer, much more was burnt.

divided in two halves; and each half grows oats and potatoes year about for eight or ten years. At the end of that time a new patch is broken up and the patch that has been tilled is left down to pasture. Till recently it was the custom to let the patch sow itself; but now mixtures of grass and clover seeds are sometimes sown down. The remaining fourteen acres are grazed by the farmer's cows and calves and by the pony, if he have one.

Here and there some barley and a small quantity of rye are also grown; there are a few patches of turnips; and recently mangels have been tried. This, of course, means drill cultivation.

The land is manured as follows:—The stubble or grass intended for potatoes is heavily manured with seaweed in November, and again in spring.[1] Ridges from six to ten feet wide are then marked out; and two or three feet of a trench is dug out between them: the dug-out soil being thrown on the ridges to cover the manure. When the potatoes are planted, dung is also added; and, when they appear above the ground, a little more soil from the trench is spread over them.

This farmer's stock is usually two cows; two calves which are sold when they are from fifteen to eighteen months old; thirty sheep; a pony mare which rears a foal nearly every year; and one or two pigs. Indian meal is bought to fatten the pigs.

His annual export is approximately as follows:—

2 yearling cattle, value	. .	£10	5	0
12 sheep,	„ . . .	7	4	0
2 pigs,	„ . . .	9	0	0
1 foal,	„ . . .	4	10	0
60 lbs. of wool,	„ . . .	1	10	0

Mr. Kilgallon, who was instructor in agriculture on the island till recently, estimates the annual total export of agricultural produce as follows:—

45 one-year-old cattle, value	.	£225	0	0
55 two-year-old cattle,	„ .	385	0	0
25 three-year-old cattle,	„ .	235	0	0
5 cows,	„ .	40	0	0
300 sheep,	„ .	180	0	0
120 pigs,	„ .	540	0	0
26 horse foals,	„ .	117	0	0
Wool[2]	„ .	100	0	0
		£1822	0	0

[1] The seaweed thus used is about three times as much as the quantity of farm-yard manure.

[2] An equal quantity is kept in the island to be woven into cloth.

To this has to be added about £250 from the fishing and about £105 from the kelp-burning.

At the same time Mr. Kilgallon says that there are usually imported annually about twenty young calves, five rams, one or two cows and occasionally a bull; as well as seed potatoes, oats, rye, mangels, turnips, and grasses, chiefly perennial rye-grass, and red clover. Young pigs are also imported.

It ought to be mentioned that very little can now be learned from the live stock on the island. They are now what the male stock brought in by the Congested Districts Board have made them. A few of the cattle show that there is Longhorn blood in them, and from this we might infer that the old island stock was swamped by Longhorns imported from the mainland in the eighteenth, perhaps the nineteenth, century; but for the most part they show strong traces of the recently imported Galloways. The sheep show faint indications of an older breed somewhat similar in character to the modern Welsh; but the ponies are indistinguishable from the Connemara pony of the mainland.

For the assistance of others engaged in the Survey of Clare Island the following may be set down as approximately the dates for the introduction to Ireland of the plants and animals referred to:—

Oats: near the beginning of the Christian era. *Barley*: about the time of the Roman invasion of Britain. *Rye*: either the same date as for the oat or as late as the thirteenth or fourteenth century. *Wheat*: anywhere from the time the Romans were in Britain till the twelfth or thirteenth century, but most probably after Strongbow's invasion. *Potatoes*: the end of the sixteenth century. *Turnips*: the eighteenth century. *Red Clover*: ditto. *Lucerne*: ditto. *Sainfoin*: ditto. *Italian Rye Grass*: ditto. *Swedes*: 1790. *Mangels*: 1790. *Hornless Cattle*: the ninth century. *Longhorns*: the seventeenth century. *Red Cattle*, from the south of England: the seventeenth century. *Shorthorns*: 1760. *Herefords*: 1760. *Aberdeen-Angus*: 1840. *Long-woolled Sheep*: the seventeenth century.

The writer of this paper wishes to express his deep indebtedness and thanks to the following gentlemen for invaluable suggestions and criticisms: Dr. L. C. Purser, F.T.C.D., and Professor J. I. Beare, F.T.C.D.; Mr. A. E. Quekett, M.A. (Oxon.); and Professor Carl Marstrander, of the School of Irish Learning.

He has also to express his sincere thanks to Messrs. M'Cabe and Kilgallon, of Clare Island, for information about the island in the present day, and, above all, to the librarians and attendants in the National Library of Ireland, for their constant and unfailing courtesy and kindness.

6

CLIMATOLOGY.

By W. J. LYONS.

Plates I–II.

Read January 12. Published February 23, 1914.

Introduction.

The scientific survey of Clare Island and district has resulted in a collection of knowledge as to the flora and fauna of a particular area which is probably unique. The full significance of the work will only appear when the facts that have been established are co-ordinated and correlated and interpreted broadly with reference to such subjects as ecology, dispersal, and geographical distribution. In any attempt towards such correlation the conditions of climate which obtain over the area in question will claim attention and reliable knowledge as to such conditions must be available.

The present report is intended accordingly to serve as an appendix to the biological memoirs on Clare Island. It cannot claim to be a contribution to meteorological science. With this point in view it was considered to be more satisfactory to base the report on the comparatively few and poor records available for the district than to attempt to draw doubtful conclusions from a study of what might be regarded as the meteorological factors in operation over the area.

The following elements of climate are considered :—

1. Winds.
2. Barometric Pressure.
3. Air Temperature.
4. Humidity.
5. Rainfall.
6. Sunshine.

The author begs to acknowledge here the assistance he received in the preparation of the report from the Department of Agriculture and Technical Instruction for Ireland, the Board of Irish Lights, the Meteorological Office, London, and the British Rainfall Organization.

1. Winds.

The present report on the winds of Clare Island is based on the light-keeper's observations as officially recorded in the Weather Journals of the Clare Island lighthouse. The Weather Journals placed at our disposal were such as to give a satisfactory record for not more than 17 years, viz. 1894

to 1910 inclusive. The observations which are made at noon, 4 p.m., 8 p.m., midnight, 4 a.m., and 8 a.m., give the direction to sixteen points, and the intensity on the Beaufort scale. The accuracy of these observations, notwithstanding the official instruction that the lightkeeper "should be prepared to swear to it in a Court of Justice at any time," is unfortunately from the scientific standpoint not very satisfactory. No instruments were used in making the observations; and of course the personal equation in its fullest sense must have played an important part. This was made evident in many ways in the course of the study of the records; thus, for example, as regards observations on direction, we find, on summarizing the six daily returns for the month of June extending over seventeen years, the following numbers for the sixteen points of the compass:—

N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.
489	6	145	14	291	29	151	18	283

SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.	Calm.
36	429	53	536	47	414	59	60

It will be seen that the main points N, NE, E, SE, S, SW, W, NW were unduly favoured by the observer at the expense of the intermediate directions. A corresponding lack of discrimination was found in the records of the intensity of the wind according to the Beaufort scale.

This scale, it might here be pointed out, represents, by numbers from 0 to 12, the intensities of winds from a calm to a hurricane. The following table gives the description and velocity of wind corresponding to the Beaufort number as recently[1] decided and accepted by meteorological authorities:—

Beaufort Number.	Description of Wind.	Velocity in miles per hour.
0	Calm.	Less than 1.
1	Light air.	1–3
2	Slight breeze.	4–7
3	Gentle breeze.	8–12
4	Moderate breeze.	13–18
5	Fresh breeze.	19–24
6	Strong breeze.	25–31
7	High wind.	32–38
8	Gale.	39–46
9	Strong gale.	47–54
10	Whole gale.	55–63
11	Storm.	64–75
12	Hurricane.	Above 75.

[1] See Meteorological Office Handbook for Observers.

In the analysis of the lighthouse records we have considered wind direction from only eight points; and we have divided the intensities into three grades, viz.:—

Beaufort number.	Description.	Velocity in miles per hour.
0 to 3 inclusive.	Calm to gentle breeze.	0 to 12
4 ,, 7 ,,	Moderate breeze to high wind.	13 to 38
8 ,, 12 ,,	Gale to hurricane.	Above 39

With those broad divisions it is reasonable to regard the observations as quite satisfactory for our purpose.

The study of the wind records was conducted with the following objects in view:—

(*a*) To determine for each month the relative frequencies of the winds from the eight main points.

(*b*) To determine for each month the relative frequencies of each grade of intensity of the wind in each of the eight directions.

(*c*) To consider in general and for each month whether winds of any particular intensity (i.e. light, moderate, or strong) were more frequent by day (8 a.m., noon, 4 p.m.) than by night (8 p.m., midnight, 4 a.m.).

(*d*) To consider whether in passing from day to night there was evidence of any general tendency for winds to change in intensity or in direction.

The reduction of the observations was effected in the following way. The six records for each day of each month were transferred from the weather journals, and entered so as to distinguish between day and night observations, and to classify the intensity in one of the three grades already specified. The records were in the first place referred to the sixteen points as regards direction; then the number of occurrences of wind from an intermediate point—*e.g.* ENE.—was divided equally between the two corresponding main points NE. and E. In attempting to reduce the occurrence-frequencies to percentages in a uniform way, it was noted that the four months with thirty-one days gave $6 \times 31 \times 17$ or 3162 records in all, whereas the months of thirty days gave only $6 \times 30 \times 17$ or 3060 records. The numbers for these latter months were in each case increased in the ratio of 3162 to 3060, so as to bring all the months to a common value for comparison.

TABLE I.—*The Frequency of Occurrence of Winds in Percentages for each Month.*

	—	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
JANUARY,	Light,	2	1	4	2	3	4	2	2	1
	Moderate,	5	3	7	6	12	15	13	9	—
	Strong,	—	—	—	—	—	**2**	**3**	**4**	—
		7	4	11	8	15	21	18	15	1
FEBRUARY,	Light,	5	3	6	3	3	3	3	4	2
	Moderate,	4	2	7	5	10	13	12	7	—
	Strong,	—	—	—	—	**1**	**2**	**3**	**2**	—
		9	5	13	8	14	18	18	13	2
MARCH,	Light,	5	3	6	2	3	4	5	2	1
	Moderate,	8	4	6	2	8	13	15	9	—
	Strong,	—	—	—	—	—	—	**2**	**2**	—
		13	7	12	4	11	17	22	13	1
APRIL,	Light,	4	4	6	2	5	5	5	3	1
	Moderate,	6	2	7	4	9	12	12	10	—
	Strong,	—	—	—	—	—	—	**2**	**1**	—
		10	6	13	6	14	17	19	14	1
MAY,	Light,	8	5	10	3	5	6	6	6	2
	Moderate,	8	2	5	2	5	8	11	7	—
	Strong,	—	—	—	—	—	—	—	**1**	—
		16	7	15	5	10	14	17	14	2
JUNE,	Light,	10	4	7	4	4	8	10	7	2
	Moderate,	7	1	3	2	6	8	9	8	—
	Strong,	—	—	—	—	—	—	—	—	—
		17	5	10	6	10	16	19	15	2

The accompanying tabular statements (Tables I and II) give for each month the percentage-frequency of occurrence of winds of each of three degrees of intensity for each of the eight main directions. The same results

TABLE II.—*The Frequency of Occurrence of Winds in Percentages for each Month.*

	—	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
JULY,	Light,	7	2	6	2	4	9	12	8	2
	Moderate,	5	1	2	1	6	11	12	10	—
	Strong,	—	—	—	—	—	—	—	—	—
		12	3	8	3	10	20	24	18	2
AUGUST,	Light,	6	2	5	2	5	8	9	5	1
	Moderate,	5	2	3	2	5	12	15	11	—
	Strong,	—	—	—	—	—	—	**1**	**1**	—
		11	4	8	4	10	20	25	17	1
SEPTEMBER,	Light,	7	3	9	5	5	8	7	3	1
	Moderate,	4	1	5	5	7	8	12	8	—
	Strong,	—	—	—	—	—	—	**1**	**1**	—
		11	4	14	10	12	16	20	12	1
OCTOBER,	Light,	5	3	7	4	3	5	4	2	—
	Moderate,	7	4	11	5	6	9	12	9	—
	Strong,	—	—	—	—	—	—	**2**	**2**	—
		12	7	18	9	9	14	18	13	0
NOVEMBER,	Light,	4	4	7	4	4	4	3	2	—
	Moderate,	5	3	8	4	8	10	14	11	—
	Strong,	**1**	—	—	—	—	—	**2**	**2**	—
		10	7	15	8	12	14	19	15	0
DECEMBER,	Light,	2	1	5	3	3	4	3	1	1
	Moderate,	4	2	8	7	10	13	14	11	—
	Strong,	—	—	—	—	—	**1**	**3**	**4**	—
		6	3	13	10	13	18	20	16	1

are represented graphically in Plates I and II; but in this case the storms or strong winds are not separately represented on account of their rare occurrence. Such winds are in the plates added to and considered with the

winds of Class II as moderate. It will be seen on inspection that the length of the thick portion of the radial line, as measured from the inner circle, represents the percentage-frequency of the moderate and strong winds, and the length of the thin line measured from the end of the thick one represents the percentage-frequency of the light winds.

TABLE III.

The Frequency of Occurrence of Winds of different Intensity as Percentages for each Month.

—	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual.
Light, .	21	32	31	35	51	56	52	43	48	33	32	23	38 %
Moderate,	70	60	65	62	48	44	48	55	50	63	63	69	58 ,,
Strong, .	9	8	4	3	1	0	0	2	2	4	5	8	4 ,,

Conclusions.

A study of the tables and graphs will show that :—

1. The most prevalent winds are those from the W., SW., and NW.
2. The SW. is particularly prevalent in January and February.
   The N. is particularly prevalent in May and June.
   The E. is particularly prevalent in May, September, and November.
3. The wind is more frequently moderate than light, except in the months of May, June, and July. (See Table III.)
4. Moderate and strong winds are particularly prevalent in January and December.
5. Strong winds or storms occur most frequently in January, February, and December. They are rare in June and July, in which months also the light winds are more prevalent than the moderate (see Conclusions, section 3).
6. Calms are rarely recorded in October and November.
7. Strong winds or storms are most frequently from the NW. in January and December, and from the W. in January, February, March, April, October, November, and December. They usually occur from the S. only in February, and from the N. only in November.

It has been mentioned previously that an investigation into these wind

records was made for the purpose of determining if strong winds are more or less frequently recorded by night than by day, and if any evidence existed to show a general tendency towards a change in intensity or in direction of the wind in passing from day to night. A definite decision on these points would be of considerable meteorological importance, and would also be of general interest. It seems that popular opinion is inclined to the view that the wind drops in intensity towards the evening, and yet that severe storms are more frequent at night.

The following tables, which embody the results of our analysis of Clare Island records, would seem slightly to support the latter view, but not to justify the former. It is, moreover, evident that there is no very striking difference between day and night as regards the prevalence of strong winds; nor is there evidence of any marked tendency of the wind to change in direction or in intensity at nightfall. The results are, however, sufficiently significant to merit consideration.

TABLE IV.

The Percentage-Frequency for each Month and for the Year of Winds of different Intensity by Day and by Night.

—	Jan.			Feb.			Mar.			Apr.			May.			Jun.		
Day, . .	11	35	4	16	30	4	15	32	3	18	31	1	25	24	1	28	22	0
Night, . .	10	35	5	16	29	5	16	31	3	17	31	2	25	24	1	28	22	0
—	Jul.			Aug.			Sep.			Oct.			Nov.			Dec.		
Day, . .	26	24	0	21	28	1	24	25	1	18	30	2	17	31	2	12	34	4
Night, . .	26	24	0	22	27	1	23	26	1	17	31	2	16	31	3	11	34	5
	L.	M.	S.	L.	M.	S.	L.	M.	S.	L.	M.	S.	L.	M.	S.	L.	M.	S.

	Light.	Moderate.	Strong.
Annual Day,	19·2	28·8	2·0
Night,	18·9	28·8	2·3

Table IV shows the percentage-frequencies of the winds of each of the three grades of intensity for the day and the night periods for each month. The light and moderate winds are practically equally distributed over day and night. The strong winds were found in the case of each month (excepting

July, when they were equal) to have occurred more frequently by night than by day; but the difference was such as not to always appear in the small numbers that expressed, as a percentage, the frequencies of such winds.

A study of the changes in intensity between 12 noon and 12 midnight, each day, gave the results expressed as percentages shown in Table V.

TABLE V.

Cases of Change of Intensity between 12 *noon and* 12 *midnight.*

	Percentage.			
	↓	—	↑	
January, . .	25	35	40	
February, . .	27	31	42	
March, . .	29	36	35	
April, . .	25	39	36	
May, . .	31	31	38	
June, . .	30	40	30	
July, . .	25	42	33	
August, . .	27	39	34	
September, . .	31	38	31	
October. . .	25	38	37	
November, . .	25	37	38	
December, . .	26	31	43	
	12) 326	437	437	1200
Annual, . .	27	37	36	100

↓ Means *fall* in intensity.

↑ ,, *rise* ,,

— ,, no change in intensity.

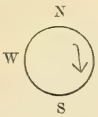
It will be seen that no change in intensity occurs, on an average, in about 37 per cent. of cases. The changes are, on the whole, more frequently in the form of an increase in intensity towards night, especially in the winter months, January, February, November, and December.

The changes in direction of the wind in passing from noon to midnight were studied next and are represented in Table VI. No change is recorded in 50 per cent. of cases on an annual average, and of the changes, 28 per cent. are clockwise, and 22 per cent. anti-clockwise. A change in direction occurs most frequently in February, March, and December. The excess of clockwise changes over anti-clockwise changes is most marked in January, February, and September.

TABLE VI.

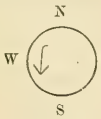
Table showing Percentage-Frequency of Change of Direction, irrespective of Intensity, between 12 noon and 12 midnight.

	↓	—	↓	
January, . .	28	52	20	
February, . .	32	46	22	
March, . .	30	48	22	
April, . .	25	52	23	
May, . .	22	55	23	
June, . .	25	55	20	
July, . .	24	53	23	
August, . .	29	49	22	
September, . .	29	53	18	
October, . .	29	49	22	
November, . .	27	50	23	
December, . .	30	43	27	
Annual, . .	330	605	265	1200
Summary, .	28°/₀	50°/₀	22°/₀	100

↓ Means 

clockwise on this diagram.

— Means no change or calms.

↓ Means 

counter-clockwise on this diagram.

The well-known effects of land- and sea-breezes are not manifest in the above summaries. This may be accounted for easily by the fact that the prevailing winds are westerly, and, as such, would obscure any sea-breeze effect by day which would have the same direction. The land-breeze at night, on the other hand, would scarcely become evident in direct opposition to the prevailing wind from the west. We have seen that these prevailing

winds are usually of moderate intensity: and it is well known that the land-breeze at night is usually gentle as compared with the sea-breeze by day. It is interesting to note that Table VI represents the summer months to be those in which changes in direction of wind least frequently occur, and in which the changes that do occur are almost as much in one direction as the other. In these summer months the land- and sea-breezes should be most marked.

In concluding the report on the winds the author would point out that the very laborious analysis of the records was done by Mr. James Lowry, B.SC. (LOND.), A.R.C.S.I., who exercised the greatest care and exceptional ingenuity in the work.

2. Barometric Pressure.

The numbers in Table VII refer to Blacksod, and were obtained from the manuscript copies of the monthly summaries for that station. The mean values for Clare Island would in the case of each month be slightly in excess of those for Blacksod. The monthly means are characterized by the low values for December, January, and February, and by the high values for May and June as compared with those for Dublin and other stations in approximately the same latitude in the British Isles.

3. Air Temperature.

In the absence of any satisfactory temperature records for Clare Island it was found necessary to refer for the present report to the very complete records of Blacksod. Blacksod is a Telegraphic Normal Climatological station. The results set out in the accompanying tables were obtained from manuscript copies of monthly summaries which were kindly lent to me by the Director of the Meteorological Office, London. The summaries for Blacksod could lay claim to such a high degree of accuracy and reliability, and the proximity to Clare Island is such, that it was decided to give in detail in this report the temperature statistics for Blacksod rather than attempt a general and problematical deduction of the corresponding values for Clare Island. This decision was further justified by a study of the Temperature Charts of the British Isles.[1] The mean monthly isotherms, with certain exceptions, have such a form as to suggest that the mean values for Clare Island differ but slightly from those of Blacksod. These differences

[1] See Meteorological Atlas of the British Isles (Official Publication of the Meteorological Office, No. 53).

TABLE VII.

BAROMETRIC PRESSURE (inches).

Readings taken at 7 a.m., *and reduced* to 45° Latitude. 0° C. and Mean Sea-Level.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Annual.
Mean monthly.—Taken over 35 years (1871-1905).	29·871	29·880	29·872	29·879	29·979	29·975	29·942	29·896	29·920	29·868	29·845	29·818	29·895
Highest value of monthly mean, .	30·274 (1907)	30·299 (1891)	30·105 (1901)	30·166 (1893)	30·334 (1896)	30·178 (1887	30·172 (1898)	30·090 (1896)	30·226 (1894)	30·117 (1890)	30·144 (1901)	30·128 (1885)	29·983
Lowest value of monthly mean, .	29·600 (1890)	29·396 (1885)	29·498 (1897)	29·692 (1885)	29·716 (1885)	29·837 (1900)	29·747 (1888)	29·696 (1891)	29·657 (1896)	29·425 (1903)	29·600 (1888)	29·577 (1903)	29·779

Small figures in brackets indicate the year.

may be approximately estimated from the Isothermal Charts, and lead to the following rough corrections to be applied to the mean monthly temperature for Blacksod so as to give the corresponding values for Clare Island :—

January,	0·0° F.	July,	0·0° F.
February,	− 0·2	August,	0·0
March,	0·0	September,	+ 0·4
April,	+ 0·1	October,	0·0
May,	+ 0·2	November,	− 0·2
June,	+ 0·1	December,	0·0

The differences for the means of maximum and minimum and the values of absolute maximum and minimum would not necessarily be of the same order.

In consideration of the general scope of the work of the survey of Clare Island the temperature statistics considered were the following :—

A. The mean monthly temperature.
The highest and lowest values recorded for the monthly means and the years when such extreme values occurred.

B. The mean monthly maximum temperature.
The highest and lowest values recorded for the mean monthly maximum and the years when such occurred.

C. The mean monthly minimum temperature.
The highest and lowest values recorded for the mean monthly minimum and the years when such occurred.

D. The highest and lowest values of the absolute maximum temperature for each month and the years when such were recorded.

E. The lowest and highest values of the absolute minimum temperature for each month and the years when such were recorded.

The mean values were taken for a period of thirty-five years from 1871 to 1905. The Blacksod records did not extend over all this period, but the values were worked up by comparison with the stations of Ardrossan and Valencia.

The highest and lowest values in each case were taken over a period extending up to 1910 inclusive.

The results are given in Table VIII.

TABLE VIII.

—	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual.
Mean Temperature, . . .	**42·8**	**42·9**	**43·8**	**47·2**	**51·0**	**56·1**	**58·1**	**58·2**	**55·6**	**50·1**	**45·9**	**43·3**	49·6
,, ,, Highest,	46·5	46·1	47·3	51·0	55·8	60·2	60·1	62·9	59·3	55·4	49·8	47·2	51·0
Year,	1898	1891	1893	1893	1893	1887	1887	1899	1895	1908	1908	1898	1893
,, ,, Lowest,	38·5	34·8	40·0	44·2	47·3	52·5	55·7	56·3	53·1	45·8	42·5	39·3	48·0
Year,	1895	1895	1892	1897	1885	1907	1890	1889	1892	1896	1910	1890	1885
Mean Maximum, . . .	**46·6**	**47·1**	**48·3**	**51·9**	**55·8**	**60·8**	**62·3**	**62·3**	**59·7**	**54·2**	**49·8**	**47·2**	53·8
Highest,	50·0	50·4	51·8	56·1	60·8	66·9	65·0	68·6	64·0	57·9	53·6	50·8	55·6
Year,	1898	1891	1893	1893	1893	1887	1897	1899	1895	1898	1899	1898	1893
Lowest,	42·5	39·7	44·4	48·7	52·4	57·9	59·7	59·7	56·8	50·1	47·5	43·2	52·0
Year,	1895	1895	1888	1888	1902	1890	1890	1889	1892	1892	1887 1891 1910	1890	1885
Mean Minimum, . . .	**38·9**	**38·7**	**39·2**	**42·5**	**46·1**	**51 3**	**53·9**	**54·0**	**51·5**	**45·9**	**41·9**	**39·4**	45·3
Highest,	43·0	42·0	42·8	45·9	50·7	53·6	56·3	57·1	54·6	48·4	45·4	43·5	46·3
Year,	1898	1896	1893	1893	1893	1893	1887	1899	1895	1890	1899	1898	1893
Lowest,	34·1	29·8	34·8	37·7	43·3	49·7	51·7	51·4	49·4	41·5	39·0	35·2	43·8
Year,	1897	1895	1892	1897	1891	1894 1898	1890	1904	1894	1896	1893	1896	1892
Absolute Maximum, Highest, .	**56·0**	**61·0**	**64·0**	**71·0**	**75·0**	**82·0**	**80·0**	**78·0**	**78·0**	**71·0**	**60·0**	**59·0**	82·0
Year,	1890	1891	1894 1899	1893	1890	1887	1894	1894	1896	1898 1908	1897 1899	1899	1887
Lowest,													
Year,	49·0 1895	48·0 1895	51·0 1888 1903 1908	53·0 1889 1904	57·0 1885	63·0 1885	64·0 1890 1903	63·0 1896 1903	60·0 1892	54·0 1892	51·0 1887 1891	51·0 1887	48·0 1895
Absolute Minimum, Lowest, .	**20·0**	**24·0**	**26·0**	**29·0**	**34·0**	**40 0**	**42·0**	**42·0**	**39·0**	**29·0**	**26·0**	**25·0**	20·0
Year,	1894	1902	1891 1900 1909	1897	1910	1894 1907	1898	1887 1888	1899	1905	1890	1906	1894
Highest,	34·0	35·0	35·0	40·0	43·0	49·0	54·0	50·0	49·0	40·0	36·0	38·0	54·0
Year,	1898 1905 1906	1894	1893 1896 1907	1896	1889 1893	1904	1901	1896 1899	1890	1897 1898 1902	1897	1905	1901
Factors for computing a closer approximation to the true Mean Temperatures, . .	0·520	0·500	0·485	0·475	0·470	0·465	0·465	0·470	0·475	0·485	0·500	0·520	

The numbers in the last row are taken from Appendix III to the Weekly Weather Report, 1906. If the difference between the mean maximum and mean minimum for each month be multiplied by the corresponding factor, and the result added to the mean minimum temperature, a closer approximation to the true mean temperature will be obtained for each month.

General Conclusions and Remarks.

August is the warmest month as regards the mean temperature and the mean maximum and mean minimum. January is the coldest except in respect of the mean minimum temperature, which falls in February. The temperature curves for the years are remarkable for their flatness, indicating a small range of temperature-variation, especially over the months December, January, February, and March, and over the summer months June, July, and August.

The difference between the mean minimum and mean maximum is small, and is nearly constant from month to month. The highest temperature recorded is 82·0°F. in June, 1887, and the lowest is 20·0°F. in January, 1894.

4. Humidity.

The data presented in Table IX were compiled from the manuscript copies of the monthly summaries of Blacksod. The means of the dry-bulb and wet-bulb thermometers refer to readings taken at 8 a.m. for a period of thirty-five years (1871–1905). The Blacksod records began in 1899; but the means were estimated and "weighted" in the usual manner by reference to suitable stations. The values for dew-point and percentage-humidity were calculated by means of Glaisher's factors. The employment in these calculations of the differences between the monthly means of the dry-bulb and wet-bulb temperatures, instead of the monthly means of the differences, is unsatisfactory. It is, however, recognized by the Meteorological Office; and, following the rule in such cases, the percentages are only given in whole numbers. The annual humidity percentages for Valencia, and Markree Castle (Co. Sligo), are given for comparison. The values in these two cases refer to observations made at 9 a.m., and are based on a twenty-five years' record (1881–1905).

Table IX.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean Dry-Bulb,	42·7	42·5	43·3	46·6	51·2	56·3	57·8	58·0	55·4	49·7	45·8	43·4	49·4
Mean Wet-Bulb,	41·3	40·9	41·5	44·5	48·4	53·3	55·3	55·4	52·9	46·9	43·9	41·5	47·1
Difference,	1·4	1·6	1·8	2·1	2·8	3·0	2·5	2·6	2·5	2·8	1·9	1·9	2·3
Dew-Point, .	39·6	39·0	39·4	42·1	45·5	50·5	53·0	53·1	50·5	43·9	41·7	39·2	—
Percentage-Humidity,	89	88	86	84	80	81	84	84	84	80	85	85	—

Blacksod Point, . . Mean Annual Humidity = 83·0 %
Valencia, . . . ,, ,, = 84·5 ,,
Markree Castle, Sligo, . ,, ,, = 84·1 ,,

The decrease in humidity in passing from January to May, and the subsequent increase, are in accordance with observations at other stations. The variation from June to December is, however, remarkable for the slow rate of increase. The pronounced drop in humidity in October is most unusual and inexplicable, and seems open to question. It would appear, however, that the Blacksod humidity does not increase as rapidly in passing through autumn to winter as does the humidity of such stations as Valencia and Markree Castle. It is stated that fogs are unusual on the north-west coast of Ireland; and this might be connected with the lower autumn humidity.

5. Rainfall.

For the purpose of studying the rainfall of Clare Island and district reference was made to—

(*a*) The manuscript copies of the monthly summaries for Blacksod, which were supplied by the Meteorological Office.
(*b*) Appendix III to the Weekly Weather Report, 1906.
(*c*) The volumes of "British Rainfall."
(*d*) Records of gauges kept in Clare Island, 1910–1912.

The monthly summaries contained the mean monthly rainfall and mean number of rain-days per month for Blacksod, based on a twenty-five year period (1886–1910). The Blacksod observations extended only from 1899–1910, but were "weighted" by comparison with the values for Crossmolina and Enniscoe, which were given in "British Rainfall." The highest and lowest values for each month's rainfall, and the corresponding years of occurrence, were also given, as well as similar information for the number of rain-days. (See Table XI.)

In Appendix III to the Weekly Weather Report, 1906, there are given in Table II the average rainfall and average number of rain-days for each month, and of the whole year, for a large number of stations in the British Isles, including Blacksod, Markree Castle (Co. Sligo), and Valencia. The values are estimated for a thirty-five-year period (1871–1905).[1] "British Rainfall," 1911, contains the values of the total rainfall for that year at the following important stations:—Blacksod, Westport, Dugort, Crossmolina, Cong, as well as three returns for Clare Island.

[1] In the case of stations with shorter records, e.g. Blacksod Point, the averages were weighted in the usual way, "by comparing the observed fall with that for a corresponding period at a neighbouring station, possessing records for thirty-five years, and assuming that, in the long run, the amounts recorded at the two stations bear a constant percentage relation to one another (see Hann, 'Lehrbuch der Meteorologie,' ed. 1906, p. 243)."—Extract from notes to Weekly Weather Report, 1906.

In June, 1910, rain-gauges were fitted up at three places on Clare Island, viz. at the lighthouse, in charge of the lightkeeper, Mr. P. Duffy, at the Abbey, in charge of Mr. A. M'Greal, and near the hotel in charge of Mr. J. J. M'Cabe, who also attended to a recording rain-gauge. The gauges which were lent from the Royal College of Science for Ireland, by kind permission of the Department of Agriculture and Technical Instruction, had unfortunately to be removed after two years. The returns for the year 1911 were, however, very complete and of particular significance for the fact that over that part of Ireland the rainfall in 1911 was very nearly normal. In support of this view we find that the Blacksod total for 1911 was 49·36 inches, which closely agrees with the mean annual rainfall (1871–1905). The 1911 total for Westport was 46·67, the mean annual being 46·20. At Markree Castle (Co. Sligo) and at Cong the figures for 1911 differ by less than one per cent. from the mean annual values.

The following table furnishes some important data as to the annual averages and space-distribution of rainfall over the district under consideration:—

TABLE X.

Station.	Mean Annual Rainfall.	Average Number of Rain-days per year.	1911.	
			Rainfall.	Rain-days.
Blacksod Point, . .	48·93	263	49·36	186
Markree Castle, . .	4 201	248	—	—
Valencia, . . .	56·45	248	—	—
Westport, . . .	46·20	—	46·67	200
Dugort, . . .	—	—	67·89	213
Crossmolina, . .	52·87	—	—	—
Clare Island Hotel, .	—	—	47·74	217
,, ,, Abbey, .	—	—	49·98	226
,, ,, Lighthouse,	—	—	43·02	170 (?)

The numbers in the above table must be studied with due consideration of the limited accuracy of all rainfall observations, and of the numerous sources of error, personal and otherwise. The values for Clare Island lighthouse are undoubtedly too low. Small falls were frequently ignored; and the daily returns in other cases were very much at variance with the indications of the self-recording gauge at the hotel. It seems safe and

reasonable to conclude, however, that the rainfall at the Abbey is highest, and that at the lighthouse lowest; and that the low-lying district near the hotel is representative of the mean for the whole island. Those results are in accordance with the known effects on rainfall of exposure to wind and of configuration.

The average number of rain-days per annum for Blacksod is the highest quoted in the Appendix to the Weekly Weather Report, 1906, out of 119 stations in the British Isles. Clare Island, Westport, and district would appear to approximate to, if not actually to be in excess of, Blacksod in the frequency of rain. As regards amount of rainfall, however, Clare Island is probably below Blacksod. The rainfall over the sea is generally supposed to be less than over the land: and the well-known effect of mountains on rainfall would not generally appear over Clare Island. It is, however, marked in the returns from Dugort and Crossmolina.

The monthly variation and general conditions as regards means and extremes of rainfall will be best studied by reference to the numbers for Blacksod Point contained in Table XI.

The most striking feature of the above table is the second part referring to the frequency of rain in this district. The very high annual average of 266 is found to accompany the high average for practically every month. The driest months, May and June, on an average have more wet than dry days; and in the case of the wet months, December and January, we find the average number of wet days in each to be twenty-six. The highest values include several instances where every day in the month had a record of rain, and in the case of the year 1898 only on sixty days did no rain fall. The frequency of rain in this area is, however, perhaps, best emphasized in the numbers giving the lowest number of rain-days recorded in the twenty-five years from 1886 to 1910. January, March, October, and December never show less than half of the days with some rain, and the lowest number of rain-days for a year is 213 in 1896. A comparison of Blacksod and Valencia shows a parallel variation from month to month as regards annual rainfall and average number of rain-days. But, whereas the Valencia rainfall is for every month higher than that of Blacksod, the number of rain-days for the latter is always greater except in June and September, when they are equal.

The mean monthly variation during the year for Blacksod may be regarded as typical for the whole district, and presents the following points of interest. The autumn and winter months show a much higher rainfall than the spring and summer months of April, May, June, and July. December and January show the heaviest rainfall. This is in marked contrast with the mean monthly variation in Dublin, where the months of December, January, February,

TABLE XI.

RAINFALL (*over 25 years*). (*Figures indicate inches of rain.*)

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Annual.
Mean over the 25 years (1886–1910),	5·13	3·80	4·00	2·95	2·87	2·78	3·14	4·84	4·08	5·10	5·06	5·83	49·58
Highest, ...	8·73 (1890)	6·37 (1893)	7·34 (1903)	5·37 (1899)	4·65 (1900)	5·65 (1900)	4·49 (1903)	8·10 (1903)	7·65 (1896)	8·36 (1903)	8·53 (1890)	10·99 (1899)	60·89 (1903) 57·57 (1900)
Lowest, ...	2·40 (1896)	0·80 (1890)	1·57 (1898)	1·48 (1894)	0·76 (1895)	0·88 (1889)	0·73 (1898)	2·11 (1889)	0·63 (1894)	2·50 (1897)	1·92 (1896)	2·21 (1890)	42·8 (1893)

RAIN-DAYS (*over the same period*).

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Annual.
Mean of 25 years, ...	26	22	24	20	19	17	22	23	20	23	23	26	266
Highest, ...	30 (1892) (1899) (1900) (1904) (1906)	29 (1904)	31 (1902)	30 (1899)	29 (1885) (1902)	27 (1907)	29 (1894)	30 (1907)	30 (1899)	31 (1903) (1907)	30 (1898)	31 (1900) (1901)	305 (1898)
Lowest, ...	17 (1888) (1896)	10 (1896)	16 (1892) (1893)	10 (1896)	7 (1896)	7 (1887)	13 (1892) (1897)	14 (1885)	7 (1910)	16 (1910)	10 (1896)	19 (1885) (1890)	213 (1896)

and March have a small rainfall compared with July, August, October, and November, and where August is the month with the greatest average rainfall.

I conclude my remarks on rainfall by giving Table XII, showing the duration of the rainfall at Clare Island in 1911. The values are based on the daily records made by the self-recording gauge or hyetograph which was fitted up near the hotel in charge of Mr. J. J. M'Cabe. The records were subjected to a very careful analysis by Dr. H. R. Mill, Director of the British Rainfall Organization. They are in Dr. Mill's opinion the only records of the kind available so far for the whole of Ireland, and are of some interest apart from the present subject. The numbers were calculated and supplied by the British Rainfall Organization. For references I give also the monthly totals given by a standard Snowdon gauge, which was placed very near the recording gauge, and also the mean monthly totals for Blacksod Point as given in Appendix III to the Weekly Weather Report.

TABLE XII.

—	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual.
No. of hours of Rainfall at Clare Island, 1911, . . .	80·7	88·4	57·8	87·3	60·7	51·4	45·3	65·1	52·6	65·8	110·8	131·9	897·8
Rainfall by standard gauge at Clare Island, 1911, .	3·25	4·48	2·26	2·94	2·82	3·28	4·02	4·05	2·64	3·73	6·34	7·93	47·74
Mean Rainfall for Blacksod, 1871–1905, . . .	4·94	3·56	3·83	2·89	2·69	2·63	3·02	4·88	4·26	5·13	5·29	5·81	48·93

Opportunity must here be taken to express my obligation to Mr. J. J. M'Cabe, Mr. P. Duffy, and Mr. McGreal, for their undertaking the daily observations of rainfall for nearly two years. Mr. P. Duffy, the lightkeeper, was also responsible for general meteorological observations.

6. SUNSHINE.

The information available for a report on the duration of sunshine on Clare Island and district is very poor. The nearest station for which sunshine records exist is Markree Castle (Sligo); and the conditions there are such as to make a close parallel with Clare Island area quite impossible. In the official publication No. 98 of the Meteorological Office there is given a summary of "Ten Years' Sunshine in the British Isles, 1881–1890." The

following conclusions based on this analysis for 46 stations are of importance in the present case :—

(*a*) "The sea-coast receives more sunshine than the inland parts of the country. This is natural, as the sea-coasts are low, as a rule, and clouds form inland where the ground rises to hills."

(*b*) "In the summer and early autumn the north-west of Ireland and of Scotland, together with the Orkneys, receive very little sunshine."

(*c*) "In the late autumn Ireland generally receives more sunshine than most of England."

(*d*) "In January the number of hours of bright sunshine, taken as a percentage of the total possible number of hours is given as 22 for Valencia, which comes third after Jersey (25) and Aberdeen (24)."

(*e*) May is the sunniest month, except at a few of the southern stations. Thus for May, Falmouth (46), and St. Anne's Head (45) are less than for June, when they both record 47 per cent. Valencia has 44 for May and only 40 for June.

(*f*) In July the least sunny stations are Markree and Glasgow (26 per cent., and, speaking generally, the north-western and extreme northern stations are below 30.

(*g*) August is particularly sunless on the north-west of Ireland.

(*h*) In September Markree is one of the worst stations, and records only 25 per cent.

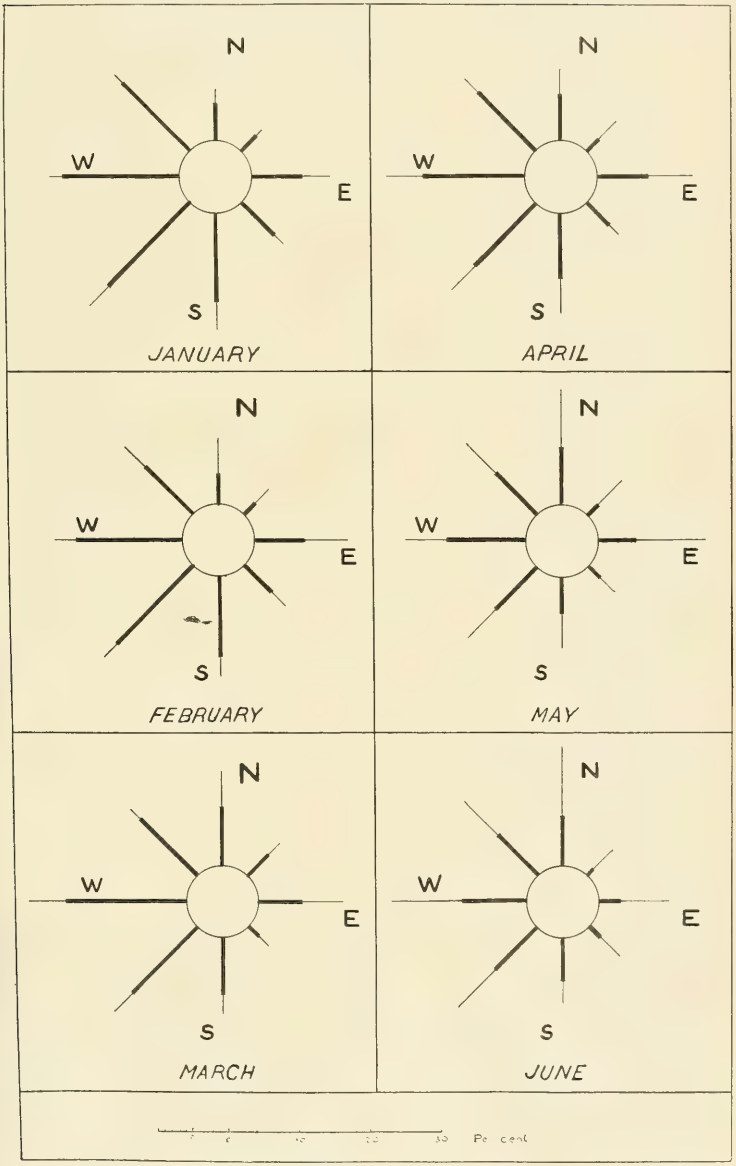
(*i*) In the months November and December the north-west of Ireland improves relatively, and becomes about as sunny as Southampton and Oxford.

The above unfavourable conclusions about the north-west of Ireland are based solely on the records of Markree Castle. These conclusions must not, however, be made to apply generally to the Clare Island district in view of the first conclusion given in section (*a*), and owing to some other considerations. The excessive prevalency of westerly winds, which bring air more or less saturated with vapour from the sea, results in almost continuous condensation over the Connemara and Achill mountains. This condensation can be seen taking place frequently from Clare Island on clear sunny days. This local condensation often results in rain, and in most cases must give rise to cloudiness over a considerable area to the east and north-east. The high sunshine returns for Valencia, Falmouth, and St. Anne's Head give much support to the view that Clare Island district is much sunnier than Markree, and more comparable with Valencia than with Sligo.

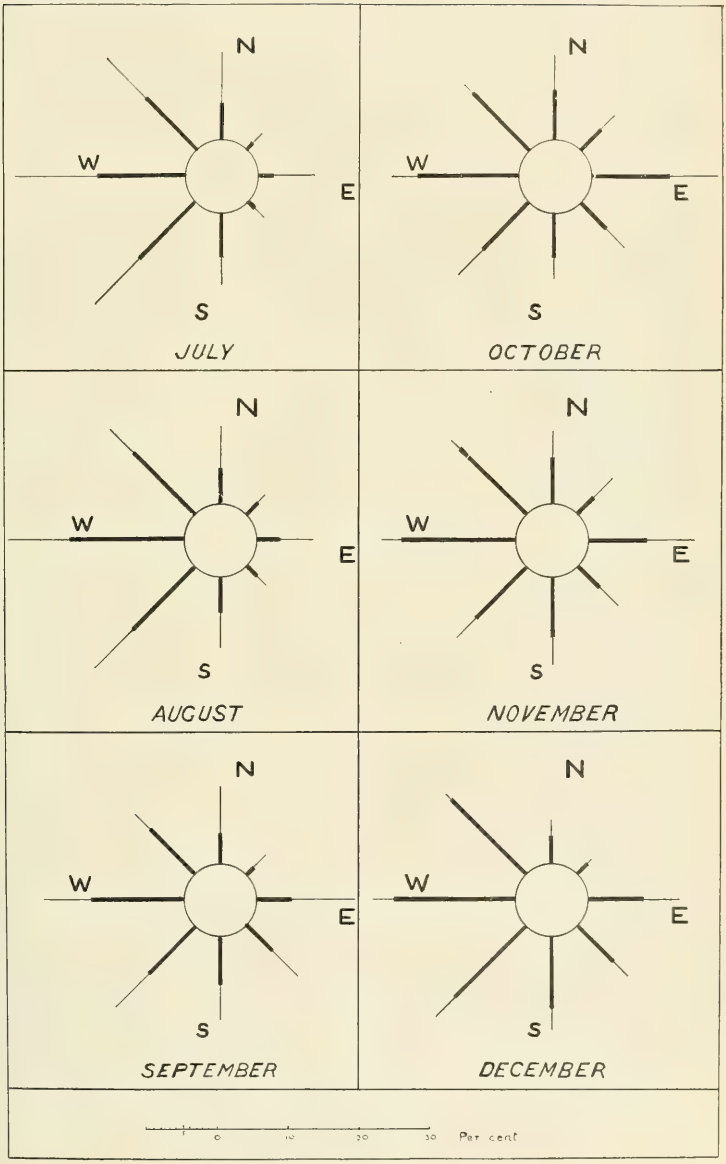
TABLE XIII.

	Jan.		Feb.		March.		April.		May.		June.		July.		August.		Sept.		Oct.		Nov.		Dec.		Annual.	
	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%	Hours	%
Average (1881–1905) number of Hours of Bright Sunshine, with percentage of possible duration—																										
At Markree Castle, . .	42	18	62	23	105	29	146	35	189	38	170	34	129	26	129	28	199	29	88	27	54	22	34	15	1257	28
At Valencia, ...	51	20	72	26	126	35	158	38	212	44	193	40	153	31	153	34	130	35	103	32	65	25	41	17	1457	33
Average percentage of days with "blue sky" at Clare Island, . . .	40		37		54		59		63		68		56		54		52		44		40		36			

The numbers in Table XIII referring to Markree and Valencia are taken from the Appendix III to the Weekly Weather Report. The last row of figures are obtained from an analysis of the Weather Journals of Clare Island Lighthouse for a period of eight years, 1903–1910. The number of instances was taken for each month in which the observer, at 8 a.m., noon, and 4 p.m., recorded (b) "blue sky" with or without hazy atmosphere or detached clouds. The totals for each month for the eight years were taken as a percentage of the total possible number of observations. The numbers thus found are given in the table. They may be taken as approximate values for what might be called "fine day" conditions. The monthly variation is fairly comparable with that of the duration of bright sunshine at Markree and Valencia; but it must be clearly recognized that the duration or occurrence of blue sky is quite distinct from that of "bright sunshine"—i.e. sunshine sufficient to leave its mark on a sunshine recorder. The maximum number of "fine days" is found in June. This result does not necessarily lead us to conclude that for Clare Island June is sunnier than May; but it may be compared with the results already quoted for Falmouth and St. Anne's Head.



Clare Island Survey.—Lyons: Climatology.



Clare Island Survey.—Lyons: Climatology.

7

GEOLOGY.

By T. HALLISSY, B.A., M.R.I.A.

Plates I–VI.

Read January 26. Published July 27, 1914.

[COMMUNICATED WITH THE PERMISSION OF THR DIRECTOR OF THE GEOLOGICAL SURVEY OF IRELAND.]

GENERAL DESCRIPTION.

Situated off the west coast of Mayo, at the entrance to Clew Bay, between the parallels 53° 47′ 15″ and 53° 49′ 45″ N. lat., and the meridians 9° 56′ 25″ and 10° 3′ 20″ W. long., Clare Island forms one of the most westerly outposts of the continent of Europe. It is separated on the south-east from the nearest point of the mainland west of Louisburgh by a strait 3 miles wide, and is $3\frac{1}{2}$ miles distant, on the N.N.E. side, from the mainland at the entrance to Achill Sound.

If we except the triangular promontory on the north, the island is roughly of the form of a trapezoid, 4 to $4\frac{1}{2}$ miles long from east to west, and about a mile and a half wide. The shape of the northern promontory is approximately that of an equilateral triangle, each side of which measures about a mile and a quarter. The entire breadth of the island from Lecknacurra to Portnakilly is $2\frac{3}{4}$ miles, and its total area slightly less than $6\frac{1}{3}$ square miles.

A marked feature of the above-mentioned promontory is the extremely rugged character of its surface. Prominent hummocks of bare or scantily covered rock stick out here and there, and deep valleys, often occupied by peat, run east and west along the general strike of the rocks. These irregularities of the ground have been determined by the differential weathering of the rocks which enter into the formation of the area, the soft shales giving rise to deep valleys and depressions, and the more resistent grits standing out as well-defined knolls and ridges.

In the trapezoidal area, the most prominent features of the landscape are two considerable hills, viz., Croaghmore (Knockmore), 1520 feet in height, on the western side, and Knocknaveen, towards the eastern end of the

island, rising to 729 feet above Ordnance datum. Both hills rise rapidly from the general level of the ground, and are separated by a fairly wide hollow, forming a gap that connects the comparatively low-lying northern and southern areas. A steep scarp along the northern side of Knocknaveen follows the course of a great zone of fracture which extends across the island from north of the harbour to the western coast.

The coast along the north and west is formed of precipitous rocky cliffs, rising to considerable elevations. One of these, at Allahan, to the west of Croaghmore, reaches the formidable height of 900 feet above the level of the sea. The cliffs of the north-east coast, composed mainly of drift (see Plate I), often attain a height of 60 or 70 feet; while those of the eastern and southern coasts are comparatively low, rarely rising above the 50-foot contour.

The island is drained by several small streams. Two of these take their rise in the watershed occupying the hollow between Croaghmore and Knocknaveen; one, the Doree River, flows northward through Lecarrow and Maum, and the other southwards through Strake, entering the sea near Pitacurry. Another larger stream, the Owenmore, drains the south-eastern slopes of Croaghmore into the sea at Ooghvunanal. The drainage of the remainder of the island is effected by five or six streamlets descending from Croaghmore and Knocknaveen, and two flowing through the townland of Ballytoohy More.

Three small lakes occupy the undulating ground to the north-west of Knocknaveen, and another, Lough Avullin, is situated in the townland of Maum, where the Pollabrandy streamlet joins the Maum River on its way to the sea.

A comparison of the geological structure of Clare Island, and of the wild and rugged features of its scenery, with those of the neighbouring mainland, shows clearly that the island once formed an integral part of the highlands round Clew Bay. At what period of its history it first became isolated from the mainland, it is impossible to say. It is probable, however, that in Lower Carboniferous times it formed, if not an island, at least part of the shelving shore-line of a western inlet of the sea that then extended over most of the present Irish area. Confirmatory of this hypothesis, it will be seen, on examination of a geological map of the Clew Bay district, that sandstones of this date, typical shore deposits, occupy the north-east of Clare Island, and fringe the Clew Bay basin on its landward side, except at its southern margin, where the beds are partly cut out by a fault. These rocks must have been laid down in close proximity to an old land-surface that partly enclosed the Clew Bay inlet, and extended westwards over a considerable portion of the present Atlantic area.

More than a third of the island, consisting of a marginal platform along the north-eastern, eastern, and southern coasts, lies below the 200-foot contour line, and from this level the hills of Croaghmore and Knocknaveen rise with remarkable abruptness. A similar phenomenon is seen on the mainland to the south of Clew Bay. Here, at about the same level, the rock-platform extends from the bay inland to the foot of Croagh Patrick, and from the coast near Roonah to the Corvockbrack granite ridge, beyond which the land rises abruptly as before. The form of the ground here indicated cannot be attributed simply to differential weathering, but the lowland and highland features must be considered rather as representing different stages of the sculpturing of the land by denudation. Thus the low rock-platform of Clare Island and its counterpart on the mainland, doubtless, form part of the great post-Carboniferous peneplain that extends over the central plain of Ireland, while the hills of Croaghmore and Knocknaveen are remnants of a higher and older plateau from which the mountains of the western highlands have been carved.

SOLID GEOLOGY.

The original survey of the island was made in the year 1868, by the late R. G. Symes of the Geological Survey, and the map showing the "solid" geology of the district on the 1″ scale was published in 1879; but, in the original memoirs accompanying the maps of the country round Clew Bay, only very scanty references, amounting in the aggregate to a page or two of letterpress, have been made to Clare Island. In 1909 the ground was re-surveyed by Mr. J. R. Kilroe, and an exhaustive description of its structure has been given by him in a Survey memoir just published.[1] The brief account of the solid geology of the district contained in the present paper is based mainly on information derived from the latter source. The accompanying colour-printed map, also published by the Survey, is included to illustrate the geological structure of the island, as well as the distribution and extent of the various superficial deposits which cover the greater part of its surface.

Rock Formations.

The solid rocks of Clare Island consist of at least five sedimentary groups, together with a few inextensive igneous intrusions, all of which are fairly comparable with the rocks of the neighbouring mainland.

Except in the Carboniferous strata, no fossils have been found in any of the groups; hence reliance has had to be placed alone on the field relations of

[1] Memoirs of the Geological Survey of Ireland. "The Geology of Clare Island, Co. Mayo." 1914.

the series, and on the lithological characters of their component rocks, in determining the position which must be assigned to them in the geological record. As, therefore, the identity of the series is still more or less a matter of conjecture, they have been named in the recent Survey memoir after localities in which they occur, and the same nomenclature is adopted in the present paper. The sequence of the series, in descending order, with their probable stratigraphical positions, is given in the following table:—

5. Cappnagower Series (Carboniferous).
4. Maum Series (? Upper Old Red Sandstone).
3. Harbour Series (? Lower Old Red Sandstone).
2. Knockmore Series (? Upper Silurian).
1. Ballytoohy Series (? Lower Silurian).

Igneous Rocks.

Serpentine.
Epidiorite.
Lamprophyre.
Basic minor intrusions.

Ballytoohy Series.—This series occupies the northern triangular promontory, and consists of sandstones, and black and dark-grey shales, often highly indurated, and in parts cleaved. The beds strike east and west, and are folded into an irregular syncline. If we except the doubtful zone of crushed rocks occurring in the townlands of Strake, Kill, and Glen, these are the oldest rocks in the island. Although they have yielded no fossils, they may be safely referred to the Lower Silurian system, and are indeed lithologically similar to rocks of known Llandilo age occurring in other parts of Ireland.

Knockmore Series.—The next group of rocks in ascending order has been called the Knockmore Series. Outcropping over more than half the area of the island, these beds enter into the formation not only of Croaghmore (Knockmore), but also of Knocknaveen and most of the ground to the south of these mountains. A great variety of rocks, a few of which are crushed and cleaved, is included in this group. Several types of coarse-grained and fine-grained sandstones, grey, pink, and green-coloured, as well as fine-grained conglomerates, calcareous mud-stones, and flaggy slates, are encountered on the hill of Knocknaveen; all of these dip southwards at high angles, from 70° to the vertical. Croaghmore itself is formed of interbedded grey and greenish-grey flaggy sandstones, red and purple shale and shaly sandstone, red sandstone, and greenish-grey pebbly grit. Here the beds dip south-easterly from 5° to 45°, but change at Strake hamlet to north at 85°. South of the crushed

zone, which runs through the townlands of Strake, Kill, and Glen, almost from end to end of the island, red argillaceous sandstone is the prevailing rock; but other varieties, as dark slate, red and green sandstone and shale, and greenish-grey slate, are also represented.

Crushed Zone.—Mr. Kilroe thinks that the rocks of the faulted area, referred to as the crushed zone, are simply altered forms of the adjoining rocks lying outside the fault lines. Their extremely altered character, however, and their striking resemblance to the great metamorphic group of Dalradian rocks, render this interpretation rather doubtful. It is, in fact, extremely likely that they represent portion of the old Dalradian floor, which has been brought to the surface by the faulting down of the Upper Silurian trata lying to the north and south of the area. These altered rocks consist of epidiorite, mica-schist, quartzite, and quartzose conglomerate.

Harbour Series.—Occupying a small area around the harbour, in the south-east of the island, may be seen another group of rocks, the Harbour Series, which is obviously different from the Knockmore strata. The beds, consisting of grey sandstones, and purple and chocolate sandstones and conglomerates, are apparently of Old Red Sandstone date, and probably belong to the older division of the system.

Maum Series.—North of the great fault which runs W.N.W. across the island from the northern end of the Harbour strand, a group of red sandstones and conglomerates, the latter containing large rounded pebbles of white quartz, jasper, and quartzite, extends over parts of the townlands of Lecarrow, Maum, and Ballytoohy. The beds are not of very great thickness, and may be regarded as forming the base of the Carboniferous strata, but in keeping with the principles upon which the mapping was carried out on the mainland at Achill, these red rocks have been separated from the Carboniferous series of the adjoining ground, and mapped as Upper Old Red Sandstone.

Cappnagower Series.—On the north-east of the island, in the townlands of Cappnagower, Fawnglass, Lecarrow, and Maum, the Carboniferous system is represented by the Cappnagower series, consisting of grey sandstones, shales, and calcareous beds, but no limestone. The beds, which dip from 5° to 10° to the east, are for the most part covered with drift; but good exposures are to be seen along the coast-line for about a couple of miles (Plate II, fig. 2). The fossil forms found in this series, viz., molluscan shells, crinoid stems, indistinct corals, and plant impressions, have been adjudged to be distinctly Carboniferous in type, and probably belonging to the Lower Carboniferous.

Igneous Rocks.—An interesting band of igneous rocks runs along the line of the great fault north of Croaghmore and Knocknaveen. The rocks contain, in places, small quantities of the minerals malachite and copper

pyrites, and indeed the entire band is suggestive of a mineral lode. The great variety of rock-types, which include serpentine, dolomite, biotite-lamprophyre, dolerite, olivine-basalt, &c., occurring here, within a comparatively small area, must be attributed to successive intrusions of igneous material into the zone of fracture. Serpentine and dolomite of the same date as the corresponding rocks just mentioned appear also as a narrow band in the faulted area at Portruckagh.

The only other igneous rocks in the island are a few masses of epidiorite exposed in the neighbourhood of Kill, some minor basic intrusions in the townlands of Ballytoohy More and Ballytoohy Beg, and a small basic sill, south of Croaghmore, in the townland of Bunnamohaun.

An explanation of the system of faulting by which the older Ballytoohy strata were brought down against the newer Knockmore series may be here desirable. Mr. Kilroe accounts for this anomaly by supposing that an upthrust from the north took place early in the history of the district, in fact contemporaneously with the dislocation that produced the inversion of the strata of Croagh Patrick, in post-Wenlock, and probably early Old Red Sandstone, times. The older northern series was thus brought to a high level, and when a certain amount of denudation had taken place, and after the Upper Old Red Sandstone and Lower Carboniferous beds had been deposited on the shores of this old land-surface, normal faulting ensued, bringing down the Carboniferous rocks against the Lower Old Red Sandstone series, and the older northern series against the newer southern group.

Glacial and Post-Glacial Geology.

During the progress of the Biological Survey of Clare Island there arose many problems concerning the present distribution of the fauna and flora of that district, and incidentally of Ireland as a whole, for the solution of which as full a reconstruction as possible of the recent geological history of the island is of fundamental importance. Had Clare Island already been cut off from the mainland in late pre-Glacial times? Was it overwhelmed with ice in the general glaciation of the Great Ice Age? Was there a land-bridge uniting the island with the mainland on the recession of the ice, or has there been a land-connexion between them at any subsequent date? What changes in the relative level of the sea and land have taken place over the Irish area during the Pleistocene and Recent Periods? All these are questions deeply concerning the problems which the biologists that took part in the Clare Island Survey have set themselves to solve.

The present writer, whose privilege it was to examine and map for the Geological Survey of Ireland the superficial deposits of Clare Island, kept

these questions in mind, and, in order to become acquainted as far as possible with the recent history of the area, studied the glacial phenomena not only of Clare Island itself, but also of the country round Clew Bay.

In this paper the observations of the previous workers in the district, principally those of Kinahan and other officers of the Geological Survey, and of J. F. Campbell and Maxwell Close, have been freely used, and whenever the work of geologists of other lands has helped to throw light on the nature of the more recent crustal oscillations that have taken place in the British area, it has been laid under contribution.

Previous writers on the glacial geology of Ireland have frequently referred to evidences of ice-action occurring in the mountain districts of west Connaught. Kinahan noted that Bengower, one of the Twelve Bens of Connemara, a mountain 2184 feet high, situated about eight miles east of Clifden, Co. Galway, was polished and ice-dressed to its summit.[1] J. F. Campbell, the author of "Frost and Fire," records numerous localities in the western highlands where the rocks have been polished and grooved by moving ice, and where morainic matter and perched boulders, foreign to the underlying rocks, rest on glaciated surfaces. According to the latter observer, the top of Shannaunnafeola, a mountain situated about six miles south of Lough Nafooey, and two and a half miles west of Lough Corrib, rising to a height of 2012 feet above Ordnance datum, is polished and grooved by the passage of ice across its summit, and "looking towards the places at which the grooves point, there is no higher land to account for this manifest glaciation."[2] On three other hills of this neighbourhood, far apart, but still within sight of one another, he noted similar ice-markings, and though satisfied that these phenomena were not attributable to local ice, but rather to some general glacial system, he believed that they were produced by floating icebergs during a partial submergence of the Irish area. When Campbell wrote his quaint but interesting book, the land-ice theory was as yet undeveloped, so that it was only natural to find him calling in the aid of floating ice to produce the groovings and polishings of the rocks that occur on the summits of the mountains of Connaught, as well as to account for the carriage of huge foreign boulders to situations where human or gravitational agents were obviously not the means of transport. It is not necessary to discuss here the merits of the land-ice theory; it has been evolved from the study of the work of existing polar ice-sheets, and is now very generally accepted by geologists all over the world.

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[1] "On the Drift in Ireland," Journ. Royal Geol. Soc. Ireland, vol. i, p. 194, foot-note.
[2] "Frost and Fire," vol. ii (1865), p. 32.

What has been said of Bengower, Shannaunafeola, and the neighbouring mountains is equally true of many other of the mountains of the western highlands; and if evidences of glaciation have not been observed more frequently, it is because the markings are either hidden beneath peat or drift, or have become obliterated by the ordinary processes of weathering. Even on Clare Island, where the uncovered rocks are not particularly well calculated to withstand the weather, the rounded forms of roches moutonnées are still in evidence as high as the 600-foot contour-line on the shoulder of Knocknaveen.

It is certain that phenomena such as those described could not have been produced by the action of local mountain glaciers, and it becomes necessary to postulate a regional ice-sheet of considerable dimensions. What has been the origin of such an ice-sheet, and whence has it come, are questions which involve us in the consideration of an extraordinary episode in the recent geological history of northern Europe, that of the Glacial Epoch. At a distant period, impossible to reckon in years, but somewhere at the close of the Tertiary Epoch, arctic conditions set in over the whole of the northern portion of the European continent. Snow accumulated on the great Scandinavian plateau, and being converted into ice, flowed outwards, under the influence of gravity, from that axis in all directions. As the cold became more intense, the snowfall increased, and the Scandinavian glacier, enriched by constant and increasing accessions of glacial material, drained into the North Sea and Baltic basins, finally extending southwards as far as the 50th parallel N. lat. The ice, having filled the basin of the North Sea, invaded the British area, as is proved by the boulders of Norwegian and Swedish porphyries, gneisses, granites, &c., which have been found embedded in the drifts of the east of England. As no Scandinavian boulders have been found in Scotland, it is inferred that the ice which gathered on the Scottish Highlands was sufficiently massive to bar the progress of the glacier from the North Sea. The two ice-sheets therefore coalesced to form a continuous ice-cap which buried the whole of Britain as far south as the valley of the Thames. As the Scottish ice developed, it drained freely from its ice-shed westwardly and south-westwardly into the Atlantic Ocean, the North Channel, and the Irish Sea, and appears to have swept over the north-east of Ireland, scoring and polishing the rocks in its path, and bringing along with it many varieties of foreign boulders from the Scottish area. It is probable, however, that it did not push its way far inland; its progress was, no doubt, soon arrested by the increasing glacial accumulations of a central Irish ice-field, and the current was deflected into the Irish Sea and Atlantic Ocean.

The splendid work of the Belfast Naturalists' Field Club in investigating the distribution of the "erratics" in the drifts of the north of Ireland enables us to trace the Scottish glacier approximately to its western limits. Fragments of the unique riebeckite-eurite of Ailsa Craig, which have been found so persistently in the drifts of the north-east of Ireland, do not appear to have been carried very far westward into the country. "In spite of careful search, Mr. Robert Bell never found any west of the Bann until this year (1906), when he picked up a solitary piece on the shore of Lough Neagh near Moyola River."[1] Since then, however, Ailsa Craig "erratics" have been recorded from Limavady and Kilrea, and, quite recently, the known area of their distribution has been extended westwards to Moys, about three miles S.S.W. of Limavady, where a specimen of the rock was found by Madame Christen, of the Belfast Naturalists' Field Club, at an elevation of over 400 feet. Judging from the distribution of these foreign boulders, it seems likely that a line running south-east from the mouth of the river Foyle marks approximately the limit to which the Scottish glacier penetrated into the country.

The great central Irish snow-shed occupied comparatively low ground south of the Ox Mountain range, and extended along an axis running north-east and south-west from Lough Neagh to Lough Corrib. From this axis the ice moved towards the sea in all directions, swamping the whole of the present Irish area, and passing at its north-eastern and eastern margins into the Scottish glacier. Westwards it overspread the highlands of Connaught and extended far into the sea along the present submarine plateau, probably reaching the 200-fathom line at the edge of the Atlantic abyss.

This description represents briefly the condition of north-western Europe during the period of maximum glaciation. From whatever cause, the ice, as has been seen, developed in a south-westerly direction from its Scandinavian focus, fresh centres of distribution arising as it proceeded along its course; but the ice from all sources united to form one general ice-cap which completely buried both sea and land north of a line running east and west along the valley of the Thames.

During the period of maximum ice-development, Clare Island and the Clew Bay area were overwhelmed by the Central Irish Glacier which invaded the district in a direction a little south of west. Confirmatory of this hypothesis, it may be mentioned that the principal glacial phenomena of the island indicate a great ice-movement seawards in this direction. Thus the rocks of the low platform along its southern shore are deeply furrowed and polished by ice that moved out to sea in a direction bearing 10° to 15° south

[1] Proceedings of Belfast Naturalists' Field Club (1906), vol. ii, p. 324.

of west. Also, a conspicuous drumlin ridge situated on the south side of the island has its long axis similarly oriented, and the roches moutonnées which occur at various elevations up to the 600-foot contour line all present their ice-dressed surfaces towards the east. In like manner the orientation of the drumlins at the head of Clew Bay indicate the same general direction of the current, and the few striae observed in the rocks of this heavily drift-covered country give confirmatory evidence that the general trend of the ice was westwards from the central ice-axis.

On examining the glaciated surfaces of the rocks of this district it was noted that, at several localities, a second set of striae, occurring on the same or adjacent rock-surfaces, crossed those that pointed westward at a fairly wide angle. This phenomenon, occurring as it does alike on the northern and southern side of the island, as well as on the southern shore of Clew Bay, cannot be due to a temporary or local oscillation of the Central Irish Glacier, but must be the result of a distinct transverse ice-movement. The latter, however, cannot have been very intense, nor of very great duration, for the grinding to which the rocks were subjected by the second glacier was not sufficient to obliterate the traces of the previous glaciation.

The following extract from the Geological Survey memoir[1] already mentioned gives an account of the local district glacier which produced the transverse striae and which brought along with it a not inconsiderable proportion of the loose superficial material at present found on Clare Island:—

"When the ice coming from the central snow-field diminished in mass, the country round Clew Bay was invaded by a local district glacier, fed by a snow-field situated in the mountainous district west of Lough Corrib, with probably, as suggested by Kinahan and Close,[2] the mountains on either side of the pass of Maum Con and the Twelve Bens as centre. From this ice-shed (see sketch-map, Plate IV) a great glacier flowed north-westward into Clew Bay, overwhelming the greater part at least of Clare Island in its course, submerging the hill of Knocknaveen, but possibly not overtopping the mountain of Knockmore. Another portion of the ice descending from the northern side of the ice-shed flowed northward over the low ground into Killala Bay. In confirmation of the foregoing theory of the glaciation of this region, an examination of the drift on the southern shore of Clew Bay will show that the deposit consists of two types of boulder-clay. On the shore of the bay directly north of Louisburgh, a 30-foot section of drift may be seen which clearly illustrates this twofold character of the deposit. The lower part of this section consists of blue-grey boulder-clay, rich in scratched limestone,

[1] pp. 31–34.

[2] "The General Glaciation of Iar-Connaught and its Neighbourhood in the Counties of Galway and Mayo" (1872), p. 12.

and serpentine boulders which must have come from the east. This lower boulder-clay, forming the main mass of the drift, is overlain by an upper or newer boulder-clay of a brown iron-rust colour, containing grey granite erratics from Corvockbrack, but not containing limestone. The material of the latter drift is much coarser than that of the former, and consists largely of sandstone rock detritus. A similar description applies to an 80-foot section of drift on the shore of the bay west of Carrowmore. This cliff also exhibits along most of its length, especially on its eastern side, a marked difference in colour and composition between the materials of its upper and lower layers, and it is interesting to note that half-way up the cliff there occurs a 10-foot band of stratified sand and gravel, which at the western end of the cliff dips almost to sea-level. At this end, too, the deposit is particularly rich in granite boulders from Corvockbrack. A 40-foot cliff-section of drift at Roonah Quay, four miles west of Louisburgh, is similarly suggestive of an upper and lower boulder-clay. The 80-foot section on the shore at Old Head, on the other hand, does not show the same distribution of material as is found in the cliff-sections already described, although it also is probably made up of débris contributed by both glaciers. The basal portion of the deposit contains scratched limestone boulders as before, and here the matrix is finely laminated in places, as frequently happens in the lower boulder-clay formation, but serpentine boulders are very prevalent and fairly uniformly distributed throughout the entire section. Here the limestone, as in the other cases, must have come from the east, but much of the serpentine must have come in the southern ice from the serpentine band running parallel to the shore north of Kilgeever Hill. Owing to the relative geographical positions of Old Head and Corvockbrack, granite boulders from the latter mass coming in the southern glacier would not touch the shore of Clew Bay as far east as the former locality, and consequently no grey granite erratics are to be found in the drift of the Old Head section.

"The islands in the east of Clew Bay, which consist of drumlin mounds with their western ends deeply cut into by the sea, present excellent sections for the study of the drift of this neighbourhood. In the great cliff of the island of Dorinish More (Plate III, fig. 1), which shows a magnificent section of boulder-clay about 100 feet in height, no essential difference can be noticed between the top boulder-clay and that lower down. The erratics seen in this section are principally scratched limestones with a small proportion of boulders of grit, red granite, schist, etc. At Dorinish Beg a 60-foot cliff-section of boulder-clay is to be seen with the same uniformity of material throughout, except that three or four feet of the deposit at the surface appear to have weathered to a lighter

colour than the rest of the drift below. The boulder-clay of the western cliff section at Inishlyre, which is 40 feet in height, is similar in type to that of Dornish More and Dornish Beg, and the material at the base of the cliff is finely laminated like the lower boulder-clay of Old Head. All the drift in these islands appears to have been laid down from the eastern glacier, and there is nothing on the ground at the head of Clew Bay to indicate that the southern ice from the Iar-Connaught snow-field passed northwards, as it must have done, over the district lying round Westport and Newport. In addition to the uniformity of the drift material of this area, the trend of the drumlin ridges is in the path of the glacier that moved towards the west. They show no signs of having been disturbed by a subsequent northerly ice-flow, but farther east in the Castlebar district the drumlin ridges have their long axes pointed north and south, at right angles to those at the head of Clew Bay (see Plate IV). Mr. Kilroe[1] suggests as an explanation of this phenomenon, that the Croagh Patrick mountain range shielded the Westport region from the ploughing action of the southern ice, while, farther to the east in the open plain, the boulder-clay already deposited, being fully exposed to the action of the later glacier, was swept northwards by it and was replaced, as in the Castlebar area, by drumlin ridges whose axes are oriented in a direction a little to the east of north. Instead of this more obvious explanation, Kinahan and Close[2] express the opinion that the ice moved landwards over the site of Newport, 'notwithstanding a little difficulty about the boulder-clay stones of that vicinity,' while at the same time the ice a little farther south moved seawards into Clew Bay. This latter part of the ice-current they believed to be a deflection of the glacier from the south, which curved round on the lee side of the Croagh Patrick range of hills, but, farther north, encountering another barrier at the other side of the bay, was compelled again to flow north-eastwards to join the other portion of the southern stream which moved northwards over the Castlebar district into Killala Bay."

The foregoing descriptions of the movements of the two principal ice-currents that glaciated the Clew Bay district will enable us to understand the origin of the drifts which encumber a considerable portion of the surface of Clare Island.

Glaciation of Clare Island.

Marks of glacial action can be traced on many of the uncovered rocks of the island. Striae are not of very frequent occurrence, many of the soft

[1] "Soil Geology of Ireland," p. 143.

[2] "The General Glaciation of Iar-Connaught and its Neighbourhood in the Counties of Galway and Mayo," p. 13.

shales and rough sandstones being ill adapted for retaining these impressions, but the characteristic ice-grooved and ice-planed rocks so often found in the paths of great glaciers are common here also, especially along the southern shore. As already stated, the principal modifications of the rock-surfaces were produced by the glacier from the east. The peculiar ice-dressed rocks known as roches moutonnées are common even at considerable elevations. Thus, on the western coast, south of the lighthouse, a good example of these glaciated hummocks may be seen. Glaciated rocks of this type occur, also, near the signal-tower on the west coast, at a height of 470 feet, and on the east side of Knocknaveen, at a height of 600 feet above Ordnance datum. All these phenomena bear testimony to the great mass of the earlier ice-sheet that swept over Clare Island, as well as to the intensity and persistence with which it performed its work.

Fine examples of the striae which it inscribed on the rock-floor may be observed at various points along the whole of the southern coast from Ooghnamaddy to Kinatevdilla. With some minor oscillations, probably due to the unevenness of the rock-surfaces over which the ice moved, most of the striations point seawards in a direction a little to the south of west. Well-marked cross-striae, produced by the district glacier coming from the ice-shed of the mountainous country between Clew Bay and Galway Bay, were noted in at least four widely separated localities on the island; they are oriented in a direction bearing 30° to 35° north of west.

The distribution in this area of certain distinctive foreign erratics, which cannot be matched with any of the fundamental rocks of the island, is confirmatory of the movements of the principal ice-currents as deduced from the evidence furnished by the manner in which the rocks are glaciated. Thus, boulders of scratched limestone, which are common in the oldest and and most massive of the superficial deposits of the island, must have come in the great ice-stream that flowed westward from the central Irish axis from the limestone area lying to the east of Clew Bay. Also, granite boulders, lithologically identical with the granite of Corvockbrack (situated to the south of Clew Bay), are of frequent occurrence on the southern portion of the island. Massive blocks of this rock, some of which weigh from about half a ton to a ton, were noted along the course of the Owenmore stream on the south-eastern slopes of Croaghmore (Knockmore), and smaller fragments of the same rock appear also, amongst other places, on the top of Knocknaveen, 650 feet above the level of the sea. Again, scratched serpentine erratics, identical with the serpentine from Croagh Patrick, are fairly common along the southern coast of the island. Both the granite and serpentine boulders either rest on the surface of the ground, or are embedded in the more superficial

drift which is obviously later than the lower or limestone boulder-clay. It is clear that these foreign boulders must have reached the island in the District Glacier that came from the south-east. From a little rocky bay south-east of the old abbey, and situated about 600 yards from it, Professor I. Swain obtained a very interesting collection of foreign boulders. These included specimens of calc-diabase, schistose diabase, altered porphyritic rhyolite, gneiss, amphibolite, and red granite; but as it is impossible to trace the rocks to their source, they do not throw any light on the ice-movements under discussion. Various other erratics corresponding in character to local rocks, but often differing lithologically from those that underlie them, are widely distributed over the island, even at the greatest elevations. Amongst others, a large boulder of red sandstone-conglomerate, weighing about a ton, remains perched almost on the summit of Croaghmore.

Glacial Drifts.

Boulder-Clay.

As the distribution and extent of the various superficial deposits of Clare Island are sufficiently indicated on the accompanying colour-printed map, they need not be referred to here in any great detail. A more exhaustive account of them will be found in the Geological Survey memoir already mentioned. The chief of these deposits is the boulder-clay; this drift rests on the low rock-platform fringing practically the whole of the north-eastern, eastern, and southern coasts, and extends inland from the sea-margin for various distances up to that of about a statute mile. The form of the ground in the boulder-clay area is hummocky, with the hollows between the drift-knolls often occupied by little flats of peat or alluvium. Great numbers of loose angular boulders lie strewn on the surface of the hummocks, especially in the north-eastern corner of the area; on the southern coast the surface features of the deposit are smoother in outline, with fewer boulders encumbering the ground. At Rooaunbeg, to the south-east of Knocknaveen, the deposit assumes the form of a longitudinal mound or drumlin ridge, having its long axis oriented in the direction of the principal ice-movement; this hummock forms quite a conspicuous feature of the landscape. The best sections of the boulder-clay are seen along the north-eastern coast, where cliffs have been cut in the deposit by the erosive action of the sea. These cliff-sections exceed a vertical height of 40 feet at various points along the coast, while at Leckaprison a vertical section of more than 70 feet of boulder-clay is exposed.

The most cursory examination of the sections reveals the presence of two distinct varieties of the deposit. In the deeper layers the matrix of the till consists of fine-grained dark-grey material, closely compacted, and containing numerous scratched limestone boulders. Resting on this stratum is a much coarser and looser material, which is lighter in colour, and characterized by the absence of limestone blocks. The latter variety of the deposit, however, contains a considerable proportion of angular, or but slightly glaciated, rock-fragments. An analysis of representative samples of these types, made by Mr. P. A. Baldock, of Liverpool University, shows that the lower or limestone variety contains, in its finer material, an average of about 18·5 per cent. of carbonate of lime as against 3·5 per cent. of that ingredient in the upper portion of the deposit. In this part of the island, the limestone boulder-clay attains a thickness of from about 12 feet at Leckascannalmore to about 25 feet at Ooghmacnamara; it is completely covered all along this coast by the upper or non-calcareous drift. It is only in the south of the island that the limestone boulder-clay appears at the surface, where it is traceable from the drumlin at Rooaunbeg northwards along the Owenmore stream up to about the 300-foot contour-line. To the south-west of Croaghmore, the drift is extremely coarse and morainic in character, and seems to have been brought thither in the higher part or on the surface of the glacier, and then let down loosely on the rock-floor as the ice melted.

It may be mentioned here that a remnant of glacial drift still persists on The Bills, which are rocky islets, lying well out to sea, about eight miles to the north-west of Clare Island.

It is interesting to note that the sandy boulder-clay at Ooghcorragaun, in the north of Clare Island, contains small fragments of marine shells. Mr. J. de W. Hinch, who made this important observation, has kindly furnished the following account of his discovery:—

Notes on the Glacial Mollusca of Clare Island and North Mayo.

The only locality on Clare Island in which any shells were found was a stretch of the coast-line around Ooghcorragaun. Here in the calcareous boulder-clay a considerable number of shell-fragments were found. Most of the fragments obtained were in too poor a condition to be identified, but the following genera and species were recognisable:—

LAMELLIBRANCHIATA:—*Ostrea edulis* Linn., *Mytilus* sp., *Pecten opercularis* Linn., *Cardium echinatum* Linn., *Cardium edule* Linn., *Saxicava rugosa* Linn.

GASTEROPODA:—*Patella vulgata* Linn., *Turritella communis* Risso, *Dentalium* sp.

CIRRIPEDIA:—*Balanus* sp.

An examination of the present distribution of the above species shows that all are very common in the British and Irish Seas at the present day, and that their presence in the boulder-clay of Clare Island throws no light on the climate of western Ireland during Glacial times. It was decided to see if the great development of drift around Clew Bay would yield more definite information. The coast-line around the bay was searched without any shells being found. In 1881 the Geological Survey had reported shelly drift in North Mayo near Ballycastle, and Canon Grainger had named eight species from the collection made. Two of these eight species were arctic types; and Ballycastle being only about twenty-five miles to the northward, it was decided to see what fresh information could be obtained by a careful examination of these deposits. The coast-line of North Mayo was examined from Lacken Bay to Port Urlin, and the shelly drift was found to be confined to the coast between Glenulra and Belderrig. The district is one in which ice-movement was apparently of frequent occurrence, and at least three boulder-clays were distinguished. These were as follows:—

1. In Glenulra and Owenbehey occurs a blue till (the "blue mud" of the district) with a great number of shell-fragments. The following species were recognisable:—

LAMELLIBRANCHIATA:—*Ostrea edulis* Linn., *Mytilus* sp., *Nuculana* (Leda) *pernula* O. F. Müller, *Cardium edule* Linn., *Cyprina islandica* Linn., *Astarte borealis* Chem., *Tellina balthica* Linn., *Corbula* sp., *Glycimeris* (Panopea) *norvegica* Speng., *Mya truncata* Linn.

GASTEROPODA:—*Turritella communis* Risso, *Purpura lapillus* Linn.

CIRRIPEDIA:—*Balanus* sp.

2. From Lackan Bay to Port Urlin the greater part of the country is covered with a brown boulder-clay which contains shell-fragments when it rests on the denuded surface of the blue till.

3. At Belderrig, and for about a mile to the eastward, occurs a calcareous boulder-clay much less tough than the blue till, and apparently resting on the denuded brown boulder-clay. In addition to many of the blue-till species this boulder-clay is made very important by the presence in large numbers of the well-known northern form *Tellina lata* (known also as *Tellina proxima* and *Tellina calcarea*). The individual valves of this shell are very well preserved, the epidermis being retained in many cases. This shelly drift of north Mayo is very important, as showing that, judged by the present distribution of mollusca, the species found in these drifts indicate a lowering of the temperature, *Astarte borealis, Leda pernula,* and *Tellina lata,* being distinctly northern forms. A more extensive account of these north Mayo shelly drifts will be found in the "Irish Naturalist," vol. xxii (1913), pp. 1–6.

Modified Boulder-clay.

In the zone between the outcrop of the boulder-clay and the hills, there occurs a drift consisting of boulder-clay that has been considerably modified by detrital matter washed down from the higher ground. The distribution and extent of the deposit are indicated by a slate-colour on the accompanying map.

Local Drift.

A local drift, consisting of morainic material, and possessing few glacial characters, clothes the rough projections of the rock-floor, in the undulating central area, between the mountains of Croaghmore and Knocknaveen. The deposit, which is generally about 3 or 4 feet in thickness, is derived entirely from the débris of the local rocks.

Moraines.

Another interesting drift is that produced by the local mountain-glaciers, in the final stages of the glaciation of the island. One example of this deposit occurs at Loughanaphuca, where a series of parallel terminal moraines marks the pauses in the retreat of a shrunken glacier that debouched through a small rock-bound valley to the east. Another small terminal moraine stretches across the hollow of a cirque, about half a mile farther north. These moraines once banked up small lakes now drained dry by a streamlet which has cut its way through the morainic barriers that confined them.

Recent Drifts.

Aeolian Deposits, Storm-beach, Peat, and Alluvium.

The newest drifts on the island consist of aeolian deposits, a storm-beach, peat, and alluvium. Along the margin of the storm-swept western coast, there occurs an inextensive aeolian drift, composed of material driven inland from the cliff-faces by the force of the prevailing western winds. The material has been laid down in stratified layers, sometimes intermingled with peat, hill-wash, or local detritus. Another wind-borne deposit is the barrier of blown-sand which separates the bay, north of the harbour, from a low-lying marshy flat, situated immediately to the west.

The storm-beach or spit of Kinnacorra occupies the most easterly point of Clare Island; it is V-shaped in outline, and the limbs of the V bound a salt marsh, which is the only one of its kind in the district.

The peat and alluvium, shown on the map, occur mostly in the hollows of the glacial drift, but, in addition to the deposits so represented, much of the high ground, mapped as "bare rock," is, or has been, covered with thin peat. This material is undergoing denudation by the natural processes of weathering and decay, and some of it is being rapidly cut away for fuel. It is interesting to note that roots and trunks of trees, principally Scotch fir, the remains of post-glacial forests, are dug in numbers out of some of the low-lying bogs.

Recent Changes in the Relative Level of Sea and Land.

A short time prior to the advent of the Glacial Period, the land and sea in western Europe occupied pretty much the same relative level that they do to-day. Ireland had already been separated from England, and, except perhaps that the Straits of Dover had not yet been cut, both stood isolated from the Continent of Europe, and the Clew Bay basin admitted the waters of the Atlantic, insulating Clare Island from the mainland, just as at the present time. This statement is borne out by the following facts:—

A late pre-Glacial beach occurs at some few feet above the present sea-level, not only round the Irish coast, but at many widely separated points throughout the British Isles and the coasts of France. In the south of Ireland it forms a remarkable feature, recurring persistently along the coast. Its presence here has been recorded by Messrs. Wright and Muff (now Maufe), to whom we are indebted for an exhaustive study of the phenomenon.[1]

On the rock-platform representing the pre-Glacial beach, a series of deposits reposes. First, immediately above the rock, is found the old beach-gravel, over which has accumulated a stratum of blown-sand; this deposit in turn is covered with "head" or waste from the cliffs behind, and then follow in ascending order a boulder-clay drift and an upper or recent "head."

An important conclusion to be drawn from this succession is that, prior to the advent of the ice, the land had been raised beyond the reach of the waves for sufficiently long a period as to permit of the accumulation of the lower

[1] "The Pre-Glacial Beach of the South of Ireland," Sci. Proc. Royal Dublin Soc., vol. x (1904), p. 250; and Irish Naturalist, vol. xiii (1904), p. 291.

"head" or scree. The evidence does not preclude the possibility that in the short time that elapsed between the formation of the beach and the Glacial Epoch the land stood much higher than it does at present. Indeed, as, at its present level, the "head" is being rapidly eroded by the action of the waves, it is probable, as suggested by Messrs. Wright and Maufe, that it did stand higher while the deposit was being accumulated.

Another reason for supposing that in late pre-Glacial times the sea and land occupied about the same relative positions in the Irish area as they do now, is the presence of marine shells in the boulder-clays of Clare Island, north Mayo, and various localities in the east of Ireland. As the shells are found, with respect to the main ice-current, only on the down-stream side of existing arms of the sea, the inference is that during the period of maximum glaciation, or, at least, at a short time previous to that episode, the sea still occupied the present basins.

Whether the Irish land occupied a higher level when the glaciation was most intense, no local evidence entitles us to say; but such slender information as is obtainable from the geological records in places outside this area points to an elevation of the whole of north-western Europe at that time. Many of the land valleys of this region, which run down to the existing coast-lines, have been traced out to sea for considerable distances, and as the portions of them now above the sea-level have obviously been fashioned into their present form under aerial conditions, their submerged prolongations must have been formed in the same manner. But although this consideration shows that the area was considerably higher at some comparatively recent period, it does not very definitely fix the date as that of the Glacial Epoch. Surer evidence of such a glacial elevation is furnished by dredgings of dead littoral shells from considerable depths in the seas round the British Isles, Faröe Islands, and off the coast of Norway, and the distribution, at great depths in the floor of the North Atlantic, of dead shells of the shallow water arctic species associated with the Yoldia Clay deposit.

The subsequent movements of the earth's crust in north-western Europe, at the close of and since the Glacial Epoch, can best be studied in the Baltic area, where so many natural records of the fluctuations of the relative level of sea and land have been preserved. From the evidence there obtainable, it would appear that the fading of the general ice-cap was accompanied by a depression of the land in the Scandinavian area. The southern portion of that peninsula sank and admitted the sea, which spread over a great part of the Swedish plains. This sheet of water, known as the Yoldia Sea, connected the Skager Rak with the Gulf of Bothnia, and extended over Finland as far

as the White Sea. On its floor was deposited a laminated clay containing the shell *Yoldia arctica*, a species characteristic of that deposit.

As southern Denmark does not appear to have been involved in this movement of the earth's crust, the presumption is that the subsidence was not of regional dimensions. Scotland, however, appears to have participated in this depression, for marine clays containing distinctly northern shells *in situ* have been found at some distance above sea-level round the Scottish coast. But we have no evidence that other parts of the British Isles sank below their present level.

Following the period of subsidence during which the Yoldia Sea was formed, a general elevation of the lithosphere took place in the northern part of our hemisphere. The recently submerged land slowly rose again; the floors of the Cattegat and the Belts became dry land, and the Baltic area became converted into an immense fresh-water lake, known as the Ancylus Lake. A considerable amount of new land was thus won from the sea and added to the European Continent, and on the land surface thus recovered peat-mosses and forests flourished. In a subsequent sinking of the crust, these became submerged, and traces of submarine bogs and forests, belonging to this period, are of very common occurrence, fringing the existing coasts of northern Europe.

"In the Baltic area itself, at Falsterbo, a peat deposit with oak and hazel has been found at a depth of 100 feet. Submerged peat and submerged kitchen-middens with neolithic remains have been found on the western coast of Denmark,[1] and at several points round the coasts of the British Islands and the north of France similar indications of a recent subsidence are to be seen. From the positions in which peat *in situ* has been found round the coast of Britain, it is inferred that the land stood at least 60 or 70 feet above its present level, and probably very much more. The map of Ireland (Plate V), giving the localities at which submerged peat has been observed round the coast, shows that this country, too, sank in recent times considerably below its former level. That the depression took place at a period prior to the formation of the lowest raised beach is proved by the succession seen on the shore near Portrush, and again on the shore to the south-east of Wexford. In these localities submerged peat underlies marine deposits which are now some feet above the level of high tide."[2]

Quite recently peat containing stems and roots of trees, seeds, leaves,

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[1] Nils Olof Holst "Kvartär-studier i Danmark och norra Tyksland," Geol. Fören, Forähndl. Bd. 26, p. 433 et seq.

[2] "The Geology of Clare Island, Co. Mayo." Mem. Geol. Survey of Ireland (1914), p. 41.

mosses, and the elytra of beetles has been dredged in the North Sea, on the slopes of the Dogger Bank, from a depth of 22 to 23 fathoms.[1] The occurrence of submerged peats and forests round the Irish coast is dealt with fully in the Geological Survey memoir on Clare Island, and in the map (Plate V) prepared for that memoir are shown the localities in which these deposits have been found. As they occur fairly uniformly round the coast, the inference is that the whole island has sunk from the position which it occupied during the peat and forest period. The partially submerged bog at the back of Dunworley Bay, Co. Cork, furnishes us with evidence of a considerable subsidence within recent times. This bog, the surface of which at present stands at about the level of high tide, has been bored to a depth of 50 feet without reaching the bottom of the peat-deposit. As peat could have accumulated only above high water, we have here evidence that this area must have sunk, at least, more than 50 feet from the level which it occupied when the peat began to form. In Britain, the position of the submarine peats proves a subsidence of the land of at least 60 or 70 feet from its former level; it is, therefore, fairly certain that the whole of the British area participated in the movement to a similar extent.

Probable Post-Glacial Land Connexion of Clare Island with the Mainland.

On all the low ground fringing Clew Bay, great accumulations of drift remain as testimony to the vast amount of material that must have been imported by the principal ice-sheet that invaded this region. Along the coast near Louisburgh, and in the islands in the east of the bay, formidable cliffs of boulder-clay, often 100 feet in height, are of frequent occurrence. Great depths of drift occur also on Clare Island itself, and along the northern shore of Clew Bay, so that on the low ground on every side of the present basin, there are found vast deposits of loose glacial material, which undoubtedly extended far seawards in former times. The isobaths or contours made from the soundings in Clew Bay give us a good idea of the form of the sea-floor in this area. A reference to the map (Plate VI) shows that the bay is really a very shallow inlet of the sea. Nowhere in the basin does the depth exceed 20 fathoms, while the shallow strait separating Clare Island from the Louisburgh coast is less than 60 feet in depth.

[1] Clement Reid and (Mrs.) Eleanor M. Reid. "Some Notes on 'Moorlog,' a Peaty Deposit from the Dogger Bank in the North Sea." Essex Naturalist, Part I., vol. xvi (1909), pp. 51–60.

Assuming that the land stood at its present level when the ice-sheet dissolved, it is probable that sufficient material would have been left behind, when the ice melted, to choke up practically the whole of the bay and convert it into dry land. But even if we eliminate the part played by the glacial drift in elevating the floor of the Clew Bay basin, it is clear that at a subsequent date, with the land standing above its existing level at the minimum height proved by the present position of the submerged peats and forests, the submarine ridge above referred to would rise well above the sea, and form a land-connexion between Clare Island and the mainland.

R. Welch, *Photo.*

General view of the northern part of Clare Island, looking west from Ooghbeg cliffs. Croaghmore in the distance.

Fig. 1.—Knockmore Series. View of the S. W. shore. Kinatevdilla in the distance.

R. Welch, *Photo.*

Fig. 2.—Capnagower Series, overlaid by 40 feet of Boulder-clay, east of Portlea.

CLARE ISLAND SURVEY.—HALLISSY: GEOLOGY.

Fig. 1.—Section of Boulder-clay, Dorinish More, Clew Bay. Height about 100 feet.

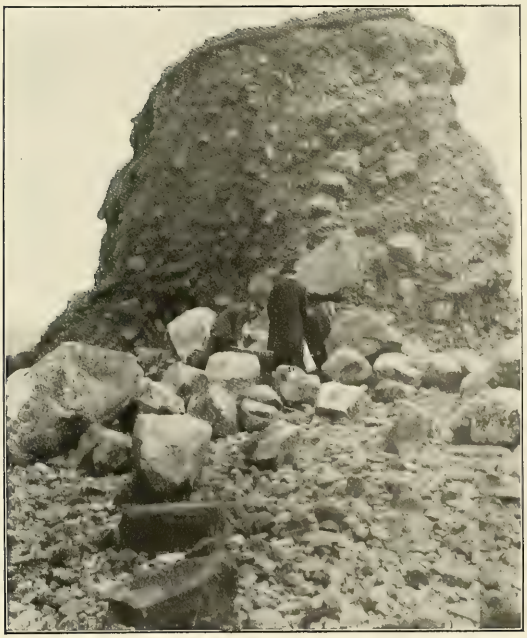
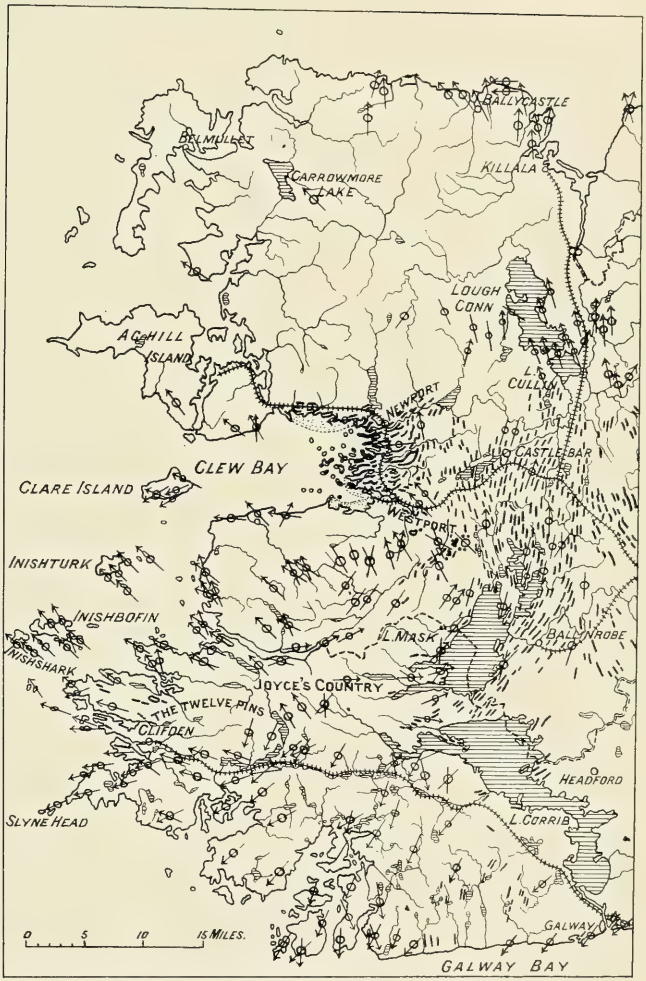


Fig. 2.—The Scotch Bonnet: the remnant of an island of Boulder-clay, Clew Bay.



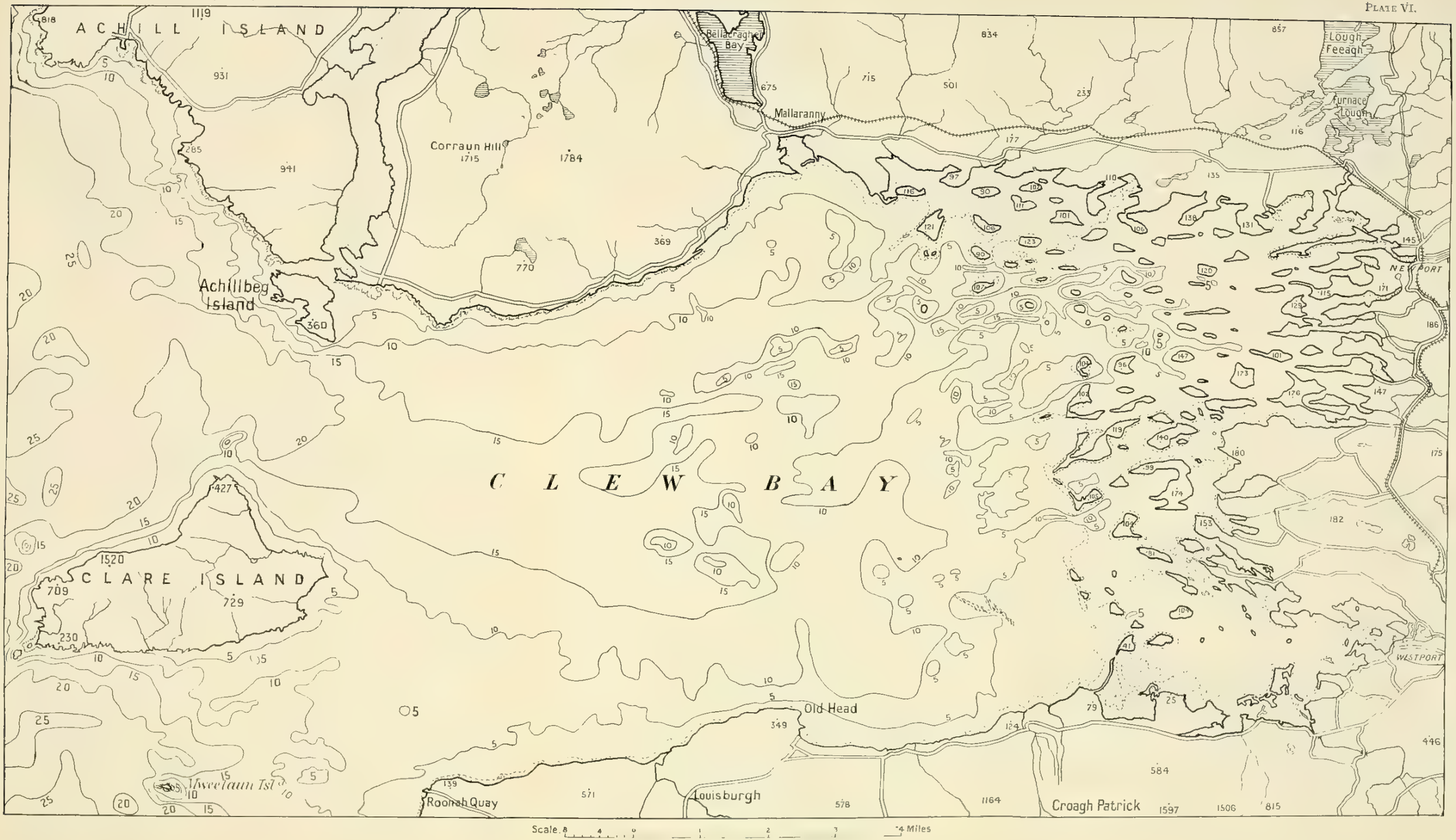
Explanation.

←O— Glacial Striæ, the arrow marking the direction of ice flow. // Drumlins.

Map showing direction of ice-movements and orientation of drumlins in West Connaught, including the observations of Messrs. Kinahan and Close, and of the Geological Survey.

[Reproduced, by permission of the Controller of H.M. Stationery Office, from the Geol. Survey Memoir: "The Geology of Clare Island, Co. Mayo."]

[Reproduced, by permission of the Controller of H.M. Stationery Office, from the Geol. Survey Memoir: "The Geology of Clare Island, Co. Mayo."]

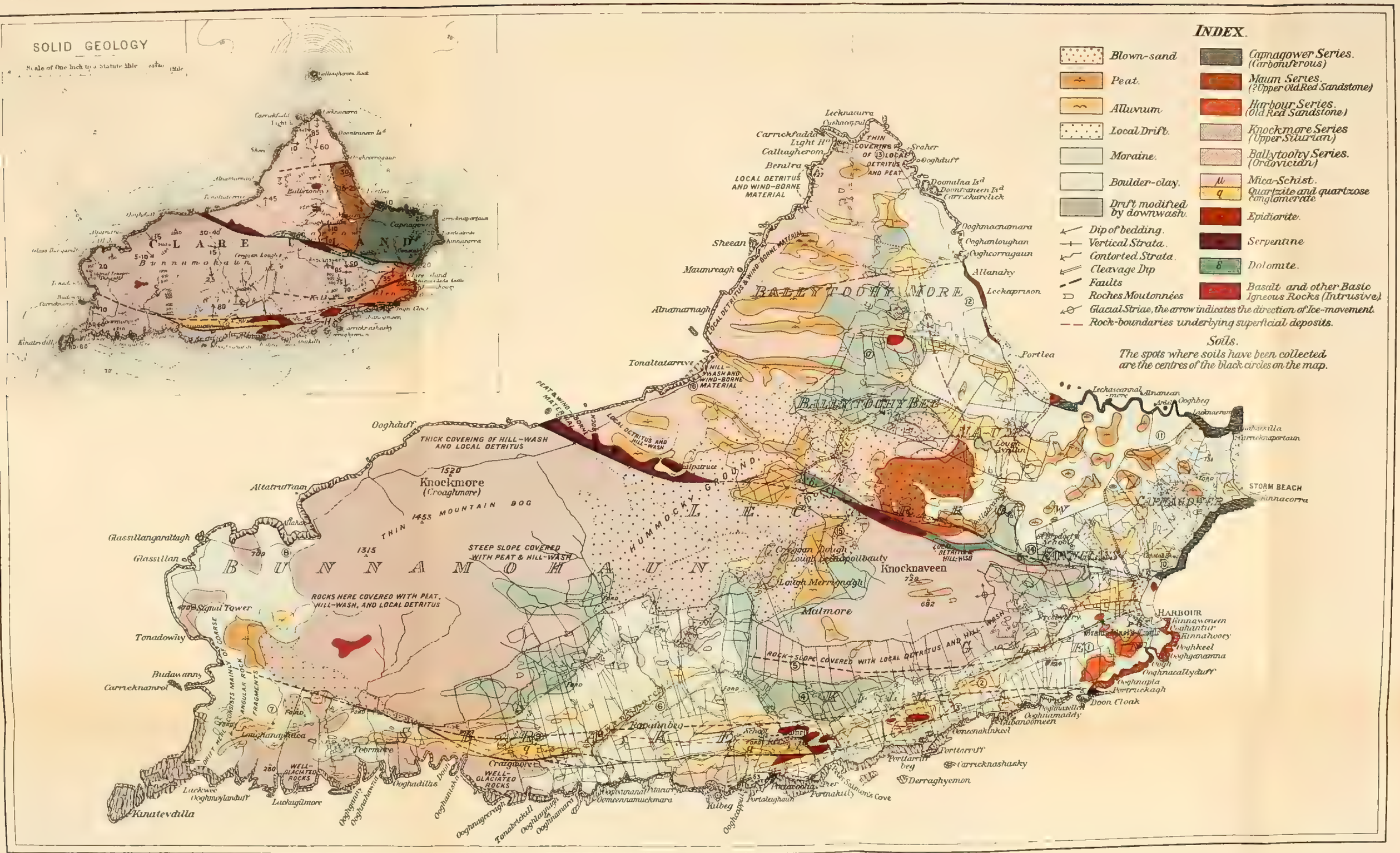


Map showing the submarine contours of Clew Bay.

Clare Island Survey.—Hallissy: Geology.

GEOLOGICAL SURVEY OF IRELAND.

CLARE ISLAND, Co. MAYO.



Superficial deposits surveyed by T. Hallissy, B.A.
Underlying rocks revised by J. R. Kilroe, A.R.C.Sc.I., 1910
Grenville A. J. Cole, Director.

Scale—Three inches to a Statute Mile = $\frac{1}{21120}$.

Feet 1000 500 0 1000 2000 3000 4000 5000 5280 Feet.
1 Furlong ¼ ½ ¾ 1 Mile

M. W. Gavin, Draughtsman.

CLARE ISLAND SURVEY.—KILROE AND HALLISSY: GEOLOGY.

9

TREE-GROWTH.

By A. C. FORBES.

Plates I, II.

Read April 27. Published July 15, 1914.

The scarcity of tree-growth along the west coast of Ireland and the islands lying along the Atlantic sea-board is so well known that few words are necessary to lay stress on the fact that Clare Island, in common with all islands from Donegal to Kerry, is practically treeless in the strict sense of the word. Tree species exist in several of them, it is true, but it is probably safe to say that no individual specimen can be found at present which attains a height of twenty feet, or which can be said by any stretch of imagination to contain timber. This being so, interest in Clare Island, so far as tree growth is concerned, centres round four main points, namely :—

1. Scrub and woodland species, of which traces still exist.
2. Evidence of tree-growth in the past.
3. Possible reasons for its disappearance.
4. The connexion between the Clare Island past and present forest flora, and that of the mainland.

With regard to the first of these points, not only have species to be considered which, under more favourable conditions, grow into timber trees, but also those which are invariably or usually associated with woods, and which are able to survive after the original woodland cover has disappeared. In Part 10 of the Clare Island Survey Mr. Praeger gives the following shade-, scrub-, or timber-producing species which are represented on Clare Island :—

Timber-Producing Species.

1. Quercus sessiliflora.
2. Betula pubescens.
3. Pyrus Aucuparia.

Scrub Species.

1. Corylus Avellana.
2. Ilex Aquifolium.
3. Salix cinerea.
4. S. aurita.
5. Pyrus Malus.
6. Prunus spinosa.
7. Lonicera Periclymenum.
8. Juniperus nana.

Shade Species.

1. Scilla nutans.
2. Anemone nemorosa.
3. Luzula sylvatica.
4. Primula vulgaris.
5. Oxalis Acetosella.
6. Sanicula europaea.

In addition to the above, *Fraxinus excelsior*, *Alnus glutinosa*, *Populus serotina*, and *Acer Pseudo-platanus* occur as planted trees of ten to twenty years' growth.

The occurrence of the native species is chiefly confined to four patches of broad-leaved scrub, occupying less than five acres altogether. The position of these patches is indicated on the map (Plate I), and it will be seen that all are on the south-east side of the island, with higher ground to the north and west. A photograph of the best-developed of these patches (near Portlea) is reproduced in Part 10; it consists of about two acres of fairly thick scrub of Willow, Mountain Ash, Hazel, Holly, Oak, and Birch, with a growth of Brambles, Bracken, Honeysuckle, and shade plants beneath. This patch lies from 50 to 100 feet above sea-level, and occupies a slope facing north-east, the soil being fairly deep and good, although inclined to be wet. The tree showing the best development is Birch, which occasionally reaches a height of 10 feet. Hazel also makes a good growth, while Holly develops into a thick bush seldom more than 5 to 6 feet in height. Willow, chiefly *Salix aurita*, is the most frequent species everywhere, but, from constant cutting, seldom attains its normal height, and the same may be said of Hazel. Oak forms a spreading stool clump about 6 feet in height, and is only sparsely represented in this patch. Another patch occupies a steep slope to the north-west of Lough Avullin, with the same aspect as the first, but has been more heavily grazed by cattle. It consists of Willow, Holly, and Birch,

with little undergrowth. A third patch lies between the harbour and Portlea, at the same elevation as the first, and contains Birch, Hazel, and Willow, and is also heavily grazed. A fourth, south-west of the harbour, is practically all Willow, and occupies the slope of a steep bank facing north-west, at about 100 feet elevation.

In addition to these four patches of scrub, bushes of Willow, Blackthorn, Holly, Hazel, Mountain Ash, and Birch occur east of a line between Knocknaveen and the lighthouse, and suggest that this area was originally covered with similar scrub before cultivation and grazing had destroyed it.

Of the reproductive powers of the various representatives of this forest flora little can be said, except that seedlings of Willow, Birch, and Mountain Ash occur in various places. Hazel was flowering at Portlea at the end of March, 1914, and may possibly ripen nuts in a good season, as they occasionally ripen at Glendarary on Achill, ten miles to the north-east. Holly grows about to high-watermark at Portlea, but whether it berries freely at the present time is doubtful. An old resident states that he often found the shells of the acorn in the turf bogs, and also remembered seeing the berries on the Holly bushes, but not later than about twenty years ago. Mr. Garvie, agricultural overseer on this island, writes:—"I have asked this man, and several others, about the hazel nuts, and they all say they do not remember seeing any growing on the island."

It is highly probable that the condition of this scrub cannot be taken as a fair index of the island's climate, as grazing, cutting, &c., have interfered with it to a considerable extent. But it is evident that the Oak suffers more than any other species from sea-wind, Hazel coming next. The growth made by the Oak in 1913 was found killed back quite two-thirds of the length of the stems in March of 1914, while many shoots of Hazel were uninjured, although the growth of previous seasons had shared the same fate as that of Oak. Willow and Birch are also affected by the sea-wind in the same way, but not to the same extent; but Mountain Ash and Holly appear unaffected, the former species seeding itself up to 500 feet on the north side of Knockaveen.

2. Evidence of Tree-Growth in the Past.

To obtain evidence of previous tree-growth on Clare Island, it is necessary to go further back than the oldest inhabitant, and investigate the stumps and trunks found in the patches of bog which occur more or less generally, and which give undeniable evidence of a more vigorous forest growth than that of recent times, and of the occurrence of one species (*Pinus sylvestris*) no longer found on the island as a native tree.

The bog areas containing tree-stumps are fairly numerous, and, like the scrub, are confined to the south-east side of the island, but they indicate a much wider extension than the latter now possesses.

A glance at the map shows that the Pine and Oak remains are found in or beneath the peat over about one-half of the total area of the island, and these are usually mixed with Willow, Birch, and Alder. But while Pine is the predominant species within 100 feet or so of sea-level, Oak becomes more common, and may possibly have been the chief species between 200 and 400 feet, few, if any, traces of tree-growth being found above the latter elevation. Before dealing with the significance of this fact, it is necessary to refer to the origin of peat, and see what connexion this deposit bears to the tree-stumps associated with it. Various theories have been advanced to account for peat-formation, and probably all of them contain a certain amount of truth. It is generally admitted that the first requisite is a cool and damp climate; but this condition alone would not explain its presence in a large number of cases. The term "peat" usually refers to the partially decomposed remains of various vegetable growths; but the conditions which have arrested decomposition are not always the same, and it is these conditions, rather than the character of the vegetation, which form the more important differences between various kinds of peat.

So far as Ireland is concerned, peat may be roughly divided into three classes—mountain, marsh, and high bog peat. Mountain peat originates wherever the surface conditions are too sterile, or the subsoil too impervious or water-logged to allow deep-rooting plants to flourish. The surface is accordingly taken possession of by shallow-rooting plants, which do little to maintain the connexion between the surface and subsoil, and a deficiency in the lime content of the soil sooner or later arises. This gives rise to raw humus, and Heather, Bracken, Wood-rush, Vaccinium, Molinia, Rushes, &c., gradually creep in, and a dry heath peat or sour swamp peat begins to form according to the moisture conditions. Under the heath peat, iron pan invariably arises a foot or so beneath the surface sooner or later, and brings about surface stagnation, and on both classes Sphagnum and other water-holding mosses, Cotton-grass, &c., gain a footing, and add to the accumulating mass of vegetable matter. This mountain peat is not confined to the mountains, although the most extensive development of it takes place above the 800-foot level in most parts of Ireland; but in the west it covers the entire surface down to sea-level in many districts. It varies in thickness from one to ten feet or more, and is more or less mixed up with marsh peat on undulating ground.

Marsh peat consists of the partially decomposed remains of Reeds, Sedges,

Rushes, and other similar plants which occupy shallow lakes and partially submerged ground. This form of peat constitutes the basis of all the lowland bogs in Ireland, and of a number of small bogs in mountain districts. Marsh peat is closely associated with the existence of drumlins and eskers left by the ice-sheet of the last extensive glaciation of the country, owing to the indefinite drainage system which prevailed for a long period after the ice had retreated. In course of time marsh peat fills up the lake or hollow in which it is accumulating, and the surface raises itself above the water-level. Over this surface, Bog Myrtle, Willow, Birch, Alder, and other terrestrial plants able to bear excessive moisture, gradually spread, and a layer from two to three feet in thickness is gradually built up above the summer water-table. So long as the water contains lime and nutritive salts, this peat forms as favourable a medium for the growth of most plants as ordinary soil, although the nature of the peat prevents tall trees from securing a firm root-hold, and they are liable to be overturned in strong gales. But as the peat consolidates with time and pressure from above, both its capillarity and the percolation of rain-water downwards decrease, and a point is probably reached at which the connexion between the water-table and the surface of the peat entirely disappears, while the soil-water itself may become more acid or diluted as time goes on.

This condition brings the Sphagnum peat, or high bog, into existence, which differs from the upper surface of the mountain peat more in its mode of origin than in its composition, both types consisting of the same class of plants, and both characterized by a lack of connexion between their surfaces and the soil-water, except where springs or streams happen to traverse the bogs or peat-covered surfaces. While, however, the Sphagnum peat resting on mountain bog varies in thickness more or less according to the degree of impermeability of the soil-surface, and the conditions favouring the accumulation of surface-water, the Sphagnum peat forming the high bogs presents a characteristic uniformity of growth. This consists in a gradual decrease in thickness from the centre of the bogs towards the margins, giving their surfaces a convexity which is so universal that the term "high" bog has been applied to this particular type to distinguish it from the flat or marsh bog which follows or is parallel to the water-table. This convexity is usually attributed to the high power the Sphagnum possesses of holding water by capillarity, enabling the centre of the bog to rise above the level of the margins, where natural drainage outlets prevent a further rise. But it is also probable that the lower level of the margins of a high bog is due to the partial decomposition of the peat when it comes within the influence of the soil-water. It is a well-observed fact that peat decays rapidly when

brought in contact with well-aerated soil or water containing lime. Streams and springs on the surface, if they do not prevent peat-formation, check its accumulation, while no peat forms on the margins of streams which periodically overflow their banks and leave a muddy deposit behind. Peat-accumulation increases with the degree of acidity, and this being greater the further the surface lies from the water-table, the centre of the bog naturally increases in thickness at a faster rate than the sides.

On Clare Island, mountain and marsh peat are well represented, but high bog, owing to the long duration of peat-cutting, is not much in evidence. The largest marsh bog originally surrounded the small lake known as Lough Avullin, which at one time covered ten to twenty acres of the valley in which the lough lies. This lough is fed by the most extensive drainage system on the island, but an artificial cutting, about 10 feet deep, near the bridge on the east side, has now rendered much of the bed of the ancient lake dry. From the distribution of Oak and Pine stumps in this valley and elsewhere, it would appear that Lough Avullin at one time occupied a more or less elongated depression, chiefly to the south-east of the present water, on the margins of which Pine was the principal tree. At a later period the water gradually rose and covered these Pine margins with marsh or swamp, killing out the trees on the lower levels. Either during the time the water-level was slowly rising, or after it had ceased to rise, Oak apparently spread into the Pine forest and gained a footing on the marsh round the edges of the swamp until the water-table of the latter again rose, killed out the trees, and brought the peat up to its highest level. It is probable that this marsh peat was capped with high bog, but no trace of this now remains, as the greater part of the valley has been cultivated in recent times.

Several smaller marsh-bogs occupy depressions to the south of Lough Avullin swamp, and within 200 feet of sea-level. All of these contain stumps of Pine and Oak, the former occupying the central parts and lower levels of the bogs, and the Oak appearing round the margins. This series of bogs all show the same features, whether as regards marsh-peat, the occurrence of Pine in the deeper parts, and the mingling of Oak with the Pine at the edges, and may be termed, for the sake of convenience, the Pine and Oak group. Extensions of this group appear to have existed between the harbour and Knocknaveen, towards the chapel on the south side of the island, and a small Oak stump was noticed near the chapel, resting on about 4 feet of peat.

The size of the Pine stumps in this group varies from 1 to 3 feet in diameter at the ground-level, probably corresponding to breast-high diameters of 1 to 2 feet. Only one log of Pine was noticed, which had a straight length of 9 feet, and a crooked top of 8 feet, with a diameter of 8 inches $4\frac{1}{2}$ feet from

the root. The Oak stumps in this group were smaller on the whole. Several logs were found, about 10 feet in length, and quite straight, with mean diameters of 9 to 12 inches, while west of Lough Avullin several large Oaks had recently been dug out, about 15 feet in length, and at least 18 inches in diameter at breast-height. The age to which the trees had attained varied from 100 to 200 years, but the sapwood of most having decayed away, many rings had disappeared.

The depth of the peat now remaining seldom exceeds 6 feet, and the stumps usually occur in definite layers about 2 feet above the water-table, the upper part of the bog having been cut away in all cases.

Another group of bogs with tree-stumps is found in the circular depression lying between Curraghmore and Lough Avullin, and due north of Creggan. These bogs lie in small depressions in the surface, which here slopes gradually from the cliffs on the north-west side of the island towards the south and east, and are more or less mixed up with mountain peat in the slopes and higher ground. These marsh bogs are smaller than those on the lower group, and lie from about 200 to 400 feet above sea-level. The stumps found in this group were all Oak, Birch, Willow, &c., and no trace of Pine was found, except one stump north of the path below Knocknaveen, and apparently about 350 feet above sea-level. The Oaks here were quite up to the dimensions of those found lower down, the end of one projecting from a peat-bank having a diameter of 13 inches. Most of these Oaks were rooted in a foot or more of peat, and were in definite layers, as in the case of the Pine stumps at lower levels.

The partial or total absence of the Pine from this group is difficult to explain, unless one can suppose that when Pine grew at the lower levels the climate was too cold to allow tree-growth on the higher parts of the Clare Island area. If this were so, however, it must have been followed by warmer conditions when the Oak came in, and any improvement in the climate would benefit the Pine to an equal degree, and enable it to grow at any elevation attained by the Oak. It is more probable, therefore, that the absence of Pine is connected with the period of peat-formation, and may possibly be explained by the formation of the mountain peat and the smaller marsh bogs after the Oak had thoroughly established itself, and the Pine had become comparatively scarce. If this were so, the stumps of the earlier generations of Pine would have decayed in the ordinary way, and left no trace behind. It is possible, of course, that more Pine stumps than the one seen exist on this area, but an old and intelligent islander, who was questioned on the subject, could not remember any "bog dale" being seen on that part of the island, although he was well versed in the various localities in which the Oak was found. One must

conclude, therefore, that either the Pine does not occur in the bog remains on this part of the island, or that it is confined to the deeper layers which have not yet been reached in peat-cutting.

If the tree remains in the Clare Island peat can be accepted as evidence of a succession in the forest flora due to climatic changes, it would appear that when the Pine and Birch found in the lower parts of the bogs flourished, many parts of the island subsequently covered with marsh were dry, and some of the existing marshes and swamps were without definite outlets. An increase in rainfall raised the level of these swamps at some period before the arrival of the Oak, and this rainfall either reached a stationary point or again diminished, allowing the peat to rise above the water-level, or bringing the latter down sufficiently to allow a fresh growth of Pines to spread over the peat. After or during this period, the Oak found its way in, and was probably accompanied by Hazel, Alder, Holly, and other species now established throughout the British Isles. Another rise in the water-table appears to have followed, covering the Pine and Oak on the margins of the bogs, and killing off the growth of Pines, in which Oak occasionally occurs, on the bog surface. Somewhere about this period it is probable mountain peat began to form on the poorer soils, and Sphagnum peat on the marsh bogs; but while the evidence for the latter theory is fairly conclusive, it is difficult to determine whether mountain peat in the west of Ireland is due to soil or climatic conditions, although both have probably something to do with it. There is little doubt that the mild winters, and cool, moist summers of Ireland favour the leaching out of lime from the surface soil, and bring about an acid condition of shallow soils more rapidly than would occur with a Continental climate.

If the scanty remains of tree stumps in the peat of Clare Island formed the only evidence of succession in a former forest flora, the above conclusions might be regarded as premature. But it is a striking fact that mountain and lowland bogs throughout Ireland yield certain evidence of a distinct and well-marked change in the flora during the last few thousands of years, and a succession similar to that found on the island. If a typical lowland bog is examined from the outer edge to the centre, so far as this can be done in the few cases in which the peat has been sufficiently cut out, tree-stumps are found to occur singly or in groups to a distance of 200 to 300 yards inwards. At the outer edge, where the turf has usually been cut away to the natural soil, stumps of Oak, Alder, Birch, Yew, Willow, and Pine occur more or less universally—not necessarily in one section, or in any one individual bog, but generally throughout the country, Oak being most frequently represented near the edges, with an occasional Yew or Alder, and sometimes Pine and

Birch. These species, or one or the other of these species as the case may be, extend about 100 yards in from the original edge of the bog, and occasionally to a greater distance nearer the centre, but in the deeper parts of the bog the only species found are Pine and Birch, except where eskers raise the surface of the natural soil to about the level or horizon at which the Oak occurs, when Oak or a mixture of Pine and Oak is usually found.

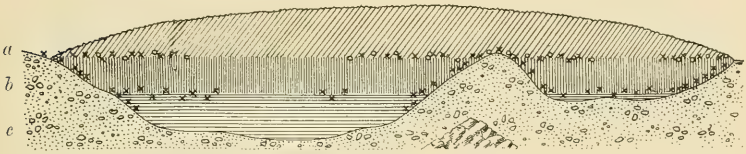


Fig. 1. Typical section through small lowland bog. xx Pine stumps. oo. Oak stumps. *a*, Sphagnum peat. *b*, Upper marsh peat. *c*, Lower marsh peat.

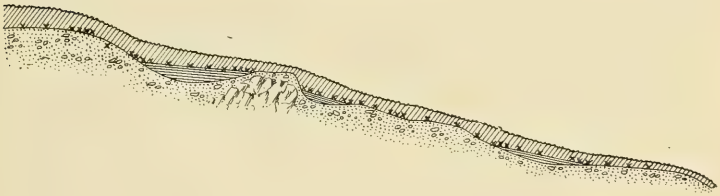


Fig. 2. Typical section through mountain slope, showing marsh and mountain peat. xx Pine stumps.

In bogs of not more than 100 acres or so in extent, the entire base of the bog may be dotted over with tree-stumps, but the larger bogs show few, if any, signs of stumps at a greater distance than 200 or 250 yards from the edge, and many bog sections are quite free from stumps, although in very few bogs as a whole are they entirely absent. Another feature of many Irish bogs is the occurrence of root-layers through the body of the bog, and at varying heights above the bog base. Near the margin of the bog, the root-layer may consist of Oak or Pine, but rarely of Pine alone, but at distances of 100 yards or more from the margin, and as the thickness of bog above the root-layer increases, Pine and Birch appear to be the only species represented. The upper root-layer is invariably under the Sphagnum peat, and usually on or near the surface of the black or marsh peat, but, beyond a few small Birch, the writer has never seen a stump above this surface. Another feature of this upper root-layer is its invariable occurrence at about 3 to 4 feet above the present water table, which, in most bogs, has been lowered by artificial drainage by at least a couple of feet.

The above statement summarizes the results of observations made in most counties in Ireland, and, briefly put, brings out the fact that Pine and Birch occupy or lie beneath the older parts of the bogs, while Oak, Pine, Yew, and various broad-leaved species occur near the margins. Exceptions to this rule may be found in some of the small marsh bogs in mountain districts, which may only contain Pine and Birch, while in a few shallow lowland bogs Oak may be found predominating throughout. Two points are quite clear, one being that the Pine was an earlier occupant of many sites than the Oak, and the other that the Oak and Pine formed a mixed forest at a later period, while it is fairly evident that the more pronounced Sphagnum stage of peat-formation is invariably treeless so far as the bogs alone are concerned.

Observations made in various parts of the Continent of Europe agree generally with the above view regarding the succession of forest associations found in bogs. Papers contributed to the Eleventh International Geological Congress in Stockholm in 1911[1] dealt with bog-formations in Norway, Sweden, Germany, Holland, Denmark, and other countries, and the writers are fairly unanimous on this point, although considerable differences of opinion exist as to the causes responsible for the tree and treeless stages respectively of the bog-formation. Van Baren (Holland) gives Pine and Birch as the oldest association, after which came Lime, Hazel, and Alder, and finally the Oak. Stoller (Germany) gives Birch, Willow, and Arctic Birch; then Pine and Birch; later Alder, Hazel, and Oak, with Birch and Pine; and finally Alder and Beech; and assumes that the Oak-Hazel-Alder association is of the same age as the submerged peat of the North Sea coast. Andersen (Sweden) supposes that Birch formed the first forest belt along the west coast, and Pine and Birch further east. After Pine forest had prevailed for a long period, a rise of temperature brought in a broad-leaved forest which pushed out the Pine. Wahnchaffe (Germany) gives Birch and Pine: then Oak, Alder, Fir, Birch, and Lime; the latter association being contemporaneous with the submerged forests.

On the other hand, Kinahan[2] and many other recorders of timber in Irish and British bogs mention the Oak as occupying the lowest position, with Pine coming in later; but it is highly probable that these statements are due to the fact that the Oak invariably lies at the edges and shallower parts of the bog, where turf-cutters would quickly come upon it on the natural soil. When the Pine layer was reached, the fact that it lay above

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[1] "Die Veränderungen des Klimas seit dem maximum der letzten Eiszeit."
[2] Geology of Ireland.

the soil or bottom of the bog was regarded as a proof of its later origin, the fact being overlooked that the Pine horizon was lower than that of the Oak, and, therefore, older, and not younger.

With regard to the root-layers, considerable difference of opinion exists in the minds of Continental investigators as to their occurrence and cause. That the stumps of trees are found in definite layers, separated by two or three feet of peat free from roots, is well known; but as their distribution in any bog can be seen only where they are exposed at the turf banks, and records of those previously found in the peat are either wanting or based on hearsay, how far they extend on a definite horizon is difficult to say. No difficulty appears to arise in tracing them over an area of two or three acres in many bogs; but when larger areas are dealt with, the difficulty arises of making sure that peat of the same age is being investigated at one place as at another. But, assuming that these root-layers exist—and this is beyond all doubt so far as limited areas are concerned—their origin is a matter of considerable interest. Swedish bog-investigators are sharply divided in their opinions on this point, one theory being that they represent a climatic change from wet to dry conditions, the other favouring the idea that a local change in the condition of the bog may account for them. Sernander and Andersen are the principal exponents of these respective theories; the former advocating the climatic theory, the latter the local or "edaphic" explanation.

Lewis[1] states that "all the Scottish peat mosses show a definite succession of plant remains. The oldest, in the South of Scotland and the Shetland Islands, have an arctic plant-bed at the base. This is succeeded by a forest of Birch, Hazel, and Alder, containing temperate plants. A second arctic plant-bed occurs above the lower forest, and is overlaid in all districts (except the Hebrides, Cape Wrath, and the Shetland Islands) by an Upper Forest covered by several feet of peat bog plants." The Upper Forest appears, according to Lewis, to consist of Pine, in one or two root-layers, separated, in the latter case, by two to three feet of peat. If the same succession holds good in Ireland, it is evident that the Lower Forest is invariably hidden beneath the water-table. In the vicinity of many bog sections which show no trace of stumps above the water-table, fragments of Birch are taken up by peat diggers; but whether Hazel and Alder are also present is a matter for further investigation.

As far as Ireland is concerned, it would appear that root-layers are chiefly confined to the smaller bogs, or to the margins of the larger ones, although in the case of the latter the deeper peat-layers are invisible, and little is

[1] Trans. Roy. Soc. Edinb., vol. xlvi, Part I (No. 2).

known about them. Where definite root-layers occur in the peat, however, the lower ones invariably appear to lie at about the level of the existing water-table or rather below it, while the upper layer lies within 3 or 4 feet of the water-table, and just below the Sphagnum or red bog. It is usually difficult to identify the true water-table of many bogs, owing to the holes cut and left in the peat by turf-cutters; but it may be assumed that the water lying in bog holes during the summer is, if anything, rather below than above the natural water-table, the latter having been lowered by drainage. The root-layers are evidently the remains of several generations of trees, for two or three large roots may be found resting immediately above each other, showing that the upper originated as seedlings upon the decayed stumps of the lower; and for these successive stages of growth and decay to have taken place a period of 500 to 1000 years would be required. Another feature of these stump-layers is that while the lower edge is frequently indefinite, and at no precise level, the upper edge finishes off along a more or less horizontal line, as if the trees had ceased to grow at one particular period. The roots themselves, especially the larger ones, are extended horizontally in all directions, but seldom show any trace of a descending tap or side roots, or even roots running obliquely downwards as is the case with Pine growing on well-drained porous soil. This flat root system suggests a water-logged condition 1 foot or 18 inches below the surface; and, furthermore, that this water-logging was due to a water-table at a fixed level. Had the bog gradually become drier, as suggested by Sernander and others, the trees would have ultimately sent down "sinkers," or perpendicular roots, as is the case when Pine is planted on artificially drained bog, with a gradually sinking water-table. A significant fact is the occurrence of the upper root-layer invariably below the Sphagnum peat, and near the upper surface of the black marsh peat, showing that the change which killed off the last layer of trees was also accompanied by a change in the composition of the bog, and was not necessarily due to an increase of moisture alone. The under edge of this Sphagnum peat often shows layers of Sphagnum which have been bent or pressed down on either side of the pointed end of a stump, showing that its rate of growth was comparatively rapid, and that it followed a period during which the peat on which it rests was of a different character, and had attained a firm surface.

Another conclusive proof of the marked chemical difference between the black peat bearing stump-layers, and the red or Sphagnum bog above, is found in the rate of growth of the bog-timber. However well high bog may be drained by natural or artificial agencies, the growth made by Pines or other trees is invariably slow after the first ten or fifteen years, and the maximum size such trees attain is seldom more than 12 inches in diameter at breast

height. In the root-layers, many pines show a rapid rate of growth during the first fifty or sixty years, and rings from one-fifth to one-tenth of an inch in breadth are common. The large size attained by many of the bog trees is well known, although an exaggerated idea of this may be easily gained from the horizontal root system. However, there is no reason to doubt that trees of 2 to 3 feet in diameter at breast height existed. A Pine in the lower group of bogs on Clare Island showed fifty rings in the first 12 inches of radius, the broadest ring being a quarter of an inch wide. This rate of growth, together with the frequent occurrence of Oak on bogs throughout Ireland, proves that the peat in which the trees grew had comparatively little acidity, whereas the acidity of the Sphagnum bog is well known, and invests the bog flora with a distinctly xerophytic character. The occurrence of Oak of comparatively large size in the root-layers proves the favourable chemical condition of the peat, as Oak never attains a large size on sour bog.

The problem of peat with and without root-layers is not, therefore, a mere question of moisture or drainage, but probably one connected with the character of the soil-water. Many facts point to the same changes in the level of the water-table having taken place, as is suggested by the Clare Island tree-remains, and render it highly probable that periodic increases and decreases in the flow of springs feeding the bogs occurred, bringing about a submergence of the tree-growth on peat, and a renewal of the marsh growth, the trees again spreading over the bogs when the level of the marsh had again become stationary. For this to have occurred, it is necessary to assume that the majority of bog areas had no definite drainage outlet in earlier times, otherwise a mere increase or decrease in the supply would not permanently alter the level of the water-table beyond a few inches, provided the supply was not too small to make good the loss from evaporation. While it is not impossible that the latter occurred, the flat-root system of bog-timber rather favours the theory of a stationary than a falling water-table during the period of tree-growth.

This assumed rise in the water-level of bogs and lakes is borne out in other directions. The majority of the crannogs existing throughout Ireland have been discovered after the lowering of lakes by arterial drainage. Many of these crannogs also rest upon peat, and are now covered by considerable depths of bog; and it is quite reasonable to assume that a certain amount of subsidence has occurred since many of the crannogs were last inhabited. But those which have appeared after the lowering of lakes usually stand upon islands and solid foundations, and these could not have sunk to any appreciable extent, but must have been submerged after they were built, and probably since they were last inhabited. Possibly the silting up of streams and the

formations of bogs may have temporarily raised the level of lakes from time to time, but the natural deepening of a drainage-channel is quite as common an occurrence, and the level of every lake cannot have been raised by silt or peat-formation.

In many parts of Ireland, again, tree stumps can be seen below the present level of the water, and the same thing has been noticed in Sweden. Wright[1] has observed these submerged stumps in Donegal, and points out the impossibility of their submergence being due to any tilting of the earth's crust which might alter the drainage outflow. In some instances, however, it is quite possible that these lakes were originally peat bogs, and the stumps now remaining are simply the residue of the bog which has been gradually eaten away by a stream which has increased in volume during comparatively recent times, and subsequent to the growth of the trees on the peat. This erosive or corrosive action of spring-water upon peat is clearly demonstrated in many parts of Ireland by the green lines which intersect stretches of mountain peat, due to streams which have cut their way through two or three feet of peat, and leaving the edges in the form of perpendicular walls along the line of flood-water mark. The course of many of these streams could not have been materially altered since the peat-formation took place, and the most reasonable conclusion is that precipitation has increased within comparatively recent times. Bog-slides and surface denudation of peat in mountain districts point in the same direction.

Another link in the chain of evidence regarding this point is the almost invariable position of the uppermost root-layer with regard to the water-table, and the existence of the lower one on or below the latter. Had all lakes in which bogs have since formed been at a fixed level from the beginning, the occurrence of the lower root-layer would have been impossible, or the upper one could not have become submerged for any length of time. Although the general subsidence and consolidation of the peat might possibly have brought about the death of one root-layer, the probabilities are that had this occurred a continuous series of stumps would be present, corresponding to the surface of the marsh, until the latter gradually became converted into Sphagnum peat.

The probable periods of time which have elapsed since the Pine, Pine and Oak, and Oak respectively flourished on Clare Island and the mainland cannot be given with any degree of accuracy. Various estimates have been made of the length of time required to form a certain depth of peat, but all are based upon such uncertain data that they must be regarded as unreliable.

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[1] Geological Magazine, N.S. Decade V, vol. ix.

Observations over a certain number of years may give results at a given point, but they afford no evidence of the rate of growth of a bog, which may have been mountain or heath peat at one period or at one spot, marsh peat at another, and Sphagnum peat at a third; nor do they enable one to judge of the periods of time during which a bog may have increased in thickness, remained stationary, or decayed from time to time, according to the prevailing local or climatic conditions. The depth of peat underlying or overlying a root bed, therefore, does not necessarily prove the age of the latter, nor does it necessarily follow that the deepest bogs are the oldest. Probably the surface area of a bog would be the best standard of age, as it implies the result of climatic and other conditions upon different soils and situations, but, even here, many factors of acceleration and retardation of an uncertain nature have to be taken into account, and the most careful estimate may be wide of the mark.

The only facts which appear to throw some light upon the antiquity of the Pine, and the approximate date of the Oak and Pine period, are the traces of submerged forests round the coast of Ireland and Great Britain, the names associated with the ancient townlands into which Ireland is divided, and the materials of which the crannogs are built. The first shows that Oak and Pine, together with Hazel and other species, existed in the country when the land stood well above its present level, and that if a pure Pine and Birch period existed, it must have been, if anything, earlier than the final submergence of the land. The names of townlands suggest that while Oak must have been common at the time they acquired the reputation upon which their nomenclature was based, the existence of the Pine at that period, probably somewhere early in the Christian era, is very doubtful. The remains of the various crannogs, which go back to Pagan times in Ireland, prove the abundance of Oak and Hazel in their construction, while Pine is conspicuous, not by its absence, but by its rarity, and appears to be confined to the more ancient structures.

As regards the submerged forests, Pine, Oak, Birch, Hazel, &c., appear fairly generally distributed amongst them; but in one at least, Ardmore, county Waterford, no trace of Pine could be found by the writer. In Blacksod Bay, and at Bray, county Wicklow, the distribution appears to be Pine at the deeper level, and Oak within five to ten feet of high-water mark, following the order found in the peat bogs round the English coasts. Clement Reid[1] records Oak, Hazel, &c., but Pine in one or two instances only, and he attributes the submergence to the Neolithic Period. Praeger[2] also

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[1] "Origin of British Flora."

[2] Proc. R. I. A., series ii, vol. iv.

states, with reference to the raised beaches of the north-east of Ireland, that the submerged peat under Estuarine Clay contains Pine, Oak, Hazel, Alder, &c., and that the overlying or later deposits indicate a warmer climate than that of the present time. Putting the various pieces of evidence together, it would appear that the submergence of the land took place during the transition period from Pine to Pine and Oak, and that the climatic optimum, in which Oak predominated, came later, and prevailed towards the close of the Neolithic Period. Clement Reid supposes that the submergence began in England about 5000 years ago, and occupied about 1500 years; but the data upon which this conclusion is based are not very clear. If the opinion of the same author[1] be accepted, to the effect that the Oak would require one million years to spread unaided from one end of the British Isles to the other, the transition from pure Pine to pure Oak in the west of Ireland would require a longer period than the geologist would allow, since the last glaciation of the country.

The origin of the townland names may be regarded as negative rather than positive evidence; but it is significant that all existing tree species are perpetuated in these names, and the general omission of the Pine becomes all the more significant. Joyce[2] suggests that the one or two instances in which Pine is associated with townlands may refer to bog-timber rather than the living tree.

The occurrence of tree-stumps in or under mountain peat is not so well marked as in the lowland or marsh bogs. In most cases they occur singly or in small groups within a foot or so of the surface, and appear to have grown on dry heath peat. Intermixed with this mountain peat, and merging into it on all sides, are numerous shallow marsh bogs, and the stumps in these may be several feet above the surface of the soil. While Oak is seldom absent over large areas, it is evident that Pine is the predominant species in this type of peat, and occurs up to elevations of 1500 feet in the Wicklow Mountains, and down to sea-level in the west of Ireland, Birch being mixed with it everywhere. Oak occurs up to 800 feet on Slieve Bloom; but observations are lacking as to the exact altitude it attains in many parts of Ireland.

Whether in marsh or mountain peat, the occurrence of tree-stumps is very irregular, thick groups and single trees being usually separated by spaces free from stumps, and the general distribution is rather that of an open park-like arrangement of the trees than that of a dense forest. The age of the trees varies from 50 to 300 years or more, but, owing to the decay of the

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[1] "Origin of British Flora."

[2] "Irish Names of Places," vol. ii.

sap-wood, exact records are difficult to obtain. Stumps in marsh peat are, on the whole, larger, and show a more rapid growth than those in mountain peat, and the character of the underlying soil has evidently influenced their growth considerably.

The Present Treeless Condition of the West Coast of Ireland, and its Probable Causes.

If Clare Island alone gave evidence of a former wooded condition which no longer prevails, it might be assumed that special influences have been operating upon that area, which would account for the disappearance of trees. The effect of cultivation and grazing upon a limited area for a long period would be quite sufficient to prevent natural regeneration taking place, and bring about existing conditions. But a review of the coast-line between Donegal and Kerry, and of the various islands lying in the Atlantic, reveals not merely a general absence of trees over wide stretches of country, but, what is of greater significance, the occurrence of tree, shrub, and shade species in the form of small detached colonies a few miles apart, strongly suggestive of a former wooded condition of the intervening spaces. The presence of tree-stumps and logs in and under the peat which covers so large a proportion of the land-surface bears out this theory, although the peat remains probably belong to an older period than that of the existing forest flora. Where patches of natural woodland occur which prove the possibility of forest-growth under existing conditions, they are found to consist of small Oak, Ash, Hazel, Holly, Birch, Mountain Ash, with an occasional Elm, Aspen, Juniper, or Yew. The general composition of this forest flora differs little, if at all, from that prevailing over three-fourths of the British Isles; and, with the exception of Birch, Juniper, Aspen, and Mountain Ash, these species, but more especially Oak and Hazel, are associated with better soils and warmer summers than those now existing in the west of Ireland generally. The condition of these scattered woods is one which suggests the last stage of debility and degradation, the stems being short, crooked, and moss-grown, while the rate of growth is so slow that little alteration in the size of the trees or condition of the woods can be noted over long periods. It is quite evident that they form the rearguard of a retreating forest-growth, rather than the outposts of an advancing one, and the general conclusion to which a careful observer must arrive from all the facts before him is that a broad-leaved forest, in which Oak and Hazel predominated, invaded the whole of the west of Ireland at some early period, flourished there for an unknown number of centuries, and is now in full retreat.

In support of this conclusion, the occurrence of tree or shade species along the entire western coast-line, on most of the islands, and on the mountain-ranges far above the present tree limit, may be cited. Barrington[1] found *Scilla nutans, Luzula sylvatica*, and *Primula vulgaris* on the Great Blasket; while Praeger records *Digitalis purpurea* and *Lonicera Periclymenum* from the same island.[2] The Clare Island forest and shade flora has already been referred to. From Inishturk, a rocky island standing out in the Atlantic in the vicinity of Clare Island, Praeger[3] records *Betula pubescens, Corylus Avellana, Ilex aquifolium, Populus tremula, Salix cinerea*, and the following shade plants:—*Lonicera Periclymenum, Primula vulgaris, Luzula maxima*; while *Juniperus nana* occurs both on Inishturk and Achill Island, although absent from Clare Island. On Inishbofin, Praeger[4] found Aspen and Mountain Ash, and *Luzula maxima*; and the same observer records *Lonicera Periclymenum* and *Luzula erecta* from the Mullet,[5] and *Luzula maxima* on the extreme west of Achill Island.[6] Hart[7] recorded various shade plants, as—*Sanicula europæa, Scilla nutans, Luzula maxima, Digitalis purpurea, Primula vulgaris, Lonicera Periclymenum*, &c., at various elevations up to 2640 feet on the mountains of Mayo and Galway; while Oak was found up to 750 feet and Hazel up to 1100 feet. These records, while not absolute proofs of the existence of woods at an earlier period, prove the survival of plants so closely associated with shade that they furnish the student of plant associations with evidence that is practically convincing on this point when taken in conjunction with other facts.

Another point of importance in connexion with these relics of previous woodland extension is the more or less universal sterility of the soils on which they exist. While they are usually absent from the peat blanket which appears to wipe out everything but a characteristic peat flora, Oak and Hazel are frequently found on rock detritus, and in crevices of rock slopes; and while their survival on these sites is easily understood, it is difficult to imagine their establishing themselves under existing conditions. Oak and Hazel woods now growing on talus and Boulder-clay ground in the extreme west are not merely in a decadent and stunted condition, showing little vegetative and still less propagative vigour, but the surface is invariably covered with a surface flora of Heather, Vaccinium, Molinia, Sphagnum, and other plants, forming the early stages of peat formation, and the conditions are the reverse of those favourable for the establishment of Oak and Hazel,

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[1] Proc. R. I. A., series ii, vol. iii.
[2] Irish Naturalist, vol. xxi.
[3] Irish Naturalist, vol. xv.
[4] Irish Naturalist, vol. xx.
[5] Irish Naturalist, vol. xiv.
[6] Irish Naturalist, vol, xiii.
[7] Proc. R. I. A., series ii, vol.

two species which demand fairly good soil and growing seasons, with temperatures of at least 55°–60° Fahrenheit, for the production of fruit on a scale which would bring about their extension on bare land, or that occupied by a competing flora.

If the geographical distribution of the Oak and Hazel over Europe is investigated, it is found that the former species occurs in Scandinavia up to latitude 61° or thereabouts, although occasional trees may be found still further north. This latitude corresponds in that region to a July mean of about 60° Fahrenheit, and a period during which the temperature remains over 50° Fahrenheit for about 100 days, or from three to four months. From Valencia in the south of Ireland to Malin Head in the north, the July mean steadily decreases from 59° Fahrenheit to 57·2° Fahrenheit; while means over 50° Fahrenheit prevail from May to October, or for a period of about 180 days, the means for the above-named months being slightly over 50° Fahrenheit in the south, and slightly under in the north. In all the western Irish stations, however, the means for August are slightly higher than for July, and indicate a relatively warmer autumn than summer, as compared with most parts of the country. While the maximum mean temperatures for the summer months are higher at the northern limit of the Oak and Hazel region in Scandanavia than in western Ireland, the length of the growing season is very much longer in the latter, and this fact must be borne in mind when assuming the climatic conditions necessary for the propagative functions of the species in question. It is a matter of common observation that the normal vegetative development of the Oak in the British Isles corresponds to a July mean of about 59° Fahrenheit. By normal development is meant an average height-growth on average soils and situations, and in close woods, of from 80 to 100 feet, with diameters of 20 to 30 inches at breast height. Where the summers are cooler than those represented by this mean, good specimens of Oak are rarely found except on good soils and aspects. This fact is brought out fairly clearly if the July isotherm of 59° Fahrenheit is followed from the west of Ireland to the east coast of Scotland. So far as scanty meteorological records go, this isotherm passes a little north of Valencia Island, and thence in a north-easterly direction along the basin of the Shannon to about Londonderry. Skirting the northern and eastern coast-line, it crosses the Irish Sea somewhere about the Isle of Man, and then again turns north, and crosses Scotland about the latitude of Edinburgh. Along the western seaboard of Ireland few stations appear to go above 58° Fahrenheit, and the records for Blacksod Point[1] for

[1] Clare Island Survey, Part 6.

July and August in 1911 are 58·1° and 58·2°. West and north of this isotherm, Oaks of large size are exceedingly scarce, and although actual records of individual trees may be quite misleading as climatic indices, the writer cannot recall having seen any tree in the north-west of Ireland which would be regarded as of average size in England, except, perhaps, on exceptionally favoured sites, as at Westport House, the neighbourhood of Sligo, and other localities with good soils and shelter from westerly winds.

In Scotland, Hutchinson[1] recorded oaks of over 80 feet from Ross, Perth, and Clackmannan, and Elwes and Henry[2] record an Oak of 118 feet in Perthshire, the last-named county showing the greatest number of tall trees north of the line referred to above. Apart from a few favoured individuals, therefore, the Oak becomes a comparatively small and slow-growing species in the extreme north and west of the British Isles, although few, if any, parts of the latter are outside its limits of distribution in the form of scrub, or fail to show its occurrence as a timber-tree in earlier times by remains preserved in peat bogs.

If this July mean of 59° Fahrenheit is necessary for the normal vegetative development of the Oak, it is certainly necessary, and probably less than is required, for its normal reproductive functions, which require more heat than suffices for growth. The truth of this statement with regard to broad-leaved species in general was well exemplified in the case of the Spanish Chestnut in Ireland in 1911. This species attains as large dimensions in the south and midlands of Ireland as in any part of the British Isles, but the ripening of its fruit is a rare occurrence apart from the extreme south-east of the country. In 1911, when the July means reached 60° to 62° Fahrenheit, crops of ripe nuts were general south of Dublin, and were produced in other parts of Ireland. In the case of the Oak, acorns are able to ripen in all parts of Ireland in summers of average warmth, but the seed years are few and far between; the acorns are exceptionally small, and the crops poor, as compared with English yields. For the Oak to have become the dominant tree throughout the west of Ireland, a more plentiful seed-production must be assumed than that now taking place; and the same may be said in a general way of the Hazel, although the long growing season probably favours the latter species more than the Oak. That this heavier seed-production was due to greater summer warmth seems the only conclusion that can be arrived at, especially when due consideration is given to the fact that Oak scrub is found at much higher elevations throughout the British Isles than those at which the species now attains a timber size, or

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[1] Trans. Highland Agric. Soc., vol. xiii, 1881.

[2] "Trees of Great Britain and Ireland."

produces fertile seed. In every mountain district Oak scrub may be found well above the 1000-feet contour line, and although this may have occasionally arisen from seed produced at lower levels, the greater part of it must be regarded as relics of a wider extension of that species at some remote period, and under conditions which no longer exist. Moss[1] suggests that the appearance of heather and Vaccinium in the surface flora of Oak woods prevents natural regeneration ; but before this ground flora can establish itself, the leaf canopy of the Oak crop must be weakened by thinning or a reduction in the vegetative vigour of the crop. While thinning alone may alter the character of the surface flora, the appearance of the shade-bearing Vaccinium suggests a deterioration of surface-soil rather than an increase of light, and this may be due to climatic changes such as a lower summer temperature and heavier rainfall, and evidence of changes of a similar nature are found in the west of Ireland.

But another climatic factor of equal importance to temperature, and one by which the latter can be considerably influenced, is wind. While a low summer temperature may check or retard the growth and propagation of Oak and Hazel, wind can not only check but actually destroy growth already made, and this is especially found to be the case in the west of Ireland. This destructive effect of the wind along the coast is chiefly due to the salt content of the air-currents from the Atlantic, and during the summer and autumn not only partially destroys the foliage of broad-leaved trees, and the needles of many conifers which are usually better adapted for resisting adverse climatic features, but destroys the woody growth formed earlier in the season. Trees exposed to strong sea-winds acquire a characteristic form, and an examination of these trees shows that the ends of all branches or shoots exposed to the wind are killed back more or less annually for a certain distance, the succeeding year's growth being continued from buds or short spurs below the dead portion. This annual shortening back of each season's growth, which on the west coast takes place usually in autumn, invests the crown with a flattened surface on the top and windward sides, as if the branches had been trimmed with shears, while the leeward side of the crown, being in shelter, develops more or less normally, the tree thus being given an unequally balanced crown and a leaning stem.

On the extreme west, trees exposed directly to the wind cannot attain more than a few feet in height unless growing in masses, or sheltered by high ground to windward, and for a considerable distance from the coast,

[1] "Woodlands of England," in New Phytologist.

few indigenous species can be found until undulating or hilly ground occurs, and then hollows, valleys, and eastern slopes alone show trees of normal shape or development.

How far the effect of the salt wind extends inland it is difficult to say, but probably no part of Ireland is quite free from it. On high ground and poor soils, the salinity of the air, however, may be obscured by the ordinary desiccation caused by evaporation and a reduced temperature surrounding the branches. The evaporation effect of wind in drying up branches to a fatal degree is usually confined to trees with low vegetative vigour, as those growing at or near the vertical tree-limit, or on poor, acid soils, while it is a common occurrence in old trees, and forms the early stage of that condition to which the term "stag-headed" is applied. The cause of desiccation in all these cases is practically the same, namely, evaporation from the surface of the branch or leaf at a more rapid rate than the loss can be made good by water absorbed by the roots. In young and vigorous trees, or those growing on good soils, fatal desiccation seldom, if ever, occurs at elevations below 1000 feet in inland districts; but all freely exposed trees show a shorter growth of twigs and branches on the windward side, and the same tendency to produce a flat-topped crown. The further east, or the greater the shelter afforded to the westward, the less marked does this habit of growth become. But at high altitudes the reduction in osmotic pressure throughout the cellular system of the tree, brought about by the low temperatures of soil and air, may often cause the death of the ends of the branches by excessive evaporation, and produce results similar to those found near the sea. Trees growing on poor, peaty, or water-logged soils are also affected in the same way, owing to the slow rate at which the roots take in water, and their reduced functional activity.

The precise cause of the effect of sea-wind upon tree-growth is difficult to determine, but probably both chemical and physical action is responsible. That the salinity or low temperature of the air, and not merely the drying action of the wind, is the cause of injury may be inferred from the condition of trees growing near sea-level on north and east coast-lines, where the winds off the sea are comparatively rare in occurrence and light in force during the summer months. Trees and hedges within two hundred yards of the sea show the same effect from sea-wind on these coasts as those on the west, although the low elevation and good soil on which many of them are growing are able to produce a vigorous growth a few yards further inland.

In connexion with this point, a few observations made on the Old Head plantation near Louisburgh may be cited. Old Head rises sharply from the sea to a height of 340 feet, and is clothed with forest growth down to within

10 feet or so of sea-level. The effect of the sea-wind can be seen on the east and north aspects, and in situations quite sheltered from the west and south-west, and appears to be greater at lower than at higher levels. As the force of the wind increases with elevation, it would appear that the character of the wind, and not its force alone, is the factor which influences the growth of trees near the sea.

It is a rather curious fact that few indigenous British trees can be described as good sea-wind resisters, or as able to produce timber at high elevations. Experience gained during the last century in planting exposed sites brings out the fact that the best species for resisting or tolerating sea wind are Austrian, Corsican, Mountain, Maritime, and Monterey Pines, White American Spruce, Sitka Spruce, Silver Fir, and one or two others amongst the conifers, and Sycamore, Alder, Ash, Birch, Willow, Mountain Ash, Poplar, Elm, &c., amongst broad-leaved trees. Of these, Alder, Ash, Birch, and Mountain Ash are probably alone indigenous to the west of Ireland, and none of these approaches the Oak in numerical importance at the present day. After many centuries of exposure, therefore, there are few indications that the forest flora of the west has adapted itself to present conditions, or that the species best represented are those best adapted for wind-resistance. Whether this point has any reference to a comparatively recent alteration in the climatic conditions in the west is difficult to say, but it is significant that Scots Pine, which at one time covered the western sea-board, shows little ability to stand sea-wind with impunity, while the Oak, which followed it, is little, if at all, better.

One very common effect of destructive wind upon Oak and other broad-leaved woods is that of preventing the ripening of wood sufficiently well to enable flower-buds to form. Much of the growth of the trees being due to adventitious buds, and produced under conditions which prevent free exposure to light and sun, well-developed flower-buds cannot be formed in any quantity, and seed-production in wind-swept woods is reduced to a minimum, and may be prevented altogether. While this may not prevent bare ground being stocked, or old woodland regenerated by means of seed produced by trees growing in sheltered spots, it diminishes the reproductive power of the species over a wide area, and it is evident that little reproduction of Oak and Hazel is taking place in the west of Ireland at the present time, and certainly none on the more exposed sites.

A third adverse factor as regards Oak and Hazel in the west is soil, which is proverbially sterile and unproductive. A few oases of good land occur here and there, but rock and peat predominate. The extremely widespread distribution of Oak and Hazel, and the absence of Pine, render

it probable that not merely the climate but also the soil must have deteriorated long before historic times, and since the Oak spread throughout the west. With the present soil conditions, the Pine, which at one time was universally distributed over Ireland, would have a better chance of maintaining its footing than the Oak, and could scarcely have been crushed out by the latter. Yet there are good reasons for supposing that this actually occurred.

Whether this deterioration of the soil and the growth of peat was a direct result of climatic change is an open question. As already pointed out, there are good reasons for assuming a heavier rainfall and cooler summers at the present time than those of two or three thousand years ago, when dry heath probably occupied the surface now covered by mountain peat, and the more extensive growth of Sphagnum peat had not commenced.

The general conclusion at which one must arrive after reviewing the whole of the facts regarding the comparative absence of trees in the west of Ireland is, that after making due allowance for human interference, grazing, and other artificial causes, the present soil and climatic conditions are not those which prevailed at the time Oak and Hazel pushed their way to such extremely wind-exposed points as Clare Island, and colonized the whole of the mainland within 1000 or 1200 feet of sea-level. Warmer summers appear to have been the most likely feature which characterized a former climate, but whether these were accompanied by a lighter rainfall and a reduction in westerly winds is not so clearly suggested by the evidence available in the west of Ireland alone. An extension of the land, ten to twenty miles further west, which is suggested by geological evidence of changes in the sea-level, would place the present coast-line far enough inland to enable trees growing along that line to escape the worst effects of the sea-wind, and while the beneficial effect of this would be somewhat discounted by the higher elevation at which trees on existing land areas were growing, there is some reason to suppose that a lowering of the present sea-level by 100 feet or so would lead to an increase in summer temperature, and a reduction in the rainfall of lowland districts.

The year 1913 appears to have provided a good example of the effect of temperature upon the ripening of wood, resulting in a greater resistance to wind in trees throughout the Blacksod and Louisburgh districts. Exposed trees of Ash, Sycamore, Oak, Hazel, Thorn, &c., show large numbers of well-ripened and uninjured shoots; so much so, that many trees have partially lost their characteristic wind-swept appearance for the time being. Two wind-swept Oaks at Old Head, with flattened tops, and about 10 feet in height, possessed well-ripened 1913 shoots of 12 to 24 inches in length

in March, 1914, and much evidence of the same sort of thing could be seen between Mulranny and Tullaghan Bay, one of the most wind-swept parts of the Belmullet area.

The only explanation that can be found of this unusual occurrence is the higher autumn temperature of 1913 in that part of Ireland. The Blacksod records of the monthly means, as given in the Meteorological Office Reports, show the following differences from the average:—

	Mean Temperature.		Rainfall in Inches.	
	+	−	+	−
July, . .	—	1·2°	—	1·19
August, . .	0·2°	—	—	3·02
September, .	0·6°	—	·45	—
October, . .	1·9°	—	1·26	—
November, .	2·6°	—	1·69	—
December, .	1·5°	—	—	·67
Net, ± .	+ 5·6°	—	—	− 1·48

If the four months July to October only are taken, an increase of 1·5 is shown in temperature and a decrease of 2·5 in rainfall, the last three months in the year being responsible for the high gain in the former. It is not probable that the comparatively small difference in rainfall had any appreciable effect, and the higher temperature appears to be the only important difference from the normal in 1913, as winds were as strong and frequent as in 1912, although perhaps rather below the average on the whole.

If similar conditions to the above prevailed during a series of years, it is quite probable that tree-growth in the west might show quite a different development. As it is, the above proves the comparatively slight climatic change that would be necessary to restore the conditions which probably existed during the climatic optimum in the west of Ireland, although the higher temperatures possibly occurred earlier in the season than those of 1913.

Relation of Clare Island Forest Flora to that of Mainland.

The position of Clare Island with regard to the mainland and the existing distribution of trees on the latter raise certain questions which are of special interest, as they afford circumstantial evidence of the antiquity of the island flora. Clare Island is at present separated from the mainland by two

straits of the Atlantic, which form the entrances to Clew Bay. On the north-east the nearest point to the island is the southern end of Achillbeg, which lies about three miles from Clare Island lighthouse, and the same distance separates the Harbour on the south-east corner of the island from Roonah Quay, near Louisburgh. Rocks projecting above the sea in the channels to the north and south of the island show that the general depth of the sea is not great, and suggest that at one time Clare Island was either connected with the mainland or was only separated from it by narrow straits joining in Clew Bay. This suggestion is strengthened by geological evidence,[1] which goes to show that much of Clew Bay was once filled with glacial drift after the disappearance of the main ice-sheet moving in a south-westerly direction, while a subsequent local ice-sheet from the south passed over the island from the Mweelrea group of mountains, the moraines of which occupied the valleys of the rivers now running into the mouth of Clew Bay in a north-westerly direction. There is good reason for supposing, therefore, that the last connexion between Clare Island and the mainland was on the southern side, while the northern connexion was more or less interrupted by the drainage system of the land lying to the north and east of Clew Bay.

A comparison of the past and present forest flora of Achill Island and the Curraun peninsula to the north, and the stretch of flat land between Louisburgh and the Mweelrea and Croaghpatrick mountains, and the character of the soils in which this flora existed, renders it probable that the country to the south of the island was more heavily timbered at an early period than that on the Achill side. On the Louisburgh side, the soil is of a comparatively fertile character, and is highly cultivated. While peat originally covered the whole district in a general way, it owed its origin to the more or less marshy character of the surface, which subsequent drainage was able to turn into agricultural land, and on and under the peat Oak and Pine once existed in large numbers, as is proved by the stumps now remaining. While the whole area is wind-swept and bare at the present-time, it is evident that the general lie of the land, a considerable proportion of which slopes in an easterly direction from the western coast-line, would, under existing climatic conditions, allow trees of the same species to thrive at the present time if planted in large masses. The existing tree-growth is chiefly confined to belts and clumps round a few farm-houses, but at Old Head a considerable area of native timber and plantation exists, and suggests that the present scarcity of tree-growth on this side of Clew Bay is chiefly due to human interference, and not to natural causes. On the sheltered side of Old Head, Oak, Ash, Beech, Pine, Sycamore, etc., of normal dimensions are found, although rather

[1] Clare Island Survey, Part 7.

smaller than the size attained by these species on similar soils and sites further inland. Oak, Birch, Hazel, Willow, and Holly scrub clothe the north and south slopes of the head, while miniature clumps of Oak, with a surface-growth of Luzula, Bracken, etc., on the summit prove that at no very distant date the greater part of this hill was covered with timber. There is good reason to suppose, therefore, that Old Head forms the last stronghold of the more modern forest flora of the district, and that at one time it extended across a ridge now broken through or covered by the sea, to Clare Island, and covered much of the valley now occupied by Clew Bay.

On the mainland to the north, a more sterile surface soil, practically covered with mountain peat, prevails over the whole of Achill Island, and the country west of a line from Newport to Belmullet. Over the whole of this tract the sterility of the surface soil is far greater than on the area already described, and the original forest covering appears to have consisted almost entirely of Pine, stumps of which are scattered over the original surface now covered by peat. The small size of the Pine stumps on the slopes facing Clew Bay between Newport and Mulranny suggests that this area was always comparatively sterile and wind-swept. Scrub Oak exists at Mulranny, Glendarary House near Achill Sound, and a few other places, but the growth of all vegetation suffers considerably from wind on this side of the bay, except where sheltered by hills to the westward. Modern plantations of Ash, Alder, Sycamore, Maritime and Scots Pine exist in a few places, and at Glendarary fine specimens of *Pinus insignis*, planted about 1870 on a peat-covered hillside, prove the fitness of this species for the west of Ireland.

The above facts favour the theory that the more recent forest flora of Clare Island came in from the south or east when a wide valley covered with Oak, Hazel, Holly, etc., occupied a great part of the site now forming Clew Bay, while the high ground to the north was covered with Pines. The former type of forest invaded the Pine forest already present on Clare Island, and by sheer force of numbers probably reduced the proportion of Pines to an extent which gradually placed them in the position of a subordinate species, and created difficulties in the way of their natural regeneration which finally brought about the total extinction of the species over wide areas, its final disappearance being possibly due to human agency, although the exact influence of the latter is a doubtful point, as already suggested.

This disappearance of the Pine from the Clare Island and west of Ireland flora is not easy of explanation. The few Irish place-names associated with trees on the island, which are quoted by MacNeill,[1] refer to Oak and woody growth generally, while Colgan[2] comments on the absence of names of trees

[1] Clare Island Survey, Part 3. [2] Clare Island Survey, Part 4.

generally in the vernacular of the island. This omission of any mention of the tree and its associations is probably connected with the increasing scarcity of this species all over Ireland from a very early period, and presents many perplexing problems. The destruction of the species by fire, grazing, and other causes might be regarded as a satisfactory explanation if Pine had been plentiful down to the historic period; but while there is no evidence that this was the case, there is much circumstantial evidence to the contrary. The omission of the tree in Irish place-names has already been referred to. Bog stumps on the whole show no trace of having been destroyed by fire or felling, and the occasional exposure of a charred or felled stump in turf-cutting proves nothing as regards the death of trees over large areas, which have evidently died *in situ*, the stems decaying away above the surface, while a growth of Sphagnum or marsh bog formed over the roots and preserved them intact, and in their present condition. This killing out of Pine over large areas of peat-bog has already been dealt with, but the disappearance of the tree over adjoining areas free from peat at the present time, and a still larger peat-free area at an earlier period, suggests some widespread cause which must have had a more powerful influence upon the life-history of the Pine than grazing or human interference.

Compared with most species, the Pine shows not only great powers of reproduction and dispersal with unfavourable surface conditions, but a vitality which is only exceeded by the Oak and Yew amongst British or Irish trees. No soil type exists in Ireland on which the Pine will not flourish, although its weakly calcifuge character might be disadvantageous in a few districts. Since its re-introduction into Ireland and England during the last two or three hundred years, it has spread over bogs, mountains, and heaths in spite of fires, grazing, and other forms of abuse, and shows no evidence that the climatic conditions are unfavourable to it, whether it is dependent upon the cool, damp summers of Ireland, or the warmer and drier ones of the south of England. No change in the climate great enough to affect the development of the tree can have occurred since it flourished all over the British Isles, or, if a slight change has taken place, it is one which should be to this tree's advantage rather than otherwise.

The only reasonable explanation of its disappearance, but one which is to a certain extent inadequate, is the increase and progressive development of Oak and other broad-leaved species in the original Pine forests during the climatic optimum, which produced a shade-flora and humus layer unfavourable to the natural regeneration of the Pine on the better classes of soil, while the poorer heath- and Pine-covered areas were ultimately affected by the mountain peat-formation when a damper and cooler climate followed. Milder

winters would also enable a great increase to take place in the spread of Gorse, beneath which seedlings of Pine would be quickly smothered. While this theory does not satisfactorily explain the total disappearance of the tree, it affords a possible reason for its speedy destruction when semi-civilized man came on the scene, and commenced to burn the Gorse and Heather for the sake of providing rough pasturage—a process which would destroy seedlings and young trees on many areas of mountain which probably formed the last stronghold of the Pine. One possible natural factor in the process of extinction may be mentioned. Many stumps of Fir in bogs show the "rhizomorphs" or mycelium of *Agaricus melleus*, the Honey Fungus. This fungus is particularly fatal to young Pines, and when the latter are planted on woodland cleared of Oak, Ash, or other broad-leaved species, large numbers succumb. On a soil more or less permeated by the mycelium of this fungus, as is old Oak and Ash woodland, the Pine may have had an enemy of considerable virulence to contend with, and this, added to the shade and thick, loose humus layer, may have practically exterminated it from large areas.

At what period the Pine ceased to be a recognizable component of the forest flora of Clare Island is difficult to say. If the absence of Pine from the higher-lying forest zone is confirmed, it appears probable that the species disappeared from the island earlier than was the case on the mainland, as there is no trace of it under the mountain peat which covers the Oak stumps on the former, while it occurs everywhere under mountain peat on the mainland. Submerged forests on Achill Sound, Tullaghan and Bellacragher Bays, &c., show that Oak and Pine formed a mixed forest when the sea-level was from five to ten feet lower than at present, while the same mixture in the lowland peat-bogs occurred previous to the formation of Sphagnum peat. As already pointed out, an increase in the temperature would favour rather than prevent the spreading of Pine on to the higher ground, but the preservation of the stumps would only occur when they were covered with peat. If the formation of the mountain peat on Clare Island took place at a later period than that on the mainland, owing to more favourable soil conditions or other causes, the Oak may have succeeded in suppressing the Pine on the restricted area available for tree-growth on the island before mountain peat-formation began, while on the poorer soils of the Achill and Belmullet areas, the extension of Oak would be hindered on the one hand, and the peat-formation hastened on the other. There are several reasons for supposing that mountain peat was not extensively developed at high elevations, or in the west of Ireland, until after the climatic optimum, a period corresponding to the greatest development of the Oak and Hazel flora. Wright[1] supposes that this optimum occurred in early Neolithic times, about the time the sea had

[1] "The Quaternary Ice Age."

attained its maximum encroachment on the land, as shown by the 25-foot beach in the north-east of Ireland. Praeger[1] summarizes the climatic changes corresponding to differences in the sea-level in this part of Ireland as follows:—"The peat bed [containing a submerged forest of mixed Oak, Hazel, Alder, Pine, &c.], so far as we know its flora and fauna, points to a climate not much differing from that which exists at present. A slight submergence allowed the deposition of the lower estuarine clay, with its rather southern fauna, and a further submergence was followed by the accumulation of deposits of mud in the shape of the upper estuarine clay, of sand banks, such as the Curran of Larne, and of shelly beach deposits, such as Portrush. At this period the southern element of the fauna attained its maximum. Finally came elevation of the land, and with the last change of level came the final fluctuation in the character of the animal life—a distinct return towards its former northern character, which has left the fauna as we now find it."

Correlating the above changes in sea-level and marine fauna with the growth of trees and peat on Clare Island, it is possible to imagine the following succession:—

Period.	Sea-Level.	Submerged or Peat Forest Type.	Peat Type.
1	20 – 30 feet lower.	Pine and Birch.	Shallow Marsh Peat.
2	0 – 10 ,,	Mixed Oak and Pine.	Deeper Marsh Peat.
3	0 – 25 higher on north-east coast of Ireland.	Oak, Hazel, etc.	Sphagnum Peat on Marsh bog.
4	Present level.	Broad-leaved Scrub.	Mountain Peat in west of Ireland and at high elevations.

While the above assumption regarding the succession of species appears reasonable, it is evident that the general absence of the Oak at more than ten feet below present high-water mark in Achill Sound does not explain its introduction to Clare Island by a land-bridge towards the end of the rise in sea-level. There is, however, proof of the existence of the Oak in the southern parts of Ireland when the sea failed to reach the present low-water mark. At Ardmore, County Waterford, no trace of Pine can be seen, while Oak, Birch, &c., extend under the present sea-level, and at Bray and several other places Oak, &c., appear to go much lower than the ten feet assumed above. But a possible explanation of the late introduction of Oak into the island by land is the strong probability of any land-bridge having partially survived the rise of the sea for a long period, owing to the time required to completely eat away eight to ten miles of Boulder-clay. There is every probability, again, that the bed of the channel between Clare Island and the mainland has been

[1] Proc. R. I. A., Series iii, vol. iv.

deepened by tidal scour during the last two or three thousand years, so that the fall in sea-level necessary to lay dry the present channel has only partly to do with the problem. Another point necessary to bear in mind is the fact that the submerged forest and peat layers in Blacksod Bay and adjoining areas were formed at a time when higher ground, in the shape of sand, gravel, or clay ridges, must have existed in a seaward direction, otherwise the formation of marsh and peat could not have occurred. Many of the trees and the overlying or surrounding peat may thus have grown on a surface actually below high-water mark, and not been submerged until the barriers on the sea side had been broken through by erosion. The appearance of having grown on a surface sloping gradually down to and under the sea, which these submerged forests now present to the eye, may lead to quite erroneous ideas being formed of the rate at which the sea advanced, and it is highly probable that this occurred in the form of a series of jerks instead of as a gradual and steady advance. Land may thus have existed several miles to seaward until quite recent times, and afforded a foothold for Oaks on islands and peninsulas no longer in existence. A familiar example of the above condition of things may be seen between Greystones and Wicklow, where the sea has encroached nearly a mile within the memory of those now living, and where the ridge on which the railway runs is the only barrier against further encroachment.

The possibility of the introduction of the forest flora by wind, water, or animals has been fully discussed by Praeger,[1] and, so far as many species are concerned, presents little difficulty. But Oak and Hazel, the two most significant components of the present forest flora, cannot be distributed by wind, while ripe acorns and nuts sink rapidly after immersion in water, and it is unlikely that they would, in the event of their floating, get beyond the high-water mark of any shore-line on which they were cast up unaided. No bird exists which would be likely to carry nuts, and although acorns are frequently carried by Rooks two or three hundred yards for more convenient consumption, the chances of their carrying them over two or three miles of sea are very remote. Acorns may be carried in an undigested state in the crops of Pigeons, but the death of the birds shortly after a meal would be necessary to enable them to germinate. The chances of the introduction of these species by any other than overland routes are, therefore, too remote to be accepted as foregone conclusions, more especially as Clare Island appears to be the only island on the western seaboard which contains Oak, although Hazel has been recorded also from Inishturk by Praeger.[2]

The absence of several mainland species from Clare Island may be

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[1] Clare Island Survey, Part 10.

[2] Irish Naturalist, vol. xvi.

regarded as bearing upon this point. Ash is probably the most common indigenous tree in the Irish flora at the present time, but does not appear to exist on any of the western islands except where planted. Compared with the Oak and Hazel, its facilities for dispersal by air and water are numerous, while it thrives better in maritime districts than either, and the same applies to the Wych Elm. Alder is almost as common as Ash on the mainland, and both species are found at Old Head and Achill, probably native. This species stands sea-wind better than any broad-leaved tree, and is now being planted for shelter hedges on Clare Island with fair success. It also distributes itself easily by wind, water, birds, etc., and, when once established, is difficult to eradicate from damp ground. Amongst the numerous samples of bog-timber collected by the writer on the island, no trace of Ash was found, and it is reasonable to assume that this species never existed there. It is highly probable, therefore, that the separation of Clare Island from the mainland occurred during the movement of the present forest flora westward, the earlier or more vigorous arrivals on the seaboard reaching the island, but later comers being shut out by the sea-barrier subsequently formed. Several of the Clare Island species, such as Holly, Mountain Ash, etc., may have arrived at any time, as the distribution of these species by birds is constantly going on; but the presence of Oak and possibly Hazel on the one hand, and the absence of Ash, Elm, &c., on the other, are inexplicable on any other grounds than the above.

The main conclusions which one arrives at from a careful survey of all the facts regarding the past and present forest flora of Clare Island are:—

1st. That the earliest tree-growth existed when Clare Island was connected with the mainland, and that Pine and Birch were the principal species.

2nd. That the Oak and Hazel followed the Pine, and reached the island before its connexion with the mainland was entirely broken off.

3rd. That the Oak and Hazel gradually dominated the Pine, when the former produced timber of medium size at an altitude of 400 feet over present sea-level.

4th. That the absence of Ash, Wych Elm, Alder, etc., from the whole of the western islands suggests that these islands possess the oldest representatives of the mainland forest flora only, and were separated from the mainland at an early period.

5th. That while the present stunted condition of tree-growth on the island is partly due to human agency, there are good grounds for supposing that the summers are cooler at the present time than when the Oak occurred in comparatively large numbers.

Clare Island, showing areas with scrub and bog timber.

Clare Island Survey.—Forbes: Tree-Growth.

Bog east of Lough Avullin, showing old Pine forest in centre.

CLARE ISLAND SURVEY.—FORBES: TREE-GROWTH.

The 1,200-foot path on Croaghmore. *R. Welch, Photo.*

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PHANEROGAMIA AND PTERIDOPHYTA.

By R. LLOYD PRAEGER.

Plates I–VI.

[Read June 12 and November 13. Published November 29, 1911.]

CONTENTS.

1. GENERAL FEATURES OF THE DISTRICT.

It is necessary, in the first place, to recall briefly what will be found in another section as to the general features of Clare Island and its environment. A glance at a map will show many features that must be borne in mind by the reader of the following pages. West Mayo and West Galway form together a great buttress, composed mainly of igneous and metamorphic rocks, and of early Palaeozoic slates, projecting boldly into the Atlantic, and forming, with the exception of the headlands of Kerry and West Cork, the most westerly

land in Europe. This district includes many groups of mountains, the higher ones rising to about 2000-2600 feet, with wide areas of lower undulating ground. On both high and low ground, peat predominates, and often stretches unbroken over wide areas, with a limited and monotonous vegetation. The coast-line is very broken and irregular, with outlying peninsulas and islands. In the area with which we are concerned, the large island of Achill, swathed in bog and almost treeless, stands boldly out, separated from the mainland by a narrow, shallow strait.

South of Achill, Clare Island, Inishturk, and Inishbofin lie in a string off the coast, separated from each other by channels about 5 miles in width. Clare Island is the nearest to the mainland (3 miles); Inishturk the furthest (9 miles). Clare Island is much the highest (1520 feet), and also the largest ($6\frac{1}{6}$ square miles). The islands all lie in the full sweep of the rollers and storms of the Atlantic. The prevailing winds are off the ocean—west and south-west. The rainfall may be taken at about 60 inches. The climate is mild and moist—mean January temperature about 43° F.; mean July temperature about 58° F. The western side of all the islands is cliff-bound, and desperately exposed; the population and cultivation are huddled in sheltered nooks, and towards the eastern side.

2. EXTENT AND CHARACTER OF THE FLORA OF CLARE ISLAND.

Prior to the expeditions of 1909–1911, the Flowering Plants and their allies were the only section of the natural history of Clare Island about which anything was known, and as regards them, this knowledge was of recent date. In July, 1903, my wife and I had spent a week investigating the flora of the island, and the results were in the course of a few months communicated to the "Irish Naturalist."[1] In this paper the flora is described and listed, and a few notes on the plant-formations are given. The vegetation of the island as noted on that occasion proved more varied and more interesting than was expected. The list of species ran up to over 360, the most striking feature of the flora being the occurrence of an extensive colony of alpines at a comparatively low elevation on the sea-scarp of Croaghmore. In the course of the survey of 1909–1911, much general work fell to me as organizer and secretary, otherwise the amount of time spent on the island would have permitted of a very detailed floristic study. As it was, little

[1] R. Ll. Praeger: The Flora of Clare Island. Irish Nat., xii, pp. 277-294. 1903.

attention could be given to critical plants, and the time devoted to botany was spent mainly in ecological work, in mapping, and in studying the influence of man upon the flora. A certain amount of time was devoted each season to the examination of remote or promising spots, and especially to the complete examination of the great precipice of Croaghmore. As a result, some 30 additional species have been found, many of these being uncommon plants, and some of them of high interest. The more important additions to the former list include *Cochlearia groenlandica, Saxifraga Geum, Erica mediterranea, Orobanche rubra, Salix herbacea, Cephalanthera ensifolia, Cystopteris fragilis, Aspidium Lonchitis.*

The total flora now stands at 393; a flora large, as are those of Inishturk and Inishbofin, in comparison with the flora of the adjoining island of Achill, or of the peninsula of the Mullet, as the following table will show:—

—	Area in square miles.	Greatest elevation in feet.	Flora.[5]
Inishbofin,[1]	$4\frac{1}{2}$	292	379
Inishturk,[2]	$2\frac{1}{4}$	629	327
Clare Island, ...	$6\frac{1}{6}$	1520	393
Achill Island,[3]	57	2204	414
The Mullet,[4]	45	434	348

This high total is, no doubt, due to the diversity of surface of Clare Island, as compared with the flatter, more wind-swept surface of the Mullet, and to the smaller proportion of monotonous peat-bog such as dominates Achill. The Inishturk and Inishbofin totals compare favourably with that of Clare Island, The poverty of the Mullet, which has had the advantage of continuous terrestrial migration, is remarkable.

Looking at the flora of these outlying areas as a whole, we are struck with the continuity of distribution of some of the rare or interesting species, and with the discontinuity in the range of others. For instance, *Saxifraga umbrosa, Sedum Rhodiola, Lobelia Dortmanna* (except Clare Island), *Juniperus nana*,

[1] A. G. More: Report on the Flora of Inish-bofin, Galway. Proc. R.I. Acad., (2) Science, ii, pp. 553-578. 1876. R. Ll. Praeger: Notes on the Flora of Inishbofin. Irish Nat., xx, pp. 165–172. 1911.

[2] R. Ll. Praeger: The Flora of Inishturk. Irish Nat., xvi, pp. 113-125. 1907.

[3] R. Ll. Praeger: The Flora of Achill Island. Irish Nat., xiii, pp. 265–289. 1904.

[4] R. Ll. Praeger: The Flora of the Mullet and Inishkea. Irish Nat., xiv, pp. 229–244. 1905.

[5] That is, species and sub-species, according to the standard adopted in "Irish Topographical Botany," which can be ranked as native or naturalized in these areas. Characeae in all cases omitted—they are included in some of the above reports.

Lastrea aemula, Osmunda regalis, have penetrated, mostly in abundance, to all these outposts, the alpine species descending in all cases to close upon sea-level.

On the other hand, the next stations of *Saxifraga Geum* and *S. decipiens* are in Kerry; of *Silene acaulis* in Sligo; of *Helianthemum guttatum* and *Hieracium hypochaeroides* in Cork; of *Ceratophyllum demersum* in Westmeath and Clare; of *Calamagrostis Epigejos* in the Aran Islands in Galway Bay; and of *Euphorbia hiberna* on Slieve Aughty in S.E. Galway. *Lychnis diurna,* found sparingly on Inishturk and Clare Island, has its next station on Lough Mask; *Trifolium arvense* is on the whole west coast of Ireland found only on Inishturk and on one of the Aran Islands.

Analytical Notes.—Of some 370 species which are known to grow, or which probably grow, in all the forty Irish botanical divisions, about 300 are present on Clare Island—in other words, about 80 per cent. of the Clare Island flora is made up of "Universal" plants. The same comparison within the flora of the whole of West Mayo would give 60 per cent. of Universal plants for that division; or within the Irish flora approximately 30 per cent. In Connacian type plants Clare Island is remarkably poor—a feature which it shares with Inishbofin, as will be seen later. Of 63 Connacian species listed in my paper on Types of Distribution,[1] only five (*Saxifraga umbrosa, Erica mediterranea, Oxyria digyna, Juniperus nana,* and *Asplenium viride*) occur on the island. As to the other types, the only Ultonian plants are *Silene acaulis* and *Saxifraga oppositifolia*; the only characteristically Mumonian, *Saxifraga Geum*; Lagenian type is not represented, save by *Carex dioica,* of which recent extensions of range suggest removal from that type. Of Marginal plants, 18 out of 46 are present; of Central plants, only one (*Juncus obtusiflorus*) out of 38.

One would expect the flora of Clare Island to be thoroughly calcifuge, and such is found to be the case. Taking the "Cybele Hibernica" standard, we find that of 56 species classed as calcicole, only 8, or 14 per cent., occur. These are 5 "calcicole B" plants (namely, *Anthyllis Vulneraria, Tussilago Farfara, ? Carduus nutans, Leontodon hirtus, Carex glauca*) and three "calcicole C" plants (*Antennaria dioica, Pulicaria dysenterica,* and *Convolvulus arvensis*). On the other hand, of 75 species classed as calcifuge, 59, or over 78 per cent., are found on the island.

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[1] R. Ll. Praeger: On types of distribution in the Irish Flora. Proc. R.I. Acad., xxiv, Sect. B, pp. 1–60. 1902.

Comparison of the Floras of Clare Island, Inishturk, and Inishbofin.

These three adjoining islands are, on the whole, so similar as regards position and physical conditions that it is interesting to note some points of similarity and dissimilarity in their floras, and we now possess the materials for such a comparison. As regards Clare Island, the list of the flora is now very full. Inishturk I explored pretty thoroughly in 1906, so much so that two additional days spent on the island in 1911 added only one plant (*Thymus Chamaedrys*) to the flora. The Bofin flora was examined by A. G. More and R. M. Barrington in 1875. To their list of 303 plants I added 82 during a three days' visit in 1911, and the Bofin list may now also be regarded as fairly complete. The relative size, elevation, and total floras of the three islands have been given above (p. 3). They are all mainly or wholly composed of Silurian slates. It may be added that Bofin is better supplied with lakelets and with sandy shores than the other two, and that Clare Island is conspicuous on account of its high hill.

We find, in the first place, 274 species common to the three islands. This represents $\frac{274}{465}$, or 54 per cent., of the combined flora of the three. These plants are all found on adjoining areas, and most of them are common plants in Ireland; but a few of the more interesting may be listed:—

Cochlearia groenlandica.	Juniperus nana.
Spergularia rupestris.	Empetrum nigrum.
Radiola linoides.	Sparganium affine.
Saxifraga umbrosa.	Carex limosa.
Sedum Rhodiola.	Festuca rottboellioides.
Matricaria discoidea.	Asplenium marinum.
Myosotis repens.	Lastrea aemula.
Pinguicula lusitanica.	Osmunda regalis.
Thymus Chamaedrys.	Ophioglossum vulgatum.
Lamium intermedium.	Selaginella selaginoides.

If we now compile lists showing the species which are confined to each of the three islands, and those which are absent from one of the three only, we shall have carried the comparison sufficiently far. I shall leave out of account a few non-naturalized introductions recorded from the several islands.

PRESENT ON CLARE ISLAND ONLY.

Anemone nemorosa.
Nymphaea alba.
Viola arvensis.
Silene acaulis.
Lotus uliginosus.
Rubus plicatus.
R. saxatilis.
Geum rivale.
Potentilla Fragariastrum.
Alchemilla vulgaris.
Saxifraga oppositifolia.
S. Geum.
S. decipiens.
Sanicula europaea.
Aegopodium Podagraria.
Eupatorium cannabinum.
Filago germanica.
Gnaphalium sylvaticum.
Saussurea alpina.
Hieracium anglicum.
H. hypochaeroides.
Erica mediterranea.
Fraxinus excelsior.
Myosotis versicolor.
Digitalis purpurea.
Veronica officinalis.
Orobanche rubra.
Ajuga reptans.
Polygonum lapathifolium.
Oxyria digyna.
Salix herbacea.
Quercus sessiliflora.
Listera cordata.
Cephalanthera ensifolia.
Scilla nutans.
Juncus obtusiflorus.
Alisma Plantago.
A. ranunculoides.
Scirpus caespitosus.
Carex sylvatica.
Phalaris arundinacea.
Alopecurus geniculatus.
Asplenium viride.
A. Trichomanes.
Cystopteris fragilis.
Aspidium Lonchitis.
A. aculeatum.
A. angulare.
Equisetum maximum.
49 in all.

ABSENT FROM CLARE ISLAND ONLY.

Fumaria pallidiflora.
Helianthemum guttatum.
Viola canina.
Trifolium medium.
T. procumbens.
Rubus dumnoniensis.
Lobelia Dortmanna.
Centunculus minimus.
Populus tremula.
Allium Babingtonii.
Agrostis canina.
Glyceria maritima.
Lolium temulentum.
Asplenium Ruta-muraria.
14 in all.

If we examine the above "present" and "absent" lists, we find that they fully reflect the features of Clare Island, as compared with Turk and Bofin. No less than 12 of the former are montane or alpine species, which owe their presence to the "Big Hill," which has a much larger mountain-flora than can be easily accounted for. No mountain species occurs in the "absent" list.

Ten more are woodland species—trees or shade-plants—brought in by the comparative shelter which obtains on Clare Island. *Populus tremula* is the only species of this group in the "absent" list. Three hydrophytes also figure, against one (*Lobelia Dortmanna*) absent.

PRESENT ON INISHTURK ONLY.

Trifolium arvense.
Rubus erythrinus.
R. Borreri.
Crataegus Oxyacantha.
Drosera intermedia.
Anthriscus sylvestris.
Sherardia arvensis.
Carlina vulgaris.
Euphorbia hiberna.
Phleum pratense.
Holcus mollis.
Isoetes lacustris.
12 in all.

ABSENT FROM INISHTURK ONLY.

Ranunculus hederaceus.
Nuphar luteum.
Sisymbrium officinale.
Raphanus Raphanistrum.
Spergularia salina.
Ulex europaeus.
Vicia hirsuta.
Potentilla procumbens.
Pyrus Aucuparia.
Drosera anglica.
Sedum acre.
Callitriche hamulata.
Peplis Portula.
Conium maculatum.
Apium inundatum.
Bidens tripartita.
Pulicaria dysenterica.
Senecio sylvaticus.
Campanula rotundifolia.
Vaccinium Myrtillus.
Convolvulus arvensis.
Symphytum officinale.
Scrophularia aquatica.
Veronica scutellata.
V. Tournefortii.
Pedicularis palustris.
Utricularia intermedia.
Salsola Kali.
Polygonum amphibium.
P. Raii.
Rumex conglomeratus.
Myrica Gale.
Luzula campestris.
Sparganium ramosum.
Lemna minor.
Potamogeton pusillus.
Scirpus maritimus.
Rhynchospora alba.
Eriophorum vaginatum.
Carex arenaria.
C. ampullacea.
Agropyron junceum.
Hymenophyllum unilaterale.
43 in all.

Here the only feature of the "present" list is a group of three woodland species (*Crataegus Oxyacantha, Anthriscus sylvestris, Euphorbia hiberna*). The first occurred as one young bush, rooted in a chink of the rocks (bird-sown probably). The others are confined to the sheltered, bushy slope over the harbour. In the "absent" list a conspicuous feature is the number of hydrophytes (thirteen species), a result of the paucity of lakelets; while the absence

of sandy beaches is accountable for the appearance in the list of *Sedum acre*, *Salsola Kali*, *Polygonum Raii*, *Carex arenaria*, *Agropyron junceum*.

PRESENT ON INISHBOFIN ONLY.

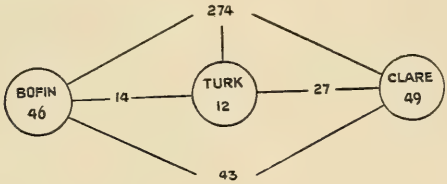
Ranunculus trichophyllus.
R. Baudotii.
R. bulbosus.
Arabis ciliata.
Brassica nigra.
Senebiera didyma.
Cakile maritima.
Raphanus maritimus.
Arenaria serpyllifolia.
Elatine hexandra.
Malva sylvestris.
M. rotundifolia.
Erodium cicutarium.
Vicia angustifolia.
Rubus carpinifolius.
R. mollissimus.
R. dunensis.
R. villicaulis.
Potentilla reptans.
Agrimonia Eupatoria.
Callitriche verna.
Eryngium maritimum.
Aethusa Cynapium.
Inula Helenium.
Tanacetum vulgare.
Centaurea Scabiosa.
Veronica Anagallis.
Bartsia viscosa.
Scutellaria minor.
Atriplex Babingtonii.
Ophrys apifera.
Habenaria viridis.
Juncus conglomeratus.
Potamogeton pectinatus.
Ruppia rostellata.
Zostera marina.
Eriocaulon septangulare.
Scirpus pauciflorus.
Calamagrostis Epigejos.
Psamma arenaria.
Catabrosa aquatica.
Glyceria plicata.
Festuca elatior.
Ceterach officinarum.
Lycopodium inundatum.
Isoetes echinospora.
46 in all.

ABSENT FROM INISHBOFIN ONLY.

Cardamine hirsuta.
Polygala vulgaris.
Lychnis diurna.
Ilex Aquifolium.
Rubus pulcherrimus.
R. iricus.
Alchemilla arvensis.
Pyrus Malus.
Chrysosplenium oppositifolium.
Cotyledon Umbilicus.
Circaea lutetiana.
Valeriana sambucifolia.
Mentha arvensis.
Betula pubescens.
Corylus Avellana.
Listera ovata.
Orchis mascula.
Sparganium minimum.
Scirpus setaceus.
Carex paniculata.
C. pilulifera.
C. Hornschuchiana.
Deschampsia caespitosa.
Scolopendrium vulgare.
Botrychium Lunaria.
Equisetum palustre.
Lycopodium Selago.
27 in all.

On Bofin an interesting feature is the scarcity of woodland plants, seven species being absent there which occur on both the other islands, against which no species occurs on Bofin only. The presence of lakelets also makes itself felt by eleven hydrophytes in the "present" list to two in the "absent" list. Xerophytes are also well represented; sixteen are present; only one absent. In this category it is interesting to note that the influence of calcareous sea-sands makes itself felt in the presence of some distinctly calcicole species, such as *Arabis ciliata*, *Centaurea Scabiosa*, *Ophrys apifera*, *Ceterach officinarum* (the last on a dry-built wall). In any case, Bofin enjoys generally a lighter soil, which gives to the flora a more xerophile facies, as is well seen in the great abundance, as compared with the other islands, of *Senecio Jacobaea*, and the corresponding scarcity of *S. aquaticus*.

The above analysis of the flora of the three islands may be expressed diagrammatically thus:—



Using the "index of floral diversity" which Colgan has proposed,[1] we find that this index, as regards Clare and Turk, is $\frac{92+26}{419}$, or ·282; as regards Clare and Bofin, $\frac{76+60}{453}$, or ·300; as regards Turk and Bofin, $\frac{39+89}{416}$, or ·308. It will be seen that the amount of difference between the floras of the three islands is pretty uniform, there being a slightly greater divergence between Turk and Bofin than between the two other pairs. This is due to the fact that Bofin is best, and Turk is worst, provided with fresh water and with sandy beaches.

It is interesting to see what common Irish plants are absent from this group of islands. We may select for this purpose those species, absent from the three islands, which occur throughout Ireland (or the maritime species around the whole coast), and are also frequent or common in West Mayo. This latter qualification cuts out certain calcicole species, such as *Euonymus*

[1] Irish Nat., x., p. 236. The index of floral diversity is "the ratio which the total of species not common to both areas bears to the total flora of the two areas combined."

europaeus, Orchis pyramidalis, and *Juncus glaucus,* which, though occurring throughout Ireland, are in West Mayo local, owing to the rarity of limestone, and would not be expected to occur on these Silurian islands.

COMMON PLANTS ABSENT FROM THE THREE ISLANDS.

Barbarea vulgaris.
Erophila vulgaris.
Reseda Luteola.
Silene Cucubalus.
Sagina apetala.
Cytisus scoparius.
Medicago lupulina.
Rubus Idaeus.
Geum urbanum.
Rosa tomentosa.
Hippuris vulgaris.
Epilobium hirsutum.
Smyrnium Olusatrum.
Sium angustifolium.
Viburnum Opulus.
Asperula odorata.
Scabiosa arvensis.
Bidens cernua.
Petasites officinalis.
Crepis paludosa.
Linaria Cymbalaria.
Scrophularia nodosa.
Melampyrum pratense.
Nepeta Glechoma.
Salicornia herbacea.
Suaeda maritima.
Rumex nemorosus.
Alnus glutinosa.
Salix Caprea.
Habenaria bifolia.
Typha latifolia.
Sparganium simplex.
Arum maculatum.
Potamogeton perfoliatus.
Carex disticha.
C. remota.
C. hirta.
Alopecurus pratensis.
Briza media.
Bromus giganteus.
Equisetum sylvaticum.

To this list might be added *Rumex conglomeratus,* of which a single plant occurred on Clare Island and another on Inishbofin, both, no doubt, casually introduced.

If we examine this list, we may extract from it certain little groups of plants which will help us to appreciate its character and significance.

TREES AND SHRUBS.—*Cytisus scoparius, Rubus Idaeus, Rosa tomentosa, Viburnum Opulus, Alnus glutinosa, Salix Caprea.* For the absence of these we must look, perhaps, to the great exposure of the islands; also to the merciless way they are grazed. Some of the arboreal species which are found on the islands occur extremely sparingly—*Crataegus Oxyacantha* as one bush on Inishturk; *Pyrus Malus* as one bush on Clare Island. If any of the missing species formerly occurred as sparingly as these do now, grazing might easily have exterminated them.

Shade Plants. — *Geum urbanum, Asperula odorata, Crepis paludosa, Nepeta Glechoma, Arum maculatum, Carex remota, Bromus giganteus.* The scarcity of trees and absence of hedges is naturally followed by a scarcity of their dependent species.

Hydrophytes and Hygrophytes.—*Hippuris vulgaris, Epilobium hirsutum, Sium angustifolium, Bidens cernua, Typha latifolia, Sparganium simplex, Potamogeton perfoliatus.* The rarity of sheets of water, and the small size of those which occur, must be held responsible for the absence of these water-plants. The great exposure, so inimical to the taller herbaceous plants, may have assisted in preventing such species as the Typha and Epilobium (both of which are very wide-spread plants) from becoming established. The absence of such a lover of wet ditches as *Bidens cernua* is difficult to explain.

Xerophytes.—*Erophila vulgaris, Reseda Luteola, Sagina apetala, Linaria Cymbalaria.* This list is not long, because many xerophytes are already rare throughout West Mayo, and do not, therefore, come within our category. The rarity of sandy ground makes the absence of the first two not unexpected, and of mortar-built walls the last. Under this head may be listed also *Salicornia herbacea* and *Suaeda maritima*, for which no suitable habitat of saline mud or gravel is available on the islands.

Unaccountably Absent. — Some of the remaining plants may be so classed, as they are widespread species in the west, and as the conditions they require would appear to be abundantly supplied on the islands. Such are *Medicago lupulina, Melampyrum pratense, Rumex conglomeratus* (see note, p. 10), *R. nemorosus, Carex hirta, Equisetum sylvaticum.*

It may be pointed out that in this list of absentees we find very few plants of those classes which we should expect from the general features of the islands to be well represented there. The sea-rocks, the peaty fields and grass-lands, and the heaths, which are the prevailing habitats on the islands, have a flora nearly as full as that of the same habitats on the adjoining mainland. It would seem, therefore, that all sections of the mainland flora have fully exploited the islands, absence of species being accounted for by absence of habitat.

It is not necessary to enter into any detailed description here of the flora of the neighbouring islands (Achill, Inishturk, Inishbofin) which have been on previous pages (pp. 3, 5–8) compared with that of Clare Island, since they are sufficiently described in the papers to which the reader is referred at the bottom of p. 3. But reference may be made to the flora of a few of the uninhabited islets that lie near Clare Island, the most remote of which is the group of rocks known as The Bills.

Floras of Adjoining Islets.

The Bills.

The Bills are a group of rocks lying close together, 9 miles north-west of Clare Island, and 8 miles S.S.E. of Achill Head. There are two large rocks, each with an area of about a couple of acres, and several small ones, which are mere pinnacles. All rise precipitously from deep water, and attain a general elevation of 100 to 120 feet above Ordnance datum. They are formed of metamorphic rock: and traces of drift, including much-rounded pebbles, are to be seen.

On the north side the rocks go straight down into 20 fathoms. On the south side a small 6- to 8-fathom bank extends. All round the prevailing depth is about 24 fathoms.

The flora of the Bills is extremely limited. We explored only the eastern or inner rock; but it has much more vegetation than the western one, and it is unlikely that a landing on the western rock would have resulted in any additions to the flora. The lower limit of vegetation ranges from 100 feet at the western end of the western island to about 50 feet at the eastern end of the eastern one. The cliffs and steep slopes rising from the sea are occupied by luxuriant *Beta maritima* and *Cochlearia officinalis* and *Atriplex hastata*. The top of the inner rock presents an undulating surface, about two acres in extent, of light, springy turf, composed almost entirely of dead *Armeria maritima*. Its surface is largely bare, studded with numerous great bosses of the same plant alive—some of the bosses being a yard across. Hollows are occupied by colonies of *Atriplex hastata*, and patches of *Festuca ovina* are abundant. The only other plant seen was *Spergularia rupestris*, growing sparingly in rock-chinks. The turf is absolutely riddled with the tunnels of the Puffins, which, with gulls, Guillemots, and Razorbills, are responsible both for the large proportion of bare ground and for the luxuriance of vegetation where it occurs.

No mosses or hepatics were seen, but lichens were abundant on the rocks, though few in number of species (see Part 14).

Mweelaun.

Mweelaun More and Mweelaun Beg lie close together two miles south of Clare Island, in the channel. They are formed of sandstone. The smaller rock is entirely wave-swept; the larger has an area of 4 acres, and a height of 77 feet above Ordnance datum. The seaward two-thirds is swept quite

bare, with only an occasional plant of Armeria nestling in a crevice. The eastern third, though not quite so high, has a certain amount of vegetation. Over a few square yards, *Festuca ovina* has formed a sward. *Armeria maritima* is abundant, and *Atriplex sp.* forms verdant colonies. The remaining vegetation consists of a little *Cochlearia officinalis* (with leaves up to three inches across), *Spergularia rupestris*, and *Glyceria maritima*, plus lichens and algae. Great Black-backed Gulls, Herring-gulls, Oyster-catchers, &c., breed on the rock, and are in part responsible for the filthiness of the stagnant pools which abound.

Caher Island.

Caher Island lies some five miles south of the west end of Clare Island, and is partially sheltered from storms by Inishturk, which rises two miles to the W.S.W. Its area is 128 acres. It is nearly a mile in length, and oval in outline; but while the eastern end is quite low, it rises steadily westward to the highest points (188–201 feet), where it drops in a fine cliff into the Atlantic. At the eastern end a pretty lakelet (Kinkeel L.) lies a little above sea-level; a pool lies on the south-east shore, and close to the highest point another lakelet occupies a little transverse valley. A three-hours' visit to the island in July, 1911, permitted an examination of its flora. Owing to limited grazing, the greater part of the surface was, at the time of our visit, covered with rank vegetation, a foot or more in height, heathery in the drier parts, with much *Salix repens*, *Calluna vulgaris*, and *Erica Tetralix*; grassy in the damper places, with abundance of *Festuca ovina*, *Triodia decumbens*, *Carex vulgaris*, and *Erica Tetralix*. To the westward these give way near the coast to Plantago sward of characteristic type, which occupies a crescent-shaped area around the western shores. In this formation, on a clayey slope facing south-west, *Juncus maritimus*, *Schaenus nigricans*, and *Phragmites communis* grow together at a height of 100–150 feet above the sea. The forehead of the promontory, from the highest point to the edge of the cliff (188–150 feet), is occupied by *Glyceria maritima*. On the north-east shore stands a ruined church with some other early remains, and around it are a few ruined fences and the signs of "lazy-bed" cultivation; but the only plants pointing to human influence were *Cnicus arvensis* and *C. lanceolatus* in the former tillage, and *Stellaria media*, *Sonchus asper* and *Urtica dioica*, growing in the shelter of a small square enclosure built of loose stones as a shelter for sheep. *Asplenium Ruta-muraria*, growing on the old church, owes its habitat to man.

Excluding these six plants, the indigenous flora of the island numbered 129 species. It is hardly necessary to give a list of these. But while no plant

occurred which is not found on some of the adjoining islands, a few of the Caher plants have a limited distribution upon them :—

Glyceria maritima Asplenium Ruta-muraria	Absent from Clare Island.
Sparganium ramosum Lemna minor Potamogeton pusillus	Absent from Inishturk.
Ranunculus Baudotii Potamogeton pectinatus Ruppia rostellata	Absent from Clare and Turk.
Alisma ranunculoides	Absent from Turk and Bofin.

3. DESCRIPTION OF THE VEGETATION OF CLARE ISLAND.

Character of the Island.

In order that the flora of Clare Island, and the problems which it raises, may be understood, it is necessary to recall briefly the position and features of the island.[1]

Clare Island lies across the entrance of Clew Bay; and while distant some fifteen miles from the land at Westport and Newport, only three miles of sea separate it from Emlagh Point, which forms the southern entrance of the bay, and the same from Achillbeg and the Curraun peninsula, which form the northern entrance; but these channels are deep and open, and in the full swing of the Atlantic roll. The island is roughly triangular in outline, measuring about 4 miles by $2\frac{1}{2}$ miles. Its area is $6\frac{1}{6}$ square miles, of which about one-third is under tillage or pasture, the remainder consisting of stony heath, thin bog, or maritime sward. The dominating feature of the island is the great east and west ridge (Croaghmore), attaining an elevation of 1,520 feet, which occupies much of the north-western shore. A second ridgy hill (Knocknaveen), attaining 729 feet, forms a prominent feature in the centre of the island; while a third parallel one, much lower but still conspicuous, extends along the south-eastern edge. The ground falls in many parts from the north and west towards the south and east, thus protecting the surface to a limited extent from the fury of Atlantic gales. The cultivated and inhabited portion of the island—it harbours some seventy families—lies along the eastern and southern margins. (See map, Plate II.) Much of the land formerly cropped has been allowed to relapse into poor pasture. Every part not under cultivation, including the

[1] The following account is taken partly from my former paper on the flora of Clare Island (*loc. cit.*).

hill-tops and sea-cliffs, is closely grazed by sheep, cattle, horses, and donkeys. The live-stock, which is the pride of the islanders, is certainly pretty severe upon the vegetation.

There is little to be said regarding the geology of the island as affecting its vegetation. The slates and allied rocks yield a light loamy, lime-free soil; but this is generally thin. The hard sandstones and pebbly beds in the east are very intractable; and much of the area occupied by them is thickly boulder-strewn, with the rock close below. Glacial drift covers much of the lower parts of the island—*i.e.*, the east and south—and in the north-east attains a great thickness. A blue limestone Boulder-clay underlies the local drift, but appears mainly in sections along the coast or by streamlets, and has no noticeable effect on the flora.

While producing a fairly fertile soil in some areas, in others the drift is exceedingly stony and barren. The deepest soil is found in one or two small valleys in the east. Thin boggy soil covers the greater part of the island, but no great depth of peat is now found, except near the top of Croaghmore. A single small area of blown sand occurs behind the bay at the Harbour. This is the only sandy shore on the island. A few boulder beaches occur but the coast is almost everywhere rocky, and generally cliff-bound. While along the southern and eastern sides the cliffs are generally under 100 feet in height, elsewhere they are higher, and along the north-western side of the island attain magnificent proportions.

The impression, as regards the vegetation, left by one's first view of the island, is its wind-swept and stunted character. No groves of trees meet the eye, no hedges even. Beyond the narrow limits of the cultivated ground, poor stony heath forms the prevalent feature, passing into bog-land as one ascends.

Maritime Vegetation.

The maritime flora is poor in variety, as is usual in the west of Ireland, and many species characteristic of the sands or rocks of the east coast are missing. The only sand on the island is at the Harbour, at the east end of the island, where shelter is greatest—a small curving sandy bay, with a little blown sand behind it. The strand flora consists of *Salsola Kali*[1] with some Atriplex and *Arenaria peploides.*

Behind that, above storm-level, two associations occupy the ground :—

(1) An open *Agropyron junceum** society with a slight admixture of

[1] Salsola appears to be curiously irregular in its occurrence. I noted it there on my first visit in 1903. In 1909 no trace of the species was seen during the season; in 1910 the Saltwort was represented by about 100 bushy plants, and formed a notable feature; in 1911 the plant was much less conspicuous, but dwarfed growth accompanying an exceptionally dry season was partly accountable for this.

*Salsola Kali** and *Arenaria peploides** below, and of *Potentilla Anserina, Senecio Jacobaea, Arctium Newbouldii,* Taraxacum officinale* var. *erythrospermum,* Planta go lanceolata*, &c., above.

(2) A close sward of *Lotus corniculatus* and *Trifolium repens,* with some *Viola arvensis*, Sagina nodosa,* Geranium molle, Trifolium pratense, Potentilla Anserina, Sedum acre,* Daucus Carota, Senecio Jacobaea, Taraxacum officinale* var. *erythrospermum,* Leontodon hirtus, L. autumnalis, Prunella vulgaris, Plantago major, P. lanceolata, Carex arenaria,* Cynosurus cristatus, Poa pratensis, Festuca rottboellioides,* Bromus mollis.* In the above lists the plants with an asterisk behind them find here their only station on the island.

At Kinnacorra, the extreme east corner of the island, there is a remarkable V-shaped boulder beach, interesting to the botanist because it encloses the only bit of salt-marsh on the island, which yields *Scirpus maritimus, Juncus Gerardi* (neither found elsewhere), *J. obtusiflorus,* &c. A more extensive boulder beach occupies the foreshore at Portlea in the north-east; behind its crest it is colonized by a low growth of willows (*S. aurita*), and some *Saxifraga umbrosa.* Between this and the lighthouse, steep high banks of Boulder-clay front the sea. They support a heathy vegetation, and here *Erica mediterranea* (Plate V., fig. 1), *Cephalanthera ensifolia,* and *Listera ovata* have their only habitat.

Everywhere else the coast is rocky or cliff-bound. Some shelter obtains on the cliffs, and sheep are often excluded by their steepness; in consequence the vegetation is often comparatively luxuriant. *Spergularia rupestris, Crithmum maritimum,* and *Beta maritima* are widely spread; *Eupatorium cannabinum* also was found only on sea-cliffs; *Angelica sylvestris* affected the same habitat in quantity.

The fine range of rugged Silurian cliffs, 300 to 500 feet in height, that stretches from Croaghmore to the lighthouse, facing north-west, has a considerable flora, vertical precipices alternating with steep grassy slopes and huge blocks of rock. In the portions examined (much of it is difficult of exploration) *Plantago maritima, P. Coronopus,* and *Festuca ovina* were the leading species, with much *Saxifraga umbrosa, Sedum anglicum, Primula vulgaris, Euphrasia officinalis, Thymus Serpyllum,* and *Lastrea aemula*; and some *Bellis perennis, Jasione montana, Trifolium repens, Empetrum nigrum, Cnicus palustris, Viola Riviniana, Blechnum Spicant. Saxifraga decipiens* is frequent down to sea-level, and *Asplenium marinum* ascends to 300 feet; among the rocks *Athyrium Filix-faemina* grows luxuriantly.

The influence of the sea is seen far beyond the coast-line. *Plantago maritima* and *P. Coronopus* grow on stony ground all over the island, ascending to 1,200 feet on the Croaghmree cliffs. *Glaux maritima* occupies in abundance

wet gravelly ground facing south, 300 feet elevation, and cut off by higher ground from the sea, which is a quarter of a mile off; and occurs in similar ground in the extreme west, ascending the stony courses of streamlets to an elevation of 400 feet. *Asplenium marinum* grows abundantly on a low inland cliff near Ballytoohy, half a mile from the sea on either hand. *Spergularia rupestris* grows with the last on the old abbey walls; Crithmum and *Carex distans* were seen on a dry cliff at the west end, a quarter of a mile from the nearest sea. On the Croaghmore cliffs, while *Cochlearis officinalis* ascends to 1,200 feet, and *Silene maritima* ascends to 800 feet, it was noted that *Armeria maritima* and *Asplenium marinum* stop at 400 feet; *Spergularia salina* grows in the lighthouse yard, 350 feet above the sea.

The best-marked formation of halophile tendencies is that which forms the exceedingly short, springy turf along the top of the cliffs, and of which *Plantago maritima* and *P. Coronopus* are the dominating plants. (See Plates II.–III.) The composition of this formation is shown by the following examples:—

HALF A MILE WEST OF THE HARBOUR.

PLANTAGO MARITIMA, *v.c.*	Bellis perennis.
CORONOPUS, *v.c.*	Hieracium Pilosella.
lanceolata, *c.*	Hypochaeris radicata.
Thymus Serpyllum, *c.*	Calluna vulgaris.
Euphrasia officinalis, *c.*	Anagallis tenella.
Viola Riviniana.	Erythraea Centaureum.
Polygala depressa.	Prunella vulgaris.
Cerastium tetrandrum.	Carex glauca.
triviale.	Oederi.
Sagina procumbens.	Aira praecox.
Radiola linoides.	Holcus lanatus.
Lotus corniculatus.	Cynosurus cristatus.
Trifolium repens.	Koeleria cristata.
Potentilla Tormentilla.	Triodia decumbens.
Hydrocotyle vulgaris.	Festuca ovina.
Scabiosa Succisa.	Ophioglossum vulgatum.

This represents a mild form of the Plantago sward which, first described from this example, is now recorded from many places along the west coast of Ireland and also from the Faeröes.[1]

It forms a dense sward about half an inch in height, with flower-stems rising to about two inches. Radiola, which proved a frequent ingredient of this formation, grows ½-inch high, and usually unbranched; Ophioglossum the

[1] Botany of the Faeröes, p. 929.

same height, and barren. The flowers of the majority of the plants grow level with those of *Anagallis tenella* and Radiola.

An extreme example—and such are not rare—is now given :

West End, near Beetle Head.

Plantago maritima, *v.c.*	Plantago Coronopus.
Radiola linoides.	P. lanceolata.
Potentilla Tormentilla.	Luzula campestris.
Sedum anglicum.	Aira praecox.
Galium saxatile.	Festuca ovina.
Jasione montana.	Mnium hornum.
Anagallis tenella.	

This was a smooth shining sheet of *P. maritima* (at least 80 per cent.) with mere scraps of the other plants. The rosettes of *P. Coronopus* and *P. maritima* measured $\frac{1}{2}$ inch to $\frac{3}{4}$ inch across. The composition of the formation varied as to the admixture of *P. Coronopus*, which sometimes equalled in quantity *P. maritima*; but one or both of these species was always absolutely dominant.

Or again :

East of Lighthouse, 350 feet elevation.

Plantago maritima (at least 75 per cent.),	P. lanceolata,
P. Coronopus,	Carex Oederi,
	Festuca ovina,

with a very little *Sagina procumbens, Cerastium triviale, Euphrasia officinalis.* Like the last, a smooth shining sheet of *P. maritima.*

The Plantago formation occurs extensively, as will be seen from the map (Plate II.), at the west end of the island, and at intervals elsewhere round the margin, from near sea-level at the east end up to about 500 feet. It is characteristic of ground greatly exposed to the sea, where in winter gales the soil becomes soaked with spray.

Meadowland Vegetation.

This comprises the lowland flora, such as is associated with a predominance of grasses, and such plants as Meadow-sweet, Yellow Flag, and Purple Loosestrife. This flora is confined to the cultivated area, and only here and there has it wholly escaped the effects of tillage. It is best seen in the north-east of the island, where a series of little east-and-west valleys harbours a comparatively luxuriant vegetation. In these favoured spots grasses and

herbaceous plants grow several feet in height, and one may see banks covered with grand hedges of Osmunda 5 feet high (Plate IV., fig. 2). In the meadowland the most conspicuous plant is *Lythrum Salicaria*; and *Equisetum maximum* is unusually abundant, extending also to exposed ground, where it attains a height of only a few inches. *Cnicus pratensis*, also remarkably abundant over the island, reaches its maximum in the meadowland, where it frequently bears branched stems with several (2 to 8) heads of flowers. On account of the moist climate and the peaty soil, species which would be usually reckoned as marsh plants, such as *Anagallis tenella* and several of the above, are common ingredients here. In drier spots *Vicia Cracca* forms large tangled beds of greyish foliage and blue blossoms. Brambles are common along banks and walls in this area, but, though embracing interesting species, are apparently in no great variety (see the notes later on, p. 28).

Without doubt much of the ground now occupied by this kind of vegetation has been artificially prepared, partly by the clearing away of original scrub, and partly by the draining of wet ground.

The only place where a marsh flora is developed in any quantity is round Lough Avullin, lying in a sheltered hollow 75 feet above O. S. datum. Around this little lake four zones of vegetation are conspicuous :—

(1) Grasses with much *Juncus effusus*.

(2) A dense broad fringe of *Menyanthes trifoliata* with much *Galium palustre*, and in addition *Ranunculus repens*, *Lotus uliginosus*, *Potentilla palustris*, *Cnicus pratensis*, *Eleocharis palustris*.

(3) *Equisetum limosum*, *Phragmites communis*, *Carex ampullacea*, *Sparganium ramosum* (on the edge or in 1–2 feet of water).

(4) *Nuphar luteum* and *Potamogeton natans* (in 2–8 feet of water).

Woodland Vegetation.

As stated elsewhere (p. 40), it would appear probable that before man's influence made itself felt, scrub occupied a good deal of the steeper and more sheltered places on the low grounds. The best fragment of the primitive woodland now remaining occupies a rocky slope north-west of Portlea (Plate IV., fig. 1). It consists of fairly dense scrub 4 to 8 feet in height (one Birch attains a height of 10 feet !), low and spreading, many of the trees being very old. The constituent species are *Corylus Avellana*, *Betula pubescens*, *Ilex Aquifolium*, *Pyrus Aucuparia*, *Quercus sessiliflora*, *Salix aurita*, *S. cinerea*, *Myrica Gale*, *Lonicera Periclymenum* and Rubi. These shelter a good shade-flora :—*Ranunculus Ficaria*, *Oxalis Acetosella*, *Viola Riviniana*, *Conopodium denudatum*, *Sanicula europaea*, *Primula vulgaris*, *Scilla nutans*, *Lastrea dilatata*, *L. Filix-mas*, *L. aemula*, and in spring the luxuriant foliage and bright

colours here contrast strongly with the bare stony heaths, still almost lifeless, which lie around. A similar but less well-preserved piece of scrub lies in a similar situation west of Lough Avullin. In wetter ground, willow-scrub (*S. aurita* and *S. cinerea*) is found here and there—notably in wet, stony fields near Kinnacorra, where it is associated with *Myrica Gale*; but the place is much trampled by cattle and the ground vegetation destroyed. The bulk of the woodland section of the flora of the island is found by mountain rivulets and on cliffs facing towards the north.

Moorland Vegetation.

Beyond the limit of cultivation—which on Clare Island is usually not higher than 200 feet, and often descends to sea-level, on account of exposure or absence of soil—the moorland area extends, in its various forms of dry banks, stony heath, marsh, bog, rock, and cliff. On the higher ground (1,000 to 1,500 feet) the peat-forming associations are better developed; and the summit of Croaghmore consists partly of heathy and partly of spongy bog. This whole area is, generally speaking, dominated by Calluna, with an admixture of *Erica cinerea* and *E. Tetralix*, and other usual ingredients of the familiar Calluna formation; but, owing to the fact that almost the entire surface has been interfered with by turf-cutting, the natural associations have been much broken up. In the few places where the peat is deep, and the surface undisturbed, which occurs here and there on the higher grounds (800 to 1,500 feet), *Scirpus caespitosus* and Cotton-grasses become conspicuous. The result of the irregular turf-cutting is an increase of Rushes, or, where the turf has been removed down to the stony subsoil, of grasses. Where the heathy ground gets wet, *Hypericum elodes* and *Eleocharis multicaulis* appear in quantity, and bring with them abundance of *Viola palustris*, *Drosera rotundifolia*, *Potentilla palustris*, *Hydrocotyle vulgaris*, *Menyanthes trifoliata*, and *Myosotis repens*. The characteristic Irish lowland bog flora, with *Drosera anglica*, *Rhynchospora alba*, *Andromeda Polifolia*, is absent as such, on account of absence of suitable habitat; but the two first-named plants occur, the former in two stations, the principal one being a floating morass around Lough Leinapollbauty, with *Carex limosa*; the second sparingly in a patch of wet bog near Lough Avullin. The boggy marshes form a connecting link with the pools and bog-holes, which yield *Utricularia minor*, *Juncus supinus*, and *Littorella lacustris*. Three little moorland loughs lie in the hollow between Croaghmore and Knocknaveen at 350 feet elevation—Creggan Lough, Lough Leinapollbauty, and Lough Merrignagh. They are bleak and exposed. The third yields *Nymphaea alba*, and the dredge revealed *Nitella translucens* in the first and second. There

is also a series of pools on the cliff near the lighthouse, which forms the only habitat of *Utricularia intermedia*, and where *Carex paniculata* may be seen growing one foot high. Patches of grass-land, apparently aboriginal, occur occasionally in the heath-land area, generally where the Silurian rocks have formed a friable soil, as on the northern slopes of Knocknaveen, and again as long streaks on the steep gable of Croaghmore which dominates the west end of the island. In the latter place, in the drier portions, *Nardus stricta* is dominant with much *Festuca ovina* and *Potentilla Tormentilla*, and some

Erica Tetralix,	Juncus squarrosus,
E. cinerea,	Carex glauca,
Calluna vulgaris,	Molinia caerulea;
Anagallis tenella,	

but the composition of the vegetation varies a good deal according to the degree of dampness of the ground.

On dry banks throughout the moorland area *Sedum anglicum*, *Jasione montana*, and *Thymus Serpyllum* are abundant and showy. *Ulex europaeus* is confined to the east of the island, where there is plenty of it: *Prunus spinosa* likewise, but in much smaller quantity. Where the ground gets steep or rocky, and some shelter is obtainable, *Saxifraga umbrosa*, *Lastrea aemula*, and *Salix repens* at once appear, and all three ascend from sea-level to the top of the Croaghmore cliffs (say 1,400 feet). Cliffy places, and the rocky banks of mountain streamlets, supply a habitat also for a little stunted Oak and Ash, Rowan, Holly, and Birch; and nooks in the same places, as already mentioned, afford the only refuge of some woodland and lowland species, such as *Anemone nemorosa*, *Geum rivale*, *Fragaria vesca*, *Potentilla Fragariastrum*, *Ajuga reptans*, *Orchis mascula* (to 1,200 feet), *Carex sylvatica*, *Aspidium angulare*.

The only inland cliff of any importance forms a conspicuous patch of black Silurian slates on the steep northern slope of Knocknaveen, overhanging the "Green Road." It lies on one of the main faults of the island. Here the vegetation is very luxuriant, and of shade type. Great masses of *Saxifraga umbrosa* and *Luzula maxima* clothe the rocks, with much *Aspidium angulare* and *Scolopendrium vulgare*, some *Asplenium Trichomanes* and *A. Adiantum-nigrum*, *Chrysosplenium oppositifolium*, &c.; some Corylus and Ilex, and one bush of *Pyrus Aucuparia*; a good patch of *Lychnis diurna*, which is extremely rare in the district, and a little *Stachys sylvatica*.

Where the ground rises into the dominating ridge of Croaghmore little change takes place in the vegetation, save that, on account of greater drainage

and less turf-cutting, the Calluna formation is better developed. The landward sides of the "Big Hill" give no indication of the interesting alpine vegetation of the seaward face; Calluna prevails up to the summit, and the only mountain plant is *Listera cordata* (800 to 1,520 feet). Some of the Calluna here is old and shaggy, and up to three feet in height. This being quite the largest and oldest Calluna on the island, a stem of it was kindly examined for me by Mr. A. D. Cotton. He found it to measure 1·8 × 1·15 cm. at 4 inches from the ground, and to show twenty annual rings of growth. This gives a less age than one might have thought, to judge from the appearance of the plants.

The summit (1,520 feet) is a narrow ridge, on which Calluna, 3 to 9 inches high, is dominant: it is accompanied by—

Polygala depressa.	Luzula maxima.
Potentilla Tormentilla.	Scirpus caespitosus.
Galium saxatile.	Eriophorum angustifolium.
Solidago Virgaurea.	E. vaginatum.
Erica cinerea.	Carex pilulifera.
Tetralix.	binervis.
Vaccinium Myrtillus.	Anthoxanthum odoratum.
Rumex Acetosa.	Festuca ovina.
Empetrum nigrum.	Sphagnum *spp.*
Juncus squarrosus.	

But close by are wetter patches, dominated by Sphagnum and *Scirpus caespitosus*, and containing also—

Potentilla Tormentilla.	Euphrasia officinalis.
Drosera rotundifolia.	Empetrum nigrum.
Calluna vulgaris (very starved).	Narthecium ossifragum.
Pinguicula vulgaris.	Eriophorum angustifolium.

There are also patches having, like the last, a smooth grassy appearance, in which Calluna and *Eriophorum vaginatum* share dominance; with much Empetrum, Sphagnums, *Racomitrium lanuginosum* and other mosses, and some

Potentilla Tormentilla.	Luzula maxima.
Drosera rotundifolia.	Narthecium ossifragum.
Pinguicula vulgaris.	Eriophorum angustifolium.
Orchis maculata.	Cladonia *sp.*

Extending thence westward, covering the long ridge of the hill and its seaward slopes, a curious mixture of associations occurs. The general appearance of the vegetation is grassy and rushy. Sometimes Calluna is dominant, sometimes *Eriphorum vaginatum*, or *Juncus squarrosus*. Other

characteristic plants are *Potentilla Tormentilla, Salix aurita, Orchis maculata, Narthecium ossifragum, Eriophorum angustifolium.* Mosses are abundant, the leading species being *Dicranum majus, Hylocomium loreum, H. proliferum,* and species of Sphagnum.

Alpine Vegetation.

Lastly, reference must be made to the flora of the great sea-scarp of Croaghmore, which forms a precipice 1,500 feet high descending into the Atlantic. This scarp consists, in its upper part, of ranges of cliffs, with very steep grassy slopes between; below are almost sheer cliffs, rising from the sea to a height, at some spots, of nearly 1,000 feet. The alpine vegetation concentrates on the upper ranges of cliffs, from 1,000 to 1,400 feet. This part of the precipice can be explored best by the aid of two little sheep-tracks, which run in from the east edge of the cliff, and became known to us as the "1,000-foot path" and the "1,200-foot path." (Plate I. The 1,000-foot-path is illustrated in Part 23, Land and Fresh-water Mollusca.) They lead along the scarp, and one can work one's way out again at the west end. The 1,000-foot path starts from a little ledge that forms a conspicuous feature on the steep edge of the hill, as seen from the east or south-east. Ten plants of Watson's Highland Type are found on the Croaghmore scarp:—

Silene acaulis.	Oxyria digyna.
Saxifraga oppositifolia.	Salix herbacea.
Sedum Rhodiola.	Aspidium Lonchitis.
Saussurea alpina.	Asplenium viride.
Hieracium anglicum.	Selaginella selaginoides.

With these some other interesting species occur—*Saxifraga Geum,* not previously known in northern Europe outside Kerry and West Cork; *Saxifraga decipiens* (Plate VI., fig. 2), elsewhere in Ireland known only from Slieve Mish, in Kerry; the northern var. *procumbens* of *Hypericum pulchrum*; and *Cystopteris fragilis.* Croaghmore forms the only island-station for almost all these, and also for a few other plants, such as *Anemone nemorosa, Polygala vulgaris, Rubus saxatilis, Geum rivale, Campanula rotundifolia.*

Among the characteristic concomitants of the alpine plants at 1,400 feet are:—

Ranunculus acris.	Jasione montana.
Viola Riviniana.	Primula vulgaris.
Cerastium triviale.	Pinguicula vulgaris.
Hypericum pulchrum.	Thymus Serpyllum.
Oxalis Acetosella.	Carex glauca.
Saxifraga umbrosa.	Hymenophyllum unilaterale.
Angelica sylvestris.	Lastrea dilatata.

The most abundant plants of the scarp include:—

Silene acaulis,	Sedum Rhodiola,
Saxifraga decipiens,	Oxyria digyna,
S. umbrosa,	Hymenophyllum unilaterale—

all of which occur in great profusion. *Silene acaulis*, and also *Hymenophyllum unilaterale* + *Mnium hornum* form large bosses (Plate VI., fig. 1); *Sedum Rhodiola* and *Oxyria digyna* occupy all the rock crevices: *Saxifraga umbrosa* and *S. decipiens* are everywhere. Small falls of stone and earth are continually dragging down clumps of vegetation. *Silene acaulis* suffers particularly in this way, but easily maintains its abundance by means of seedlings, despite the ravages of the slug *Arion ater*, which feeds voraciously upon the blossoms (Plate V., fig. 2).

The vertical limits on Clare Island of some of the plants are given below; but no systematic observations on this point were undertaken:—

Cochlearia officinalis,	0[1] to 1300
Silene acaulis,	400 to 1450
S. maritima,	0 to 1000
Lychnis diurna,	to 1000
Saxifraga decipiens,	0 to 1300
S. umbrosa,	0 to 1500
Sedum Rhodiola,	150 to 1450
S. anglicum,	0 to 1450
Angelica sylvestris,	to 1200
Armeria maritima,	0 to 1300
Oxyria digyna,	600 to 1400
Hymenophyllum unilaterale,	0 to 1500
Lastrea aemula,	0 to 1500
Asplenium marinum,	0 to 500

4. LIST OF THE FLORA OF CLARE ISLAND.

In enumerating the flora of Clare Island, I shall adopt the method most saving of space—to list the plants in columns, with no further comment than the figure or letter which follows each. The figures 1, 2, 3, are used when the species were seen in only one, two, or three stations on the island; *r.* signifies rare; *f.*, frequent; *c.*, common; *v.c.*, very common; *l.*, local. For convenience of statistics, only species and sub-species (according to the standard used in "Irish Topographical Botany") are included in this list, varieties being separately dealt with below. The present list includes all species found

[1] "0" signifies the lower limit of terrestrial vegetation.

on the island in situations other than those in which it is clear they have been planted. The question of introduced plants and man's influence upon the flora is dealt with later (p. 31).

Anemone nemorosa, 1.
Ranunculus hederaceus, *c.*
Flammula, *c.*
repens, *c.*
acris, *r.*
Ficaria, 3.
Caltha palustris, 1.
Nuphar luteum, 1.
Nymphaea alba, 1.
Fumaria confusa, 2.
Nasturtium officinale, *f.*
Cardamine pratensis, *f.*
hirsuta, *f.*
flexuosa, 1.
Cochlearia officinalis, *c.*
danica, 2.
graenlandica, *l.*
Sisymbrium officinale, 2.
Brassica Rapa *var.* Briggsii, *c.*
Sinapis, *f.*
alba, *c.*
Capsella Bursa-pastoris, *f.*
Senebiera Coronopus, *c.*
Raphanus Raphanistrum, 3.
Viola palustris, *c.*
Riviniana, *c.*
arvensis, 1.
Polygala vulgaris, 1.
serpyllacea, *f.*
Silene maritima, *c.*
acaulis, 1.
Lychnis diurna, 2.
Flos-cuculi, *f.*
Cerastium tetrandrum, *f.*
glomeratum, *f.*
triviale, *f.*
Stellaria media, *f.*
graminea, *f.*
uliginosa, *f.*
Arenaria peploides, 1.
Sagina maritima, *f.*
procumbens, *c.*
Sagina subulata, *l.*
nodosa, 1.
Spergula arvensis, *v.c.*
Spergularia salina, 2.
rupestris, *c.*
Montia fontana, *c.*
Hypericum Androsaemum, 3.
tetrapterum, *f.*
humifusum, 3.
pulchrum, *f.*
elodes, *v.c.*
Radiola linoides, *f.*
Linum catharticum, *f.*
Geranium molle, *f.*
dissectum, 2.
Robertianum, *f.*
Oxalis Acetosella, *f.*
Ilex Aquifolium, *r.*
Ulex europaeus, *l.*
Trifolium pratense, *f.*
repens, *c.*
dubium, 2.
Anthyllis Vulneraria, *f.*
Lotus corniculatus, *c.*
uliginosus, 1.
Vicia hirsuta, 1.
Cracca, *c.*
sepium, *f.*
Lathyrus pratensis, *f.*
macrorrhizus, 3.
Prunus spinosa, *l.*
Spiraea Ulmaria, *f.*
Rubus plicatus, *f.*
pulcherrimus, *f.*
rusticanus, *f.*
iricus, *f.*
saxatilis, 1.
Geum rivale, 1.
Fragaria vesca, 1.
Potentilla Fragariastrum, 2.
Tormentilla, *c.*
procumbens, 2.
Potentilla Anserina, *c.*
palustris, *c.*
Alchemilla arvensis, *r.*
vulgaris, *r.*
Rosa spinosissima, *r.*
canina, 1.
Pyrus Aucuparia, 2.
Malus, 1.
Saxifraga oppositifolia, 1.
umbrosa, *c.*
Geum, 1.
decipiens, 1.
Chrysosplenium oppositifolium, 2.
Cotyledon Umbilicus, 1.
Sedum Rhodiola, *l.*
anglicum, *c.*
acre, 1.
Drosera rotundifolia, *c.*
anglica, 2.
Myriophyllum alterniflorum, 1.
Callitriche stagnalis, *f.*
pedunculata, 2.
Peplis Portula, *f.*
Lythrum Salicaria, *c.*
Epilobium parviflorum, *f.*
obscurum, *f.*
montanum, *f.*
palustre, *f*,
Circaea lutetiana, 1.
Hydrocotyle vulgaris, *c.*
Sanicula europaea, 2.
Conium maculatum, *r.*
Apium nodiflorum, 3.
inundatum, 2.
Conopodium denudatum, 3.
Crithmum maritimum, *f.*
Oenanthe crocata, *c.*
Angelica sylvestris, *c.*
Heracleum Sphondylium, *f.*
Daucus Carota, *c.*
Hedera Helix, *f.*

Lonicera Periclymenum, *f.*
Galium verum, *f.*
saxatile, *c.*
palustre, *f.*
Aparine, *c.*
Valeriana sambucifolia, *f.*
Scabiosa Succisa, *c.*
Eupatorium cannabinum, 2.
Solidago Virgaurea, *f.*
Bellis perennis, *f.*
Aster Tripolium, *f.*
Filago germanica, 1.
Antennaria dioica, 2.
Gnaphalium uliginosum, *c.*
sylvaticum, 2.
Pulicaria dysenterica, 1.
Bidens tripartita, 3.
Achillea Millefolium, *f.*
Ptarmica, *f.*
Chrysanthemum segetum, 1.
Leucanthemum, *r.*
Matricaria inodora, *c.*
discoidea, *c.*
Artemisia vulgaris, *f.*
Tussilago Farfara, *f.*
Senecio vulgaris, *c.*
sylvaticus, *r.*
Jacobaea, *f.*
aquaticus, *f.*
Arctium Newbouldii, 1.
Cnicus lanceolatus, *c.*
palustris, *c.*
pratensis, *c.*
arvensis, *f.*
Saussurea alpina, 1.
Centaurea nigra, *f.*
Lapsana communis, *f.*
Crepis virens, 1.
Hieracium Pilosella, *f.*
anglicum, 2.
hypochaeroides, 1.
Hypochaeris radicata, *c.*
Leontodon hirtus, 2.
autumnalis, *c.*
Taraxacum officinale, *f.*
Sonchus oleraceus, *f.*
Sonchus asper, *f.*
arvensis, 2.
Jasione montana, *f.*
Campanula rotundifolia, 1.
Vaccinium Myrtillus, *f.*
Calluna vulgaris, *c.*
Erica Tetralix, *c.*
cinerea, *c.*
mediterranea, 1.
Armeria maritima, *c.*
Primula vulgaris, *c.*
Lysimachia nemorum, *c.*
Glaux maritima, 2.
Anagallis arvensis, *f.*
tenella, *v.c.*
Samolus Valerandi, *f.*
Fraxinus excelsior, 1.
Erythraea Centaureum, *f.*
Gentiana campestris, *f.*
Menyanthes trifoliata, *f.*
Symphytum officinale, 1.
Myosotis caespitosa, *c.*
repens, *c.*
arvensis, *f.*
versicolor, 1.
Calystegia sepium, 2.
Convolvulus arvensis, 1.
Scrophularia nodosa, 1.
Digitalis purpurea, *f.*
Veronica agrestis, 2.
polita, 2.
Tournefortii, 2.
arvensis, *f.*
serpyllifolia, *f.*
officinalis, 3.
Chamaedrys, *f.*
scutellata, 3.
Beccabunga, *f.*
Euphrasia officinalis, *c.*
Bartsia Odontites, *f.*
Pedicularis palustris, 2.
sylvatica, *f.*
Rhinanthus Crista-galli, *c.*
Orobanche rubra, 1.
Utricularia minor, *r.*
intermedia, 1.
Pinguicula vulgaris, *f.*
lusitanica, *r.*
Mentha hirsuta, *f.*
Thymus Serpyllum, *c.*
Chamaedrys, *r.*
Prunella vulgaris, *c.*
Stachys palustris, *f.*
sylvatica, 2.
arvensis, 2.
Galeopsis Tetrahit, 1.
Lamium intermedium, 2.
purpureum, *f.*
hybridum, 1.
Teucrium Scorodonia, *f.*
Ajuga reptans, 1.
Plantago major, *r.*
lanceolata, *c.*
maritima, *c.*
Coronopus, *c.*
Littorella lacustris, 3.
Chenopodium album, *r.*
Beta maritima, *f.*
Atriplex patula, *f.*
hastata, *f.*
Salsola Kali, 1.
Polygonum Convolvulus, *r.*
aviculare, *f.*
Raii, 1.
Hydropiper, *f.*
Persicaria, *f.*
lapathifolium, 2.
amphibium, 1.
Oxyria digyna, 1.
Rumex conglomeratus, 1.
obtusifolius, *c.*
crispus, *c.*
Acetosa, *f.*
Acetosella, *c.*
Euphorbia Helioscopia, *f.*
Peplus, *r.*
Urtica dioica, *f.*
urens, *f.*
Myrica Gale, *f.*
Betula pubescens, 3.
Corylus Avellana, 1.
Quercus sessiliflora, 1.
Salix cinerea, *f.*
aurita, *f.*
repens, *c.*
herbacea, 1.

Empetrum nigrum, *r.*
Juniperus nana, 1.
Listera cordata, 1.
ovata, 1.
Cephalanthera ensifolia, 1.
Orchis mascula, 2.
incarnata, *f.*
maculata, *c.*
Habenaria chloroleuca, 3.
Iris Pseud-acorus, *f.*
Scilla nutans, 2.
Narthecium ossifragum, *f.*
Juncus bufonius, *c.*
squarrosus, *f.*
Gerardi, 1.
effusus, *c.*
maritimus, 1.
supinus, *f.*
obtusiflorus, 3.
lamprocarpus, *f.*
acutiflorus, *f.*
Luzula maxima, 3.
campestris, *f.*
erecta, *f.*
Sparganium ramosum, *f.*
affine, 2.
minimum, 2.
Lemna minor, 1.
Alisma Plantago, 1.
ranunculoides, 1.
Triglochin palustre, *f.*
maritimum, 1.
Potamogeton natans, 3.
polygonifolius, *c.*
pusillus, 2.
Eleocharis palustris, *f.*
multicaulis, *c.*
Scirpus caespitosus, *r.*
fluitans, *f.*
Savii, *r.*
setaceus, 2.
lacustris, 2.
maritimus, 1.
Eriophorum vaginatum, *r.*
angustifolium, *r.*
Rhynchospora alba, 1.
Schaenus nigricans, *f.*
Carex dioica, 1.
pulicaris, *r.*
arenaria, 1.
paniculata, 3.
vulpina, 2.
echinata, *f.*
ovalis, *f.*
vulgaris, *c.*
glauca, *c.*
limosa, 1.
pilulifera, *r.*
praecox, *r.*
panicea, *f.*
sylvatica, 1.
binervis, *c.*
distans, *f.*
Hornschuchiana, 2.
extensa, 1.
flava, *c.*
ampullacea, *f.*
Phalaris arundinacea, 1.
Anthoxanthum odoratum, *f.*
Alopecurus geniculatus, 1.
Agrostis alba, 1.
vulgaris, *c.*
Aira caryophyllea, *f.*
praecox, *c.*
Deschampsia caespitosa, 1.
flexuosa, 3.
Holcus lanatus, 1.
Arrhenatherum avenaceum, *f.*
Triodia decumbens, *f.*
Phragmites communis, 2.
Cynosurus cristatus, *c.*
Koeleria cristata, *f.*
Molinia caerulea, *f.*
Dactylis glomerata, *f.*
Poa annua, *f.*
pratensis, *f.*
trivialis, *f.*
Glyceria fluitans, *c.*
Festuca rottboellioides, 2.
sciuroides, *f.*
ovina, *f.*
rubra, *f.*
Bromus mollis, 1.
commutatus, *f.*
Brachypodium sylvaticum, *f.*
Agropyron repens, 1.
junceum, 1.
Nardus stricta, *f.*
Hymenophyllum unilaterale, *f.*
Pteris Aquilina, *c.*
Blechnum Spicant, *v.c.*
Asplenium Adiantum-nigrum, *f.*
marinum, *f.*
viride, 1.
Trichomanes, 2.
Athyrium Filix-faemina, *c.*
Scolopendrium vulgare, *r.*
Cystopteris fragilis, 1.
Aspidium Lonchitis, 1.
aculeatum, 1.
angulare, 1.
Lastrea Filix-mas, *f.*
dilatata, *f.*
aemula, *c.*
Polypodium vulgare, *f.*
Osmunda regalis, *c.*
Ophioglossum vulgatum, 3.
Botrychium Lunaria, 1.
Equisetum maximum, *c.*
arvense, *f.*
palustre, 2.
limosum, *f.*
Lycopodium Selago, 2.
Selaginella selaginoides, 3.

NOTES ON THE LIST.

Fumaria confusa, Jord.—Both the type and var. *hibernica*, Pugsley, occur sparingly.

Cardamine pratensis, L.—The forms with proliferous leaves and with double flowers both occur.

Cochlearia groenlandica, L.—Not uncommon in chinks of rocks at the west end. Found also on Inishturk, Inishbofin, Achill, and in north Donegal.

Polygala vulgaris, L.—Only found on the great cliff, among alpines—a handsome dwarf form, with very large leaves and flowers. Mr. Arthur Bennett writes of it :—"It is very like specimens I gathered on the cliffs of chalk at Dover, and when I gathered it I thought I had found *grandiflora*. . . . It certainly seems to me to come *at least* half way between that and the *eu-vulgaris* of Syme, and is a notable form."

Silene acaulis, L.—Varies much in the colour of its flowers, from pale pink to deep rose and dull purple. The Clare Island station is the most southerly in Ireland, and its lower limit here (400 feet) is the lowest in the country—lower even than in Donegal (550 feet).

Sagina subulata, L.—Rocks near the harbour, also near the light-house, and frequent at the west end. Was found also on Achillbeg.

Lychnis diurna, Sibth.—A very rare plant in the west. On Clare Island there is a colony of it on the cliff on the north side of Knocknaveen, and another on the Croaghmore cliffs at 800 feet. Its only other West Mayo station is on Inishturk.

Spergula arvensis, L.—Both forms (*vulgaris* and *sativa*) common.

Montia fontana, L.—Var. *minor* common; var. *rivularis* only once seen.

Alchemilla vulgaris, L.—Rare on the island. *A. alpestris* Schm. was the prevailing form, but *A. pretensis* Schm. also occurred.

Hypericum pulchrum, L., var. **procumbens** Rostrup.—On the Croaghmore scarp. Elsewhere in Ireland known only from the similar scarp of Croaghaun in Achill. In Great Britain found in Shetland only.

Rubus.—Only a limited amount of attention was given to the Brambles. **R. plicatus** and **R. rusticanus** were frequent. Of some half dozen selected specimens gathered and submitted to Mr. Rogers, the fact that two of them proved to be **R. pulcherrimus** and three **R. iricus** may be taken as showing that these two forms, the latter of which appears to be endemic in Ireland, are also frequent. Another interesting gathering was unfortunately mixed; Mr. Rogers writes :—"Stem piece looks like *R. Selmeri*, while panicle strongly recalls the *R. Lettii* of Cos. Down and Armagh, and may belong to that."

Pyrus Malus, L.—One very old tree (var. *acerba* (DC.)) by the Ooghganny stream near the west end. I believe native. Found also on Inishturk.

Saxifraga oppositifolia, L.—Sparingly in one spot on Croaghmore cliffs at about 1,200 feet, with *Asplenium viride*, &c.

S. umbrosa, L.—On rough ground at all elevations, from the round stones of the boulder beach at Portlea to the summit of Croaghmore.

S. Geum, L.—The most interesting plant added to the flora by the field-work of 1909–1911. It grows on two spots on the Croaghmore cliffs at about 1,200 feet, in small quantity—a dark green hairy form, the leaf not deeply cordate at the base as in the type, but running into the stem at about right angles. I have an almost identical form in cultivation from Berehaven and from the Pyrenees. A different form of *S. Geum* was found by Miss Knowles at Old Head, Louisburgh, growing on a bank near a ruined house; it did not not occur in any other situation there, and was, I believe, an escape from cultivation.

In the west of Ireland generally, where *S. Geum* does not occur, one does not encounter those puzzling forms intermediate between *Geum* and *umbrosa* which are the despair of the botanist in Kerry. It is interesting to note that a couple of plants of a form distinctly intermediate were seen on Croaghmore, close to one of the colonies of *S. Geum*. This suggests a hybrid origin for the intermediate forms.

S. decipiens, Ehrh.—The Clare Island plant is a very strong-growing hairy form. Elsewhere in Ireland *S. decipiens* is known from Kerry only. Descends to sea-level (*i.e.*, storm-level) on cliffs at Altnamarnagh.

Sedum Rhodiola, DC.—Abundant all round the northern and western cliffs, from storm-level to 1,450 feet. Inland on rocks east of the Signal Tower at 800 feet, and sparingly on the cliff on the north slope of Knocknaveen.

Matricaria discoidea, DC.—Has greatly increased since my visit in 1903. At that time it extended for about half a mile along the roads from the Harbour. It is now nearly continuous from the Harbour for three miles along the chapel road, and is abundant at many places on the lighthouse road.

Saussurea alpina, DC.—Half a dozen colonies along the 1,200-foot path on Croaghmore.

[**Carduus nutans**, L.—"On Clare Island; Hon. Miss E. Lawless" (*Cyb. Hib.* ed. ii.) This is one of the very few previous plant-records from the island. Miss Lawless informs me that she gathered plants on Clare Island during her brief visit there at the request of A. G. More, and sent the specimens to him. Reference to Mr. More's annotated copy of *Cybele Hibernica*, ed. i., in the Royal Irish Academy, shows the above entry in

his own hand-writing, so it may be taken that he named the specimen. Miss Lawless cannot say where she gathered the plant. Not seen since.]

Hieracium hypochaeroides, Gibs., var. **saxorum**, F. J. H.—In good quantity on the Croaghmore cliffs at about 1,100–1,300 feet.

H. anglicum, Fr.—With the last, and also on low sea-cliffs at Doontraneen.

Leontodon autumnalis, L., var. **simplex**, Duby.—Frequent at the west end of the island. A very small glabrous plant with unbranched flower-stems and almost entire leaves.

Taraxacum officinale, Weber, var., **erythrospermum** (DC.).—On sand at the bay beside the Harbour.

Erica mediterranea, L.—Abundant on boulder-clay slopes (no trace of peat) facing north-east, from storm-level to about 70 feet, between Portlea and Ooghcorragaun; flowers very pale, the corolla being practically white, with a pink edge. A couple of outlying plants on top of the low cliff at east end of Portlea.

I was interested to discover what insects were fertilizing the flowers of this plant on these sunless northern banks in March, and spent half an hour capturing the insects which came to the blossoms. They numbered four flies and one bee, which Messrs. Grimshaw and Halbert identify as *Scatophaga stercoraria* ♂ and ♀, *Fucellia fucorum* ♀, *Pseudopyrillia cornicina* ♀, *Eristalis tenax* ♀. No mention of this Heath or its fertilization occurs in the well-known works of Müller or Knuth.

Euphrasia officinalis, L.—*E. brevipila*, Burn. & Gremli, and *E. gracilis*, Fr. are common; *E. occidentalis*, Wettst.; *E. curta*, Fr., var. *glabrescens*, Wettst.; and *E. scottica*, Wettst., are rarer.

Rhinanthus Crista-galli, L.—The prevailing form is *R. stenophyllus*, Schur.

Orobanche rubra, Sm.—This interesting plant was added to the flora on the occasion of my last visit to Clare Island. It was descried from the light-house yard growing sparingly on the cliff below; and Mr. Duffy, head light-keeper, kindly went down on a rope and procured a specimen.

Thymus Chamaedrys, Fr.—In several spots, but much rarer than *T. Serpyllum*.

Salix herbacea, L.—A couple of patches on Croaghmore at 1,000 feet, and another at about 1,400 feet.

Juniperus nana, Willd.—One patch on a small inaccessible sea-stack near Doontraneen, about 70 feet elevation.

Cephalanthera ensifolia, Rich.—A few small plants, flowering sparingly, on a boulder-clay slope facing north-east, 50 feet above the sea, between Portlea and Ooghcorragaun. Found by D. J. Scourfield. *Listera ovata* also has here its only station, and *Erica mediterranea* is close at hand. A curious habitat for all three plants.

Carex Oederi, Retz.—Seems characteristic of the Plantago sward. The var. *oedocarpa*, And., also occurred.

Hymenophyllum unilaterale, Bory.—Very abundant on Croaghmore up to the summit. On the scarp it forms bosses along with *Mnium hornum*, resembling those of *Silene acaulis*. It descends to about 500 feet on the north-east flanks of Knocknaveen, 200 feet at Craigmore, and at Portlea occurs at storm-level on the edge of the boulder beach.

Cystopteris fragilis, Bernh.—Several small colonies on the Croaghmore scarp at 1,200–1,400 feet.

Aspidium Lonchitis, Swartz.—Three colonies, each of about a dozen plants, on the 1,200-foot path on Croaghmore.

Osmunda regalis, L.—Common. Great tussocks growing in pasture-land are left, as large boulders might be, on account of the labour required to remove their dense matted roots. On wet clay in shady positions seedings in all stages are often very abundant. A fine cristate form found near Ballytoohy is figured in "Irish Naturalist," xii, 291.

5. THE INFLUENCE OF MAN UPON THE FLORA.

As regards the general history of the effect of human activity on the flora of Ireland we have not much to go upon. We begin with an aboriginal vegetation, its characters being the result of past geological changes, of local climate and soil, plus the overmastering influence of the native fauna, from grazing quadrupeds down to the lowest forms of animal life. The advent of the human race at first can have made no appreciable difference. So long as man merely hunted, his influence on the vegetation was very small. When he became a keeper of flocks, he must have influenced the flora locally, chiefly by reduction, owing to plants being prevented by grazing from increasing, or from maturing seed. But when he began to use fire for clearing the woodland, and to till the ground, not only did his operations destroy the local plant-formations, but the carrying and bartering of grain, for sowing or for food, must have tended to spread the seeds of many plants.[1]

All through the Middle Ages, and on through modern times, as trade and commerce increased, as towns grew, as lines of transportation spread across the world, and railways and steamboats linked cities and countries together, the scattering of alien seeds has ever gone on more and more, till nowadays a dozen American or Russian plants may often be found growing together in our own islands near centres of industry or of traffic. Recent studies by

[1] See A. de Candolle: Origin of Cultivated Plants (English edition), chap. i. 1884.

Trail,[1] Burkill,[2] and Dewey,[3] treating of certain interesting phases of this modern feature in our flora, will be found instructive. Scott Elliot[4] and Miall[5] have written good chapters on the general subject; Hooker[6] has discussed the introduction and spreading of Compositae; aliens in central London have recently excited some interest[7]; and as regards Ireland, some information will be found in certain writings by Adams,[8] Miss Knowles,[9] and myself.[10]

The influence of man upon the vegetation of the earth has been so profound, and so different both in degree and in kind from that exercised by the rest of the animal kingdom, that it is customary and useful to distinguish between them; we say that seeds brought by a bird in mud for building its nest are brought by "natural" means, while seeds brought by man in mud to build his hovel are brought by "artificial" means. It is curious to speculate at what particular period man became the author of "artificial" actions. Presumably Pithecanthropus was guilty of no "introductions"; nor could the seeds carried and dropped when man

> "bruised the herb and crush'd the grape,
> And bask'd and batten'd in the woods,"

be classed differently from those scattered by the birds. But when man began to subject first the wild animals and then the woods to his will, his influence on nature became so profound as to justify us in placing it in a separate category. It is true that Woodruffe-Peacock pleads[11] for what he considers a broader and more natural treatment of the subject, by including man and all his works among the "natural" phenomena, and placing his influence on the same footing as that of the wild beasts and birds. Certainly, one wishes this could be done; but it would only lead to confusion, especially in the domain of geographical botany. The results of man's work have been so rapid and revolutionary, so completely destructive of the gradual influences

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[1] J. W. H. Trail: Florula of a piece of waste ground near Aberdeen. Ann. Scott. Nat. Hist., v., pp. 231–235; vi., 24–31, 237–245; viii., 221–230. 1896–9.

[2] I. H. Burkill: Notes on the Plants distributed by the Cambridge dust-carts. Proc. Cambridge Phil. Soc., viii., pp. 92–95. 1895.

[3] L. H. Dewey: Migration of Weeds. Yearbook U.S. Dept. of Agriculture, 1896, pp.263–286.

[4] G. F. Scott Elliot: Nature Studies (Plant Life), chap. xxvii. 1903.

[5] L. C. Miall: Round the Year, pp. 200–208. 1899.

[6] Notes on the Classification, History, and Geographical Distribution of the Compositae. Journ. Linn. Soc. (Botany), xiii., pp. 568–577. 1873.

[7] Wild Flowers in the Strand. Journ. of Horticulture, lv, p. 122. 1907.

[8] J. Adams: On the possibility of distinguishing between native and alien species of plants in Ireland. Irish Nat., xviii., pp. 123–132. 1909.

[9] M. C. Knowles: A contribution towards the alien flora of Ireland. Irish Nat., xv., pp. 143–150. 1906.

[10] Knowledge, xxv., pp. 16–19, 1902, and Irish Topographical Botany, pp. xxxiv–xxxviii. 1901.

[11] E. A. Woodruffe-Peacock: Natives and Aliens. Journ. Bot., xlvi., pp. 390–396. 1908.

that have been at work "from the beginning," that it seems wise to keep them in a separate category.

Man has influenced the flora in many ways, but most of all by clearing away the native vegetation and growing instead certain plants, native or foreign, which are useful to himself. The ousted native species, which have hitherto held the ground against all comers, are continually breaking into these reserves, and man is as constantly employed in keeping them out. Agriculture, indeed, has been defined as "a controversy with weeds."

The majority of our present-day weeds are light-soil plants widely spread in Europe; and from the beginning these must have been weeds in the cultivated lands, into which they migrated, and from which they have never since been absent. Similarly, later on, the draining and manuring of the land, the metalling of roads, the planting of trees, all had their effect, both in providing new habitats for indigenous species, and in allowing foreign introduced plants to obtain a footing.

So one effect of even the earliest cultivation must have been a very considerable extension of the range of many native species (as well as the curtailment of the range of others)—just as the erection of mortar-built walls has resulted in the natural migration of calcicole plants, such as the Spleenworts, into areas which previously furnished them with no suitable habitat. And along with this natural migration into artificial habitats by means of wind-borne seeds, feeding birds, and so on, there went on artificial migration through the medium of seeds imported by man in various ways. From this point of view, then, we have in the farm-land three main classes of plants to deal with:—

(1) Native species which still maintain their original habitat in the cultivated areas.

(2) Native species which have migrated by natural means from adjoining aboriginal habitats into the ground altered by man.

(3) Species carried into the new ground by man, or through his operations.

As regards the date of the earliest changes in the flora, we know that the cultivation of cereals in Europe goes back to Neolithic times; and that then, as now, weed-seeds were mixed with the grain. In Ireland, we have no direct evidence of Neolithic agriculture. Among the stone implements, for instance, we do not find sickles, like the flint sickles of ancient Egypt—unless a certain curved knife of slate from Antrim,[1] sharpened on the concave face, may be looked upon as such. But the grain-rubbers

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Sir John Evans: The Ancient Stone Implements of Great Britain, p. 358. 1897.

which have been found are exceedingly ancient, antedating by a long way the well-known querns, and are probably Neolithic.[1] Coming to the Bronze Age, we find socketed sickles of the later portion of this period (possibly 900–800 B.C.) fairly common in this country,[2] which show that the cultivation of grain was widespread. Plant-remains from the Irish lake-dwellings or interments unfortunately do not help us here; seeds have seldom been identified from them, nor have these been correlated with the objects associated with them; where walnuts and beech-nuts are mentioned in the same breath with bronze implements[3] it is clearly hopeless to pursue inquiry.

When we enter on the historic period, we find the cultivation of cereals an important occupation of the people. Early Irish literature abounds in names of grains—*coirce* (oats), *cruithnecht* and *tuirenn* (wheat), *ith* and *arba, arbar* (corn), *eórna* (barley), *segal* (rye); some of these words carrying us back to the Old-Irish period (seventh to tenth century),[4] and being without question much older than that.[5]

O'Donovan, again, quotes a poem in which mills are mentioned, and the grinding of oats and wheat, written about 651 A.D.; and he gives other instances of the early prevalence of agriculture in Ireland.[6]

It is clear that from this point of approach very little that is definite is to be learned concerning the standing of the many dubious plants now found in our cultivated land; there can be little doubt that most of them are very early introductions. But if we work back from the present, we are in a more advantageous position. To do this we take the existing flora, and from careful observation of the habitats and distribution of the constituent species we can in many cases form an opinion as to their history and standing. And a test which will in many cases help us in the forming of a conclusion is to consider, in the case of each species of doubtful standing, what would happen to it, so far as we can judge, were the influence of man even now withdrawn.

It is essential for clear understanding that we should define what we mean by such terms as "native" or "indigenous," as compared with "alien," "introduction," and so on. "Native" is used here in its strict sense. "A species is only held to be native," says Dunn,[7] "in a natural locality to which

[1] I am indebted to Mr. George Coffey and Mr. E. C. R. Armstrong for notes on this subject.

[2] W. R. Wilde: Descriptive Catalogue of the Antiquities of stone, earthen, and vegetable materials in the Museum of the Royal Irish Academy, p. 526. 1857.

[3] W. G. Wood-Martin: The Lake-Dwellings of Ireland, p. 73. 1886.

[4] I have to thank Prof. Carl Marstrander and Mr. R. I. Best for these notes.

[5] This subject is treated more fully in Prof. Wilson's report on Agriculture (Clare Island Survey, part 5), published since the above was written.

[6] John O'Donovan: Antiquity of Corn in Ireland. Dublin Penny Journal, i., 108–110, 282–283. 1832–33.

[7] S. T. Dunn: Alien Flora of Britain, p. x. 1905.

it has spread by natural means from a natural source." This excludes all interference by man, direct or indirect, as regards either the origin of the seed or plant, its transport, or its subsequent development. But these tests are not easy to apply, and cannot mostly be applied directly. We have to rely rather on the absence of any evidence of introduction, making "native," in its application, a purely negative term, as Watson has pointed out;[1] and certain plants early introduced by man may now display no jot of such evidence, and be ranked as native.[2] Every plant was introduced to its present habitat by natural or artificial means at some time; a native plant means to us a plant the record of whose introduction is lost; but there is every reason to think that in the vast majority of cases these "introductions" of native species took place before the beginning of man's activities. The only positive evidence that we can hope to obtain of the "nativeness" of a plant is the discovery of its fossil remains in beds of pre-human age; and on this subject the evidence is only beginning to accumulate.

From the strictly native species we have a long series, descending to the habitual and confirmed weed, introduced from cultivated land by human hands into cultivated land; the various grades being well discussed by De Candolle,[3] and exemplified from the British flora by Watson.[4]

In the majority of English floras, "native" is not used in so strict a sense as that quoted above, and generally includes individuals of species truly native in the district or county, growing in either native or artificial habitats[5]; and in view of the fact that these two categories include between them the range to which the native plants have spread by natural dissemination, there is a good deal to be said in excuse for the practice; though, I think, the only logical definition of the term "native" is the one given above.

The extent to which human agency has interfered with the vegetation is shown by the fact that Dunn's "Alien Flora of Britain" contains 924 species which that writer looks on as sometimes or always introduced. The greater man's activity in any area, the larger will be the percentage of non-native plants, and *vice versa*. The true natives mostly shun man's proximity, and increase as we leave his works behind. In fact, if we divide our flora roughly into "anthropophobes" and "anthropophiles," we shall find that the former

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[1] H. C. Watson: Cybele Britannica, iv., p. 65. 1859.

[2] See A. de Candolle: Origin of Cultivated Plants (English edition), p. 10.

[3] A. de Candolle: Géographie Botanique Raisonnée, ii., pp. 606–611. 1855.

[4] *Tom. cit.*, pp. 71–77.

[5] An entertaining discussion on meanings of the word *native*, by an anonymous writer, appears in *The Phytologist*, N.S. i., p. 93. 1855–6.

group will correspond pretty closely with the native flora; while in the latter we shall find almost all the species which are under suspicion of introduction. The main sources of modern introduction are well summarized by Dunn (pp. xiii–xiv) and Adams (*loc. cit.*).

In populous or highly tilled districts it is generally a very difficult problem to determine which plants are indigenous, and which have been brought in, directly or indirectly, by human operations. The problem is simplified in an isolated and primitive area such as Clare Island, where the conditions are tolerably uniform, and where the large proportion of ground still remaining in a state approaching its primeval condition permits, at least partially, of a reconstruction of the original surface, and of the vegetation which it supported.

The doubtful section of any flora consists largely of annual plants, whose life-history renders them especially suited for life in the cultivated lands. They are abundant seeders; the resting-stage during which they are dispersed comes frequently; and being short-lived, they can pass through a generation between ploughings. The home of a large number of such plants is in the Mediterranean region, whence they have worked their way northwards across the cultivated lands. The dry soils of the south-east of England possess a greater number of such species, both as natives and as introductions, than the north of England, or Scotland, where they appear mainly as introductions; and some are native in eastern Ireland, which die out or become dependent on man, as the light soils of the Leinster sea-board graduate into the peaty soils of Connaught. As Dunn remarks (p. ix): "The total range of any plant comprises all the countries in which it occurs, and, in cases where artificial dissemination has enlarged the original area, the total range may sometimes be satisfactorily divided into concentric zones corresponding to the increasing dependence of the plant on man as it recedes from its native centre."

In remote areas in western Ireland many of the doubtful items are eliminated. Such genera as Papaver, Fumaria, Silene, Lychnis, Trifolium, Valerianella are rare or absent—at least as regards annual species; while the annuals on the peninsula of Howth ($4\frac{1}{6}$ square miles) on the east side of Ireland include about 130 species, or 24 per cent. of its flora of 545 species, the annuals of Clare Island ($6\frac{1}{6}$ square miles), the flora of which comprises 389 species, comprise only 18 per cent. On Clare Island almost every plant which is found *only* on cultivated ground may be ruled out as either introduced by man, or dependent on him for its continued existence. This is because the island, in its primitive condition, contained no open ground such as gravelly wastes, sand-dunes, &c., on which these species might have

maintained themselves; nor, from a very remote period, can any native grazing animals have been present, which might, at certain spots, have enriched the land for the support of those plants which like gross feeding.

Among the groups of plants which are introduced by man, and come under section (3) of the classification on p. 33, the more important are:—

(*a*) Plants deliberately brought in, as seeds or roots, for agricultural or aesthetic purposes, or for food. These include trees planted for shelter, crop plants and crop seeds; seeds, &c., used as human food, or for feeding cattle, fowl, &c.; and the contents of the kitchen-garden and flower-garden.

(*b*) Plants which come accidentally with these, especially as impurities in seed. The main body of alien weeds comes under this head.

(*c*) Plants which arrive attached to animals, or to inanimate objects brought in by man. Thus, men, cattle, and sheep may carry seeds attached to their hair or feet; and clothing, timber, and many other materials brought by man serve as carriers of seeds (see note on *Matricaria discoidea*, p. 47, and on mud from the mainland, p. 54).

On Clare Island no portion of the vegetation can be claimed as absolutely undisturbed, except that occupying certain portions of the sea-cliffs, where the ubiquitous sheep are unable to climb, and one or two other spots (see p. 40, *infra*). Even on the great scarp of Croaghmore, among the alpine plants, one comes on natural shelters under overhanging rocks, and here the sheep have left their mark behind them in the little colonies of *Poa annua*, *Stellaria media*, *Cerastium glomeratum*, &c., which are here clearly exotic. Nevertheless, the heath area, which occupies about two-thirds of the island, is still comparatively in its primitive condition. It is on the farm-land that man's influence is especially seen; here we get every gradation from an almost undisturbed native flora to a flora which is wholly artificial.

In order to determine the standing of the doubtful members of the flora, the range and habitat of each species on the island were studied, and the means by which each is dispersed; also its distribution and standing on the adjoining mainland, in Britain, and on the Continent.[1] To discover what plants are being introduced at the present day, samples of the seed brought to the island for agricultural purposes were intercepted and examined[2]; certain accidental means of introduction were also investigated.

In attempting to express with any accuracy the present standing of species as regards their being native or introduced, we are really trying to

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[1] As regards observations on these points I would acknowledge the kind assistance I received from Miss M. C. Knowles.

[2] I would acknowledge my great indebtedness to Dr. G. H. Pethybridge, in charge of the Seed-testing Station of the Department of Agriculture and Technical Instruction, and his assistant, Miss R. Hensman, for analyses of these samples.

express their past history. The test which we apply to them is of necessity a three-fold one—source, dispersal, habitat. Dunn's definition, already quoted, of a native plant—a plant which has spread by natural means from a natural source to a natural habitat—is the only possible one, if we follow the matter to a logical conclusion. Now, a plant may fail to fulfil any one, any two, or all three of these conditions—its source, its dispersal, its habitat, may be any or all under suspicion. Eight combinations of these three conditions are possible, and any of these eight combinations may occur in nature, though some occur much more frequently than others. We may tabulate these possibilities; and if we let N stand for uncontaminated conditions, and * for contaminated conditions, then we can express the standing of a plant as shown in the right-hand column :—

Source.	Dispersal.	Habitat.	Symbol.
Natural	Natural	Natural	N N N
Natural	Natural	Artificial	N N *
Natural	Artificial	Natural	N * N
Natural	Artificial	Artificial	N * *
Artificial	Natural	Natural	* N N
Artificial	Natural	Artificial	* N *
Artificial	Artificial	Natural	* * N
Artificial	Artificial	Artificial	* * *

The reader will easily select instances from his own experience in which every one of these eight sets of conditions may occur or has occurred. I hesitate to apply any of the existing terms for the standing of a plant, such as "colonist," "denizen," &c., to any of these combinations, since these have been used rather vaguely, and not always in the same sense; neither do I suggest names for them, since the formula itself is shorter than any descriptive name would be, and definite and self-explanatory besides.

We need to be clear about our definition of each of the three tests. A native source means one which has *never* been contaminated, thus carrying us back to the pre-human period; this category deals especially with *the various habitats which the plants' progenitors may have occupied before arrival in the present habitat.* Natural dispersal in the same way must of necessity refer to the continued dispersal of the progenitors of our chosen individual from the beginning, and this category deals with the means by which the said progenitors migrated from habitat to habitat until the present station was reached. The

third symbol deals with the present habitat and its condition; a natural habitat means one which has *never* been altered by man. But in certain cases in all three categories, where the interference by man was of early date, all trace of it may now be lost. The lines of investigation to be pursued in attempting to apply these tests to our flora are well put forward by Adams (*loc. cit.*).

The only point in which the formula suggested above fails to show completely the standing of a plant from this point of view is that it deals only with the plant's history up to the present, and makes no prediction as to the future—in other words, it does not express whether we believe the plant to be established in its habitat, and likely to remain there indefinitely without the assistance of man (as is the case with natives and naturalized aliens)—or whether we believe the plant likely not to endure, as in the case of the majority of agrestal species, casuals, &c. When we have an opinion on this subject, we can express probable temporary occupation of the ground by putting in brackets the triple symbol which expresses the plant's past history.

Of course, this system applies only to any particular individual we choose to select; and another individual of the same species growing close by may have a different history. A plant which we brand * * * may as a species be N N N in the district all the time. But, it must be remembered, we are dealing with a vegetation much disturbed by man, in which we are endeavouring to distinguish the fragments of the aboriginal flora; our test is applied to the individuals most nearly native that we can find. A species is set down as native in a district even though ninety-nine out of every hundred individuals may fail to pass the test, so long as there can be no doubt about the hundredth. The various individuals of almost every species in any area divide themselves among several of the categories given above; the standing of a species is indicated by the applicable formula which most nearly approaches the native standard.

This method of analysis is not very satisfactory, especially since the N or * which we assign is a matter of opinion, though founded on what evidence we can gather. It is easy to invent a *reductio ad absurdum*—for instance, is the progeny of a native plant never more to be allowed native rank, because at some time in the past one generation was spent self-sown in a disturbed habitat? Nevertheless, the method will be found to clarify our ideas as to the standing of plants in a great majority of cases, and large groups of species can without difficulty be assigned their place in the system. Let us return now to the consideration of the flora of Clare Island.

Maritime Vegetation.—On the cliffs and sea-rocks, as mentioned above,

we find in places an almost undisturbed flora. The close maritime sward, too, which occupies considerable exposed tracts near the sea, appears to be only slightly influenced by grazing, and its limits remain unchanged. Among the few spots on the island accessible to man, but inaccessible to sheep, are some small sea-stacks which rise out of the sea beside Doontraneen near the lighthouse, and Kinnatevdilla, or Beetle Head, the most westerly point of the island. These were explored by swimming and climbing, but, owing to their small size, not much can be learned from them. The dense, deep masses of *Festuca ovina* and other plants in such places contrast strongly with the closely nibbled grass of the adjoining slopes.

THE MOORLAND.—The flora here has been disturbed by grazing, by burning, and by turf-cutting; and grazing in particular has probably greatly altered the appearance—if not so much the flora—of the far-extending moorland formation. Writing on the same question in the Faeröes, Ostenfeld says:—"Indeed, one wonders how the Faeröese vegetation would look if there were no sheep. . . . The character and features of the vegetation outside the enclosures in the lower zones of the Faeröes are in a high degree due to the grazing of sheep."[1] While on Clare Island it is difficult to point to any particular species which has been driven from the heath-land area by man or sheep, or to any, save a few annuals about fences or turf-stacks, that owe their presence to the same cause, there can be no doubt that the old original formations have been largely broken up and dispersed.

THE FARM-LAND occupies two areas: the one running for three miles along the southern shore of the island; the other lying in a basin fronting the north-eastern shore; their position and limits being determined by the presence of a certain amount of soil and of shelter. Around the edges of these areas, and on uncultivated knolls within them, a shrubby or grassy vegetation is developed, and fields left untilled run back to a poor vegetation in which grasses predominate; it seems clear that grassy scrub formed one of the aboriginal types of vegetation. The remaining patches of native woodland, consisting of low scrub, are found on steep or rocky places mainly within this area. They have evidently been diminished by farming operations, and largely by grazing, and are still (as along the north face of the ridge running west from the harbour) being trampled and torn by cattle and sheep. The indications are that a good deal of the drier and steeper slopes of the farm-land area was formerly occupied by scrub, with a grassy woodland undergrowth, the flatter and wetter parts being occupied by beds of willows.

As mentioned elsewhere, the remains of Scotch Fir and other trees, of

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[1] Botany of the Faeröes, p. 894.

large size in comparison with the present tree-vegetation, occur abundantly in the peat in some places; but these belong to an earlier epoch, and there are no indications that they were destroyed by man.

It is on the farm-land area that the flora has been most profoundly altered, the operations consisting mainly of drainage and tillage. The ground is wet almost everywhere, on account of the high rainfall and perennial dampness of the air, and is usually peaty. The drainage of the land is very primitive. Deep ditches have been dug in places along the edges of the fields, and the material thrown up into high banks to give shelter. Over the whole area of the fields parallel open trenches are dug, running with the slope. These are about 6 feet to 10 feet apart, 2 feet to 3 feet wide, and 1 foot to 3 feet deep. The material is thrown on the intervening ridges, and on these "lazy beds" the crop is sown or planted. Wherever cultivation has been practised, even at a remote time, the marks of these trenches and ridges remain, giving the land a fluted appearance, and showing the high-tide mark of tillage, which occurred before the dreadful famine year of 1846. Covered drains were unknown on the island until a couple of years ago, and are still looked on as a doubtful experiment. Loose stone walls are also built, to clear the land and to give shelter. The result of all these operations is to diminish the proportion of marsh plants, and to increase the mesophile vegetation. The better drainage and shelter given by the ditches, banks, and walls, have, I think, considerably increased the quantity of Bracken and of Brambles, for instance.

The usual crops are potatoes and oats, with some barley, rye, turnips, mangels, and cabbages. The weed flora is poor in variety. Among the cereals *Brassica Rapa* var. *Briggsii* is the most conspicuous and abundant colonist; *B. alba* is the next commonest Brassica; *B. Sinapis* is a rather bad third. Other prevailing crop-weeds are *Spergula arvensis, Polygonum Persicaria, P. Hydropiper,* and *Euphorbia Helioscopia.* Poppies, Valerianellas, &c., are absent; Fumitories very rare. The human activity of the island centres about the harbour, in the extreme south-east, and the chapel, on the southern shore a couple of miles away. Around these spots are grouped such species as *Sisymbrium officinale, Trifolium dubium, Calystegia sepium, Veronica polita, V. agrestis, V. Tournefortii, Lamium hybridum, L. intermedium, Stachys arvensis, Polygonum Convolvulus,* all of which must on Clare Island rank as introduced plants.

When land is left uncultivated, it is rapidly invaded by the native flora; annual species disappear, and indigenous perennials soon form a closed vegetation; on the lower grounds, grasses become dominant, on the upper grounds Calluna. A few examples of stages of this regeneration may be given.

1. Maum.

Field of potatoes, not yet dug (October). Among the more confirmed weeds, such as Chickweed, Groundsel, and knot-weeds, were

Achillea Millefolium.
Angelica sylvestris.
Centaurea nigra.
Digitalis purpurea.
Heracleum Sphondylium.
Hydrocotyle vulgaris.
Leontodon autumnalis.
Lythrum Salicaria.
Potentilla Tormentilla.
Pteris Aquilina.
Rumex Acetosa.
Senecio aquaticus.
Viola Riviniana.

2. Between the Harbour and the Chapel.

Field sloping south, 100 feet elevation. Thin, poor, loamy soil, capable of bearing a crop only about once in ten years, when well manured. Old "lazy beds," second year out of cultivation. Vegetation almost closed.

Poa pratensis, *v.c.*
Ranunculus repens, *c.*
Potentilla Anserina, *c.*
Senecio Jacobaea, *c.*
S. aquaticus, *c.*
Prunella vulgaris, *c.*
Rumex Acetosella, *c.*
Holcus lanatus, *c.*

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Achillea Ptarmica.
Agrostis alba.
A. vulgaris.
Anagallis tenella.
Arrhenatherum avenaceum.
Cerastium triviale.
Cnicus lanceolatus.
Cynosurus cristatus.
Daucus Carota.
Epilobium obscurum.
Erythraea Centaurium.
Euphrasia officinalis.
Festuca rubra.
Hypericum humifusum.
Juncus bufonius.
J. effusus.
J. supinus.
Lotus corniculatus.
Matricaria inodora.
Plantago lanceolata.
Polygonum aviculare.
P. Hydropiper.
Rhinanthus Crista-galli.
Rumex Acetosa.
R. crispus.
R. obtusifolius.
Sagina procumbens.
Scirpus setaceus.
Sonchus asper.
Spergula arvensis.
Stachys palustris.
Stellaria media.
Trifolium dubium.
T. pratense.
T. repens.

Just above, a portion of the same field was a year or two longer out of cultivation. Here was a closer sward, composed mainly of grasses (*Cynosurus cristatus, Holcus lanatus, Poa pratensis* chiefly), bright with the flowers of *Prunella vulgaris, Trifolium repens, Lotus corniculatus, Anagallis tenella.*

3. Between the Harbour and the Chapel.

Field sloping steeply south, 300 feet elevation. "Lazy beds," at least ten years out of cultivation. Soil peaty. Closed, patchy vegetation.

Calluna vulgaris } *dom.*
Salix repens }
Anthoxanthum odoratum, *c.*
Anagallis tenella, *c.*
Nardus stricta, *c.*
Potentilla Tormentilla, *c.*
Scabiosa succisa, *c.*
——
Achillea Ptarmica.
Bellis perennis.
Carex flava.
C. glauca.
Cnicus pratensis.
Cynosurus cristatus.
Galium saxatile.
Juncus lamprocarpus.
Leontodon hirtus.
Lotus corniculatus.
Luzula campestris.
Pinguicula vulgaris.
Plantago maritima.
Prunella vulgaris.
Ranunculus acris.
Sagina procumbens.
Senecio aquaticus.
Trifolium dubium.
T. repens.

The difference in quality between this invasion on the peat-area and the last, which was on the loam, is very apparent. In both cases the number of wet-soil plants on these well-drained slopes facing south conveys a good idea of the dampness of the climate.

Trees and Shrubs.—A few trees have been planted, mostly about cottages near the east end of the island; but though some of them are now tolerably old, none have succeeded in attaining a greater height than about 12 feet. The species represented are

Acer Pseudo-platanus.
Prunus Cerasus.
Pyrus Aucuparia.[1]
Sambucus nigra.
Fraxinus excelsior.
Salix pentandra.
S. Smithiana.
S. viminalis.
Populus canadensis.
P. nigra.
Alnus glutinosa.

Near the harbour are some attempts at hedges, where we find—

Crataegus Oxyacantha.
Hippophäe rhamnoides.

A few shrubs have been planted for ornament or use about cottages:—

Ribes Grossularia,
Fuchsia Riccartoni,
Ligustrum *sp.*;

and at the little new hotel may be seen *Ribes sanguineum,* several New Zealand Veronicas, *Griselinia littoralis.*

[1] This is the only one of the eleven species listed which occurs also as a native on the island.

Culinary Herbs.—None of the herbs so generally seen about cottages seem to be present on the island—no Mints, Horehound, Southernwood, Tansy, Sage. Even *Allium Babingtonii*, so widespread on the west coast, is absent.

Garden Flowers.—These are practically absent, and none seem to have escaped and established themselves. In front of the Lodge at the Harbour one may see *Sedum Telephium*; also *Antennaria margaritacea* growing with *Ægopodium Podagraria*, the two having doubtless come together. At the hotel a few small herbaceous things have been recently planted. Near the chapel *Lavatera arborea* and *Papaver somniferum* have been planted beside a cottage.

Present Standing of the Native Species (N N N, N N *, N * N, N * *).

Out of a total flora of 393 species, about 338 may be accounted true natives on Clare Island;[1] that is, they appear to have occupied the ground continuously since before the human period, or, if arrived since, have done so by natural means from a natural source; and they are still found in certain habitats which have never been disturbed by man (N N N).

But very few of these species are found *only* in such habitats, *i.e.*, few of them are *always* N N N. As examples of such we may quote the following :—

(1) Certain alpines—*Saxifraga oppositifolia*, *Saussurea alpina*, *Salix herbacea*, *Aspidium Lonchitis*. These live on narrow ledges or in vertical rock-clefts of the Croaghmore cliffs, where even the sheep cannot penetrate; and their habitat is absolutely undefiled. Certain other less exclusive alpines, such as *Sedum Rhodiola* and *Oxyria digyna*, have had their distribution considerably altered by sheep.

(2) Certain woodland plants, which, like the last group, occupy on the island inaccessible rock-ledges; such are *Lychnis diurna*, *Orchis mascula*.

(3) Certain plants of wet, undrained swamps, such as *Drosera anglica* and *Carex limosa*, which grow where animals dare not venture.

(4) Certain hydrophytes, such as *Nitella translucens*, which grows in a swampy lakelet undrained by man.

(5) Certain sea-coast plants found on rock-ledges—*Crithmum maritimum*, *Beta maritima*.

But, of course, we cannot tell in what other habitats these plants may have grown formerly in which they have been exterminated; so we cannot be sure that their distribution has not after all been influenced by man.

[1] The list of natives of the island can be obtained by striking out of the general list on pp. 25–27 the non-native species listed on pp. 46–47.

The great bulk of the flora of the island consists of individuals which must be classed as N N *—that is, they belong to species which are *in sensu stricto* native somewhere on the island ; but they (the individuals in question) occupy disturbed ground ; they represent the invasion of the farmland by the indigenous flora ; and in less altered areas, such as the heath-land, they represent the natural regeneration of the indigenous flora.

Native species brought by artificial means into a native habitat (N * N) or into an artificial habitat (N * *) form no recognizable part, I think, of the flora of the island ; though no doubt the sheep and cattle enlarge the range of some of the native species by dispersing seeds, &c.

A few plants which I believe to be native on the island, though their claim is not altogether clear, may be referred to here :—

Ulex europaeus.—Has its headquarters on rough stony ground at the east end of the island, whence, I believe, it has spread to dry banks on which it has the appearance of having been planted.

Senecio Jacobaea.—Except in very dry places is replaced by *S. aquaticus.* Many of the dry places in which it grows are artificial ; but it is found on isolated sea-stacks near Doontraneen, and its absence from some suitable dry spots on the island is probably due to the sheep.

Arctium Newbouldii.—Native probably on the sands near the harbour, which are its headquarters on the island. But in the case of a plant so prone to ectozoic dispersal, certainty is impossible.

Bidens tripartita.—Grows mainly in a roadside ditch near the chapel—an artificial habitat ; but also in two places in wet ground on old grass-land, where I think it is native. A few plants which appeared on the gravelly beach inside the harbour in 1910 were probably brought from one of these stations by means of the barbed seeds, which are so admirably adapted for promoting dispersal by animals. But that one must be slow about assuming such dispersal is shown by the following fact : *B. cernua* grows in great abundance along the edges of the road leading from Louisburgh to Roonah, along which much Clare Island traffic passes, and in autumn its barbed seeds are ready in thousands for casual transport by man or animals. Yet it has not succeeded in reaching the island. Did *B. cernua* instead of *B. tripartita* (which is absent from the road-sides referred to) occur on Clare Island, one would certainly have been tempted to ascribe, probably erroneously, its arrival to the traffic by this route.

Lemna minor.—Occurs only in one ditch near the chapel. Probably brought by natural means (? birds) into this artificial habitat. It occurs also in a pool on Caher Island, long uninhabited.

Present standing of the non-native species (* * *, * * N, * N *, * N N).

Of the 55 or so species which, though not deliberately planted where they now grow, may be looked on as not truly native on the island, a large majority are full-blown aliens (* * *), artificially brought from non-native habitats into non-native habitats; and in most cases these are weeds of cultivated land. Working backwards from those which are most dependent on man to those which are less so, we may divide all the plants which are non-native on the island as follows:—

(1) Planted species not reproducing themselves from seed nor otherwise spreading ([* * *]). In this category come the various introduced trees and garden plants already referred to (pp. 43–44) and a few crop-plants like *Vicia sativa* and *Lolium perenne.*

(2) Found mainly on cultivated land or in disturbed ground about houses, and, though self-sowing, dependent on the continuance of cultivation, &c., for their continued existence ([* * *]). Their relative abundance is indicated below, as in the general list of species on pp. 25–27.

Fumaria confusa, 2.
Capsella Bursa-pastoris, *f.*
Brassica Rapa *var.* Briggsii, *c.*
Brassica Sinapis, *c.*
B. alba, *c.*
Raphanus Raphanistrum, 3.
Stellaria media, *f.*
Spergula arvensis, *v.c.*
Alchemilla arvensis, *r.*
Chrysanthemum segetum, 1.
Senecio vulgaris, *c.*
Sonchus asper, *f.*
Anagallis arvensis, *f.*
Veronica agrestis, 2.
V. polita, 2.
V. Tournefortii, 2.
Stachys arvensis, 2.
Lamium purpureum, *f.*
L. hybridum, 1.
L. intermedium, 2.
Galeopsis Tetrahit, 1.
Chenopodium album, *r.*
Atriplex patula, *f.*
Polygonum Convolvulus, *r.*
P. lapathifolium, 2.
P. Persicaria, *f.*
Euphorbia Helioscopia, *f.*
E. Peplus, *r.*
Urtica urens, *f.*

(3) Found chiefly on roadsides and banks, and in pastures. These are in the main less dependent on man than the last group; and some of them, it would appear, could now maintain themselves indefinitely in the absence of man ([* * *] or * * *). Some (marked ?) may possibly be of native parentage (N N *).

Sisymbrium officinale.
? Senebiera Coronopus.
Geranium dissectum.
Trifolium dubium.

Vicia hirsuta.	Mentha arvensis.
Matricaria discoidea.	Plantago major.
Cnicus arvensis.	Rumex conglomeratus.
C. lanceolatus.	Holcus lanatus.
Artemisia vulgaris.	Poa annua.
Lapsana communis.	Bromus mollis.
?Veronica arvensis.	B. commutatus.

(4) Found chiefly about houses and gardens, apparently permanently established (* * *).

Circaea lutetiana.	Calystegia sepium.
Conium maculatum.	Symphytum officinale.
Ægopodium Podagraria.	Urtica dioica.

(5) Miscellanea :—

Viola arvensis—sandy bay near the harbour, one patch ; probably * * N.

Crepis virens—a few plants only, on roadside, N * *, or * * *.

The other categories of non-native plants, no doubt, occasionally apply ; but no groups of species can be placed under them. For instance, the seeds of native plants which have invaded the farm-land of the adjoining mainland, and are maintaining themselves there without the aid of man (N N *), may be eaten by birds and so brought into natural (* N N) or artificial (* N *) habitats on the island, or their introduction into a natural habitat may be artificial (* * N); such cases are difficult to establish, and in any case they play a very small part.

A few particular cases of introduction may be dealt with at this point.

Cotyledon Umbilicus.—Has spread apparently from one of its few native habitats on the island to the walls of the old abbey, which now form its headquarters. *Spergularia rupestris* and *Asplenium marinum* have done the same. These species, elsewhere generally N N N, rank here as N N *.

Circaea lutetiana.—Only in dry-built walls in front of a cottage on the way to the light-house—no doubt introduced, probably with some bygone garden plant, but apparently established. * * *

Sambucus nigra.—Planted about cottages. Apparently not reproducing itself from seed ; but this is probably due to the prevalence about the houses of donkeys and calves. [* * *]

Matricaria discoidea.—It is easy to see how this plant was introduced from the mainland, where it is abundant on roadsides down to the edge of the sea. In a very small amount of mud, scraped off my boots on arrival on the island from Achill Sound in October, I found four seeds of this species. * * * (In this connexion see also p. 54.)

To sum up, then: according to this analysis of the vegetation, the Clare Island flora consists mainly of individuals of native origin, self-sown in ground more or less disturbed by man; and of introduced species dependent for their continued existence on the continuance of man's operations. A few natives still cling to aboriginal and undisturbed habitats, and a few aliens have become established, independently of the continuance of man and his works.

Imported Weed-Seeds.

To come now to the question as to what plants are at present being introduced to the island by farming operations. Up till 1907 the seed used on Clare Island for agricultural purposes was purchased locally; but since that year seed of higher quality has been supplied through the Department of Agriculture. In order to see what weeds were being brought into the district along with seed, a number of samples of the seeds on sale at Achill Sound (where much of the Clare Island trading is done) were obtained in the spring of 1910, by the kindness of Professor James Wilson and Mr. D. S. Simpson; at the same time, for purpose of comparison, samples of the seed supplied by the Department of Agriculture were obtained on the island; also a sample of the oats used for feeding horses and fowl. The only other channel by which seeds are brought in any quantity into Clare Island is in hay, which, on account of the lateness of the spring on the island, is imported during the early months of the year from the adjoining mainland, where it has been grown. After a boat-load of such hay, grown near Roonah, had been landed on the quay and removed in March, 1910, I swept up some of the fine material left behind. All these samples were, as has been said, examined and reported on at the Department's seed-testing station by the kindness of Dr. G. H. Pethybridge, excepting the sample of oats referred to, which was examined by Miss Knowles.

The Achill Sound samples, which were obtained from two sources, were as follows:—

1 Red Clover.
2 White Clover.
3 Perennial Rye-grass.
4 Italian Rye-grass.
5 Swede.
6 Swede.
7 Turnip.
8 Yellow Aberdeen Turnip.
9 Mangel.
10 Yellow Globe Mangel.

In the lists of weed-seeds given below, the species which occur on Clare Island are marked N or *, according as they are native there or of doubtful standing (see p. 38).

No. 1. Red Clover.—A satisfactory sample, with a purity of about 98 per cent. The impurities betray a southern or eastern origin.

* Chenopodium album.
Digitaria ?filiformis
D. ciliaris *or* sanguinale.
N Plantago lanceolata.
* P. major.
P. media *or* Rugelii.
N Polygonum aviculare.
* Polygonum Persicaria.
N Rumex Acetosella.
N R. ?obtusifolius.
Setaria glauca.
S. viridis.
Silene noctiflora.

No. 2. White Clover.—Cannot be considered a good sample, its purity being only about 95 per cent., instead of 98 per cent. Contains too much Plantago and *Rumex Acetosella*. Cuscuta and Calamintha are not usual in White Clover seed. The impurities indicate a slightly southern or eastern origin.

Alyssum calycinum.
Anthemis arvensis.
Barbarea vulgaris.
Calamintha ?Acinos.
N Cerastium triviale.
* Chenopodium album.
Cuscuta Trifolii.
Erysimum ?cheiranthoides.
Galium *sp.*
N Geranium molle.
Lychnis vespertina.
N Matricaria inodora.
Myosotis *sp.*
* Papaver somniferum.
Phleum pratense.
N Plantago lanceolata.
N Prunella vulgaris.
N Rumex Acetosella.
* Spergula arvensis.
N Stellaria graminea.
* S. media.
Viola *sp.*

No. 3. Perennial Rye-grass.—An inferior sample, with a purity of only about 86 per cent., instead of 99 per cent. or more. Contains far too much *Bromus mollis* and *Holcus lanatus*. Most of the impurities belong to species which occur locally; the others would be accounted for by an English origin.

N Anthoxanthum odoratum.
N Arrhenatherum avenaceum.
* Bromus mollis.
N Festuca sciuroides.
* Holcus lanatus.
N Hypochaeris radicata.
Myosotis *sp.*
N Poa ?trivialis.
N Ranunculus acris.
Trifolium agrarium.
T. ?procumbens.

No. 4. Italian Rye-grass.—Not a good sample; purity about 95 per cent., instead of 99 per cent. or more. Over four-fifths of the impurities

consist of *Bromus mollis, Holcus lanatus,* and *Festuca sciuroides*; almost all the impurities are common local plants.

Alopecurus agrestis.
A. pratensis.
N Anthoxanthum odoratum.
* Bromus mollis.
N Cerastium triviale.
N Cynosurus cristatus.
N Festuca sciuroides.
N Hypochaeris radicata.
N Plantago lanceolata.
N Ranunculus ?acris.
R. ?bulbosus.
N Rumex Acetosella.
N Sherardia arvensis.
* Sonchus asper.
Trifolium ?procumbens.

Samples 5, 6, 7, 8, 9, and 10 are reported as free from impurities, except for a few Galium seeds in No. 7, and a few seeds of *Polygonum Convolvulus* in No. 10.

Although these samples do not represent the seed being actually brought into Clare Island at the present time (on account of the new régime referred to), they do represent the kind of seed which has been in use there for many years past—except that probably the samples have been often much more impure.[1] The impurities in the samples give us, therefore, some idea of the alien seeds that have been showered down on the island year by year. Our present object being the question of the introduction of alien seeds into the district, we may take the various samples together as forming a single piece of evidence.

It will be seen that the majority of the extraneous seeds belong to species which are common on Clare Island, about half of them as natives, and half as plants of the cultivated land.

The balance, which are not found on Clare Island, include—

Ranunculus ?bulbosus.
Barbarea vulgaris.
Erysimum ?cheiranthoides.
Alyssum calycinum.
Silene noctiflora.
Lychnis vespertina.
Trifolium agrarium.
T. ?procumbens.
Anthemis arvensis.
Cuscuta Trifolii.
Calamintha ?Acinos.
{ Plantago media *or* P. Rugelii.
Digitaria filiformis.
{ D. ciliaris *or* D. sanguinale.
Setaria glauca.
S. viridis.
Phleum pratense.
Alopecurus pratensis.
A. agrestis.

Of these only four (*Ranunculus bulbosus, Barbarea vulgaris, Phleum*

[1] For instances of the gross impurity of much agricultural seed before the passing of recent acts and the founding of seed-testing stations, consult T. Johnson: The Principles of Seed-testing. Science Progress, i, pp. 483–495, Jan., 1907; and H. C. Long: Weeds (*supra cit.*), chap. xi.

pratense, and *Alopecurus pratensis*) can be reckoned as native in any part of Ireland. The rest have almost all been found in Ireland, their standing ranging from mere casuals like *Alyssum calycinum* and *Alopecurus agrestis*, to established aliens such as *Lychnis vespertina* and *Cuscuta Trifolii*. These plants, as a group, are light-soil species, with their headquarters far to the south and east—Mediterranean xerophiles, Siberian steppe-plants, and so on; and they testify to that artificial movement of seeds westward and northward to which reference has been made already on p. 36.

The chance that any of these aliens will become established in the Clare Island district even by repeated introduction is very remote, though some of them have settled in the more eastern parts of Ireland, and many of them in England, where climate and soil are more suitable for them.

This single group of samples shows the possibility not only of the introduction into the farm-land of a number of plants already holding the island as natives, but of the former importation into the island of many of the non-native species now found on the tilled land there. It demonstrates the ease with which these aliens are spread by the operations of husbandry, the probability that many of them were introduced to the island along with seed in earlier times, and also how their continuance is probably promoted by periodical reinforcements.

The seeds of which samples were obtained on Clare Island were as follows:—

11 Grass, "A" mixture.[1]
12 Grass, "P" mixture.[1]
13 Grass, "T" mixture.[1]
14 Barley.
15 Banner Oats, Scotch.
16 Scotch Potato Oats.
17 Waverley Oats, Scotch.
18 Yellow Globe Mangel.
19 Purple Top Turnip.

No. 11. "A" MIXTURE. Satisfactory sample: purity about 99 per cent. The presence of Rudbeckia, *Plantago Rugelii* (if correct), and Amaranthus indicates an American admixture.

Amaranthus *sp.*
* Bromus mollis.
Carex *sp.*
* Chenopodium album.
N Deschampsia caespitosa.
Lycopus europaeus.
Oenothera *sp.*
Plantago ?Rugelii.
* Polygonum Convolvulus.
* P. Persicaria.
Potentilla *sp.*
Rudbeckia ?hirta.
N Rumex Acetosella.
Silene Cucubalus.

[1] Composed as follows:—"A" MIXTURE—4 parts *Lolium perenne*, $2\frac{1}{2}$ *L. italicum*, $1\frac{1}{4}$ *Festuca pratensis*, $1\frac{1}{2}$ *Phleum pratense*, $\frac{1}{2}$ *Dactylis glomerata*, $\frac{1}{2}$ *Alopecurus pratensis*, 1 *Trifolium hybridum*, $\frac{1}{2}$ *T. pratense*, $\frac{1}{4}$ *T. repens*. "P" MIXTURE—$3\frac{1}{2}$ *Lolium perenne*, 3 *L. italicum*, $1\frac{1}{4}$ *Phleum pratense*, $2\frac{1}{4}$ *Dactylis glomerata*, $\frac{1}{2}$ *Trifolium hybridum*, 1 *T. pratense*, $\frac{1}{2}$ *T. repens*. "T" MIXTURE—2 *Phleum pratense*, 1 *Lolium italicum*.

No. 12. "P" MIXTURE.—Satisfactory sample; purity about 99 per cent. *Panicum dichotomum* and Rudbeckia show that some of the mixture is of North American origin. Oenothera is not generally found as an impurity.

Alyssum calycinum.
Anthemis Cotula.
N Carex ?ovalis.
N Chrysanthemum Leucanthemum.
Lychnis vespertina.
Oenothera *sp.*
Panicum dichotomum.
N Plantago lanceolata.
Plantago ?Rugelii.
Poa *sp.*
Potentilla *sp.*
Rudbeckia ?hirta.
N Rumex Acetosella.
Scrophularia ?vernalis.
* Sisymbrium ?officinale.
* Stellaria media.
Verbena *sp.*

No. 13. "T" MIXTURE.—Satisfactory sample; purity about 99 per cent. *Cynodon Dactylon*, *Euphorbia Preslii*, and Oenothera are unusual impurities. The second, with *Plantago Rugelii* (if correct), indicates a North American ingredient.

N Chrysanthemum Leucanthemum.
Cynodon Dactylon.
Euphorbia Preslii.
N Hypochaeris radicata.
* Lapsana communis.
N Leontodon autumnalis.
Lycopus europaeus.
Oenothera *sp.*
N Plantago lanceolata.
P. Rugelii *or* P. media.
Potentilla *sp.*
N Prunella vulgaris.
N Rumex Acetosella.
N Eleocharis palustris.

Samples 14, 15, 16, 17, 18, and 19 are reported as being practically pure.

This set of samples shows a change both in the nature and in the amount of the introduced weed-seeds as compared with the Achill Sound set. Although the list of species occurring in the samples which are absent from Clare Island is still large—14 as against 20 in the Achill samples—their quantity is much reduced, the total impurities averaging only about ·3 per cent. The species found in this batch of samples which do not grow on Clare Island are

Alyssum calycinum.
Lychnis vespertina.
Silene Cucubalus.
Oenothera *sp.*
Anthemis Cotula.
Rudbeckia ?hirta.
Scrophularia ?vernalis.
Lycopus europaeus.
Verbena *sp.*
Plantago Rugelii *or* P. media.
Amaranthus *sp.*
Euphorbia Preslii.
Cynodon Dactylon.
Panicum dichotomum.

The most striking feature in these lists is the North American ingredient

in the grass-mixture samples; but none of these American plants are species which have as yet effected a lodgment in Ireland. For the rest, we find, as in the Achill samples, a number of species long since arrived on the island as natives, and others which have followed agriculture thither. The plants not known on the island indicate (exclusive of the American ingredient already referred to) a southern and eastern origin of the seed, as in the case of the Achill batch of samples.

Seeds out of hay from Roonah.—This hay was grown a mile from Roonah on an old meadow bottom which had not been tilled for twenty years. The last crop was oats, after which the grass was allowed to grow up naturally, no seed being sown. The sweepings yielded seeds of the following species:—

N Ranunculus ?repens
Silene *sp.*
N Cerastium triviale.
* Stellaria media.
* Spergula arvensis.
Trifolium ?procumbens
N Heracleum Sphondylium.
N Bellis perennis.
N Chrysanthemum Leucanthemum.
Centaurea *sp.*
* Lapsana communis.
N Hieracium Pilosella.
N Hypochaeris radicata.
* Crepis virens.
Myosotis *sp.*
N Rhinanthus Crista-galli.
N Prunella vulgaris.
N Plantago lanceolata.
Atriplex *sp.*
N Polygonum Hydropiper.
* P. lapathifolium.
N Rumex Acetosa.
N Luzula campestris.
N Carex ovalis.
N Anthoxanthum odoratum.
Holcus mollis.
N Arrhenatherum avenaceum.
* Bromus mollis.
N Agropyron repens.

It will be seen that the bulk of these plants (marked N) are natives on Clare Island; but that some others (marked *) are of doubtful standing, and might have been originally introduced in some such manner as the present case, in which the hay, being landed, is carried on pony-back along the roads of the island, seeds being no doubt scattered in the process. The species present in this sample which are absent from the island are almost *nil*, the doubtful plants belonging in all probability to common species occurring on the island.

Oats for feeding horses and fowl.—This was received as a fair sample of the oats used for the purpose; and I was informed that no screenings or very dirty oats are imported for feeding fowl. Purity about 98 per cent. Nine-tenths or so of the impurities consisted of *Galium Aparine*, the full list being

* Brassica Sinapis
Brassica *sp.*
* Stellaria media.
N Galium Aparine.

* Lapsana communis.
N Sonchus oleraceus.
* Atriplex patula.
* Polygonum Persicaria.
* P. lapathifolium.
N Rumex obtusifolius.
N {Festuca ovina *or* F. rubra.
Grass, sp.

It will be seen that all the seeds which could be identified belong to species which already occur on the island, four of them as common natives; the rest, six in number, as weeds, mostly abundant.

Mud from the Mainland.—To see whether plants were being introduced from the mainland by means of mud adhering to the feet of men or animals, I had the boots of an island man (Pat Grady) scraped on his arrival on the island in November from Carrowmore, after a couple of days spent in Louisburgh. The material was sieved, and on being kindly examined by Miss Knowles, yielded seeds as follows:—

Stellaria media,	Polygonum ?aviculare,
Conium maculatum,	Juncus ?bufonius,
Sonchus asper,	Juncus *sp.*,
?Anagallis arvensis,	Holcus lanatus,

and about six more species, indeterminable.

It will be noted that these are all plants common about houses and roadsides, and the list is suggestive as indicating the ease with which roadside plants attain ectozoic dispersal.

6. ORIGIN OF THE FLORA.

In attempting to arrive at a conclusion as to the manner in which the present flora reached and became established on Clare Island—whether by means of a former land-connexion, or across the existing three-mile strait that separates the island from Achill on the north or the Roonah district on the south-east—we may, without having recourse to geological evidence, learn much from a study of the plants themselves. For this purpose we turn our attention to the means by which the species composing the flora increase, and spread, and migrate, and especially to the question of seed[1]-dispersal. In the case of the majority of the lower plants—Algae, Lichens, Fungi, Mosses, Liverworts, Horsetails, and Ferns—their spores are extremely minute and light, and are known to be capable of almost limitless dispersal by air currents; indeed, these spores may almost be reckoned as one of the normal constituents of atmospheric dust in temperate and tropical regions. The

[1] I follow the example of Bentham and others in applying the term *seed* to what, as Clement Reid says, is its "popular and original use"—*i.e.* that which is sown; in other words, the unit of dispersal. Nothing is to be gained from the pedantic repetition of the phrase "seeds or fruits" over and over again in the pages which follow.

evidence supplied by these groups does not, for this reason, help us much as regards the question of a land-bridge as against the alternative of air-carriage. It is among the Flowering Plants, where the species are comparatively large and their distribution well known, and where the seeds also are of fair size, plants and seeds both lending themselves to observation and experiment, that we may look for results. Many seeds possess characters which fit them for dispersal by special means across distances both of land and water, while others—and these constitute the majority—have no such special apparatus. If the whole flora of the island, or the bulk of it, be pre-Glacial, its origin stretching back indefinitely into the Tertiary Period, it cannot be *proved* that all the plants did not, in the course of the immense period of time thus placed at their disposal, one by one succeed in crossing the barrier of water (assuming its continuous existence) by one or other of the fortuitous opportunities that might offer. But the hypothesis of the pre-Glacial origin of the bulk of the flora is improbable. Geological evidence as to the conditions prevailing during the Ice Age in the district points to a state of things which would almost certainly have involved the extinction of at least the greater part of the then existing vegetation of the island, except perhaps that of the steep sea-scarp of Croaghmore, where an alpine flora still lingers. But whatever flora survived on Croaghmore, it could not possibly have included the number and variety of species which now colonize the island. It is probable that the present flora as a whole migrated into Clare Island after the Ice Age.

The question of the ability of plants to cross barriers of sea is one on which much has been written. Led by Darwin[1] and Wallace,[2] many botanists have looked on occasional long-distance dispersal as accountable for most island floras, even in the case of the most remote islands on the globe; while others, following Forbes,[3] cannot accept these exceptional means as sufficient to account for existing island faunas and floras, and advocate migration across bygone lands. If we are to keep clear of the now exploded theory of multiple origins, a choice must be made between these two explanations although both are beset with difficulties. If we accept the theory of the permanency of the ocean basins, then we have to call in all manner of accidental and exceptional means of distribution, to account for the presence of thousands of organisms on oceanic islands hundreds of miles from their original homes; even though, as Darwin himself has remarked, "it is poor

[1] C. Darwin: Origin of Species, chaps. xii, xiii.

[2] A. R. Wallace: Island Life, chap. v.

[3] Edward Forbes: On the Connexion between the Distribution of the existing Fauna and Flora of the British Isles, and the Geological changes which have affected their area, especially during the epoch of the Northern Drift. Mem. Geol. Surv. Great Britain, i, pp. 336–432. 1846.

work putting together the merely *possible* means of distribution."[1] If, on the other hand, we cannot believe that the island populations have crossed wide expanses of sea, we must invoke vast changes in the distribution of sea and land, usurping, to quote Darwin again, the right "to make continents as easily as a cook does pancakes,"[2] and "sinking imaginary continents in a quite reckless manner."[3]

In the present paper it is permissible to refer to those aspects of the subject only which have a bearing on the question of the Clare Island flora; but even from this limited standpoint it will be seen that much evidence on both sides can be quoted, and that certainty is not easily arrived at, though the barrier to be crossed in this particular instance consists of only a few miles of sea.

Even a narrow channel is, without doubt, a serious obstacle to plant dispersal. "Décidément," says De Candolle,[4] "les transports au travers d'un bras de mer, quelque petit qu'il soit, par des causes naturelles, sont infiniment rares." "Au travers d'un bras de mer comme la Manche, et à plus forte raison, au travers d'un Océan, ces causes de transport ont été ou nulles, ou sans effet, depuis que l'homme observe."

This is the opinion of many students of the question. Save by dissecting captured birds, seeds have hardly ever been taken at sea, or observed arriving on land at a considerable distance from their point of departure under conditions where colonization was possible.[5] But much observation and experiment are still required, and in the meantime opinion is not unanimous.

Sernander,[6] for instance, in Scandinavia, holds, against Hult, Blytt, and Gunnar Andersson, that stretches of sea do not present serious barriers to plant-migration. Blytt,[7] on the other hand, strongly emphasizes the slowness and overland nature of plant migration. He affirms that seed-conveyance to small distances is the rule, and long migration the exception; and he holds with Wallace[8] that discontinuous distribution signifies age, not long-distance dispersal.

Forbes, in his classic essay,[9] is strongly of opinion that the flora of Great Britain and Ireland migrated thither over bygone land-surfaces; while

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[1] Life and Letters of C. Darwin, ii., p. 82. [2] *Ibid.*, ii., p. 74. [3] *Ibid.*, iii., p. 230.

[4] A. de Candolle: Géographie Botanique Raisonnée, ii, pp. 708, 801–802. 1855.

[5] The casting up of tropical American seeds upon the coasts of Ireland or Norway, for instance, could never have effected colonization.

[6] Rutger Sernander: Den Skandinaviska Vegetationens Spridningsbiologie, p. 456. 1901.

[7] A Blytt: Immigration of the Norwegian Flora, p. 31, &c.

[8] A. R. Wallace: Island Life, p. 69.

[9] *Loc. cit.*, p. 399.

Clement Reid considers that wind and water migration, plus the "accumulated accidents of some thousands of years," are sufficient to account for the introduction of the whole present flora of the British Isles across the existing seas.[1]

These instances will suffice to show how much opinion is divided on this subject, and how students of the problem have arrived at very different conclusions.

If the flora of Clare Island came across a barrier of sea, we might hope to find, if we analyze it, that plants especially fitted for crossing such a barrier are well represented, and, *vice versa*, that species to which such a barrier would be a serious obstacle are conspicuous chiefly by their absence. This will lead us to attempt a classification of the local flora according to the means by which the constituent species are dispersed.

But it must be conceded at once that no more than a hint as to the origin of the flora is to be hoped for from so simple an analysis. As Wallace long ago pointed out, plants have existed long enough in most cases to have been carried to all suitable localities, and the determining factor of their distribution is to be found in their powers of adaptation to their new conditions. Guppy, commenting on this, observes that time has long since discounted the means of dispersal, and that as regards explaining plant-distribution, the study of the means of dispersal is often superfluous. The process of dispersal is ever going on; but its results are mainly determined by the reception the plant receives in its new country.

Thus it is seen that the present distribution of plants in our islands is but in a slight degree the result of the relative facility for dispersal which the constituent species possess. We notice, for instance, that plants with flying seeds, or, whose seeds are being continually scattered by birds, are no more widely nor abundantly spread than are those which possess neither these nor other special facilities for dispersal. Neither does the existence of a land-bridge involve the conclusion that all the plants at one end of it will eventually reach the other. Even where competition is reduced, suitability of habitat is an all-important consideration. And where, as is usually the case, competition comes keenly into play, suitability of habitat becomes a much more stringent term, for a plant can then spread and form a lodgment on new ground only where the conditions are not only fitted for its growth, but better fitted for its growth than for the growth of the other plants of similar habitat which are holding the ground on its arrival, or arrive along

[1] Clement Reid: The Origin of the British Flora, p. 31, 1899, and paper read at British Association meeting, 1911.

[2] H. B. Guppy: The Distribution of Aquatic Plants and Animals. Scottish Geographical Magazine, ix, pp. 28–33. 1893.

with it. De Candolle emphasizes this point as an important one often overlooked. Speaking of the arrival of a plant in new ground, he says :—" Enfin, si les conditions physiques du pays lui permettent de vivre, et de produire des grains, il faut encore qu'elle puisse lutter, dans ses moyens de propagation, avec les espèces antérieures. Ceci mérite une sérieuse attention, et on l'oublie presque toujours."[1]

Nevertheless, all plants must take their part in the battle of life, and the species which, owing to superior means of dispersal, can rain its seeds down on a piece of country, especially if this tract be isolated, and consequently relieved of part of the pressure of competition, will probably have the better chance of effecting a lodgment.

The means of dispersal which might be effective in a case like the present, where a barrier consisting of several miles of sea has to be crossed, can be grouped under three heads :—

1. Transport by water.
2. Transport by flying creatures.
3. Transport by wind.

Before considering in detail each of these possible means of dispersal, it may be pointed out that many of the methods of increase that are most efficient in extending the range of plants on land cease to be operative where a water-barrier has to be faced. For instance, a large number of species extend their range largely through vegetative growth—the Bracken, Strawberry, Bramble, Bilberry, and many water-plants are cases in point. This mode of increase is ineffective where sea has to be crossed. Perhaps the only case in which vegetative reproduction may materially assist dispersal across sea occurs in species in which bulbils or detachable buds are produced. It is conceivable that, when these are of small size, they may be transported by birds, by becoming attached to their feet or feathers, or by being eaten. Again, many species have more or less explosive fruits, in which, owing to unequal growth or shrinkage of the seed-coverings, the seed is eventually expelled suddenly, and cast to some distance—the Violets, Crane's-bills, and many Leguminosae are examples. This device is also ineffective—at least directly; though indirectly it may occasionally aid by casting the seed into a stream, or against a passing creature. Indeed, it may be granted at once that every device which tends to scatter seed increases the chances of eventual dispersal across a water-barrier; but the real difficulties begin only where this preliminary distribution ends.

Even for seeds which succeed in crossing a barrier, the odds against

[1] A. de Condolle: Géographie Botanique Raisonnée, ii, pp. 623–4.

them are enormous. The mortality among seeds is very great. Familiar illustrations will be found in various works—how out of every hundred thousand seeds of Foxglove only one reproduces a fruiting plant[1]; how in three generations one plant of *Sisymbrium Sophia*, if seeding unchecked, would be the ancestor of a multitude which would cover the whole land surface of the globe two thousand times over[2]; and so on.

The chances against a seed of the majority of our native species producing a mature plant under natural conditions is probably many thousands to one. The reader will find this point well discussed by De Candolle[3]; and Blytt[4] remarks:—"A single seed or a few seeds which might accidentally be imported by birds, ocean currents, or otherwise, into a country already overgrown with a native flora, must undeniably have extremely little chance of being able to grow and extend further." But he goes on to point out that the chances of colonization would be increased were the area more or less bare of vegetation, as may have been the case with Clare Island in early post-Glacial times.[5] "Numerous unsuccessful attempts at colonization," says Wallis Kew, "have been recorded; and these are of significance, I think, as helping us to understand how very small must be the chance of the ultimate establishment of a new colony as the result of transportal—often, no doubt, to very unsuitable spots—of a solitary specimen or a few individuals by accidental means under nature."[6]

"It is fully admitted," says Scharff,[7] "that many plants and animals are easily transported to new countries by accidental means or voluntarily by man; but, in most cases, they have not been able to retain a permanent footing in their newly adopted home. There are innumerable instances on record of species having been planted on spots where they did not previously exist, and

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[1] G. Bentham: Anniversary Address, in Journ. Linn. Soc. (Botany), x, p. lxx, 1869.

[2] A. Kerner: Nat. Hist. of Plants, ii, p. 878.

[3] A. de Candolle: *tom. cit.*, p. 623.

[4] A. Blytt: Immigration of the Norwegian Flora, p. 32. 1876.

[5] I do not feel convinced that this last suggestion can be applied to any but those exceptional cases in which ground fitted for the support of vegetation is *suddenly* laid bare. There is no reason to believe that the pressure of competition is less in desert regions or other thinly populated tracts than in tracts with a dense plant population. In the case of ground left bare by the retreat of ice, due to a gradual climatic change, plant dispersal is treading all the time on the heels of the retreating ice, and at any stage it seems likely that the ground is colonized up to its full capacity. I fancy that plant dispersal can work more quickly than any normal geological or climatic change, and that in this way plant competition is maintained at its full working pressure. Under exceptional circumstances, secular change may get ahead of plant dispersal, resulting in a sudden release of vegetation-pressure, and a consequent inrush of plants. Such an instance is discussed later on (p. 92) in the case of Krakatau. Here a volcanic eruption depopulated an area *fitted for the support of a large vegetation*—with the result that this vegetation was reconstructed by one means or another in an amazingly short time.

[6] H. W. Kew: The Dispersal of Shells, p. 183. 1893.

[7] R. F. Scharff: On the origin of the European Fauna. Proc. R. I. Acad. (3), iv, p. 435. 1896.

the introducers claim that it is highly interesting to watch their progress. In the great majority of cases we find that fortunately these species utterly vanish after a few years."

We may now turn to the three principal means of dispersal across a sea-barrier, which have been already referred to.

Transport by Water.

With regard to the possibility of the introduction of the flora by sea, through the medium of surface-drift or currents; it was long since shown by Darwin,[1] Martins,[2] and Thuret[3] that few seeds are able to remain long afloat in water, even if they float at all; though many are not killed by the sea-water. Darwin's conclusion in this matter is that, even when dried seeds and dried branches bearing seeds are taken into account, not more than 10 per cent. of any flora is capable of a long sea journey and subsequent germination. We may turn to the observations recorded by H. B. Guppy.[4] This naturalist records the results of experiments (made mostly by himself) on the floating power of 333 species of British flowering plants. Generalizing from these results, he concludes that about 90 per cent. of British Phanerogams have non-buoyant seeds—that is, they either sink at once, in water either fresh or salt, or sink after immersion for a day or two. The seeds are found to be usually either considerably heavier or considerably lighter than water. The balance of 10 per cent., in which the seeds are buoyant, consists almost entirely of river-side or marsh plants on the one hand, and sea-side plants on the other, the former class largely predominating; but buoyancy is not characteristic of the seeds of the majority even of the plants of such situations.[5] While without question sea-dispersal has played a prominent part in plant-distribution in the Tropics, Guppy remarks that "dispersal by currents seem to be mainly restricted to warm latitudes." "There is very little effective dispersal by currents in temperate regions."[6] "Ocean currents," says Blytt,[7] speaking of northern latitudes, "without drifting ice, are certainly no powerful means of transport." Guppy argues that buoyancy and

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[1] Darwin: Origin of Species, 6th ed., pp. 506–508.

[2] Ch. Martins: Expériences sur la persistence de la vitalité des graines flottant à la surface de la mer. Bull. Soc. Bot. de France, iv., 1857, pp. 324–337.

[3] Gustave Thuret: Expériences sur les graines des diverses espèces plongées dans l'eau de mer. Bibl. Univ. et Revue Suisse, Genève, N.P., xlvii., 1873, pp. 177–194.

[4] H. B. Guppy: Observations of a Naturalist in the Pacific between 1896 and 1899. Vol. ii., Plant-Dispersal. Note 10, pp. 535 538. 1906.

[5] *Ibid.*, pp. 24, 25.

[6] *Ibid.*, pp. 429, 432.

[7] A. Blytt: *tom. cit.*, p. 30.

non-buoyancy, as such, are merely fortuitous characters; that the structure of the fruits or seeds has been determined by causes other than the relation of their specific gravity to that of fresh or salt water; and that while seed-buoyancy has in some cases greatly assisted dispersal, it has played no part, through the agency of natural selection, in moulding the fruit or seed to its present form[1]—an opinion divergent from that expressed by Schimper[2] and others. However this may be, we see at once that the absence of buoyancy in the seeds of the bulk of the flora renders it impossible that the present vegetation of Clare Island was derived by sea-transport from the mainland, across the existing water-barrier.

Again, if we analyze the local flora according to Guppy's buoyancy tables, we obtain the following result. Of the 333 British species experimented on by him, 79, or 23·7 per cent.,[3] were found to possess the power of floating for a week or more. Out of these 333 species, 115 grow on Clare Island; and of these, 37, or 24·3 per cent., belong to the floating section. This group of 37 species represents 9·4 per cent. of the phanerogamic flora of Clare Island. For lack of information respecting the specific gravity of the seeds of many other local plants, this analysis is incomplete. Nevertheless we see that, so far as the information takes us, the flora of Clare Island shows no significant preponderance of species which bear buoyant seeds, and which might therefore have been introduced by sea. The proportion is a little higher than that suggested by Darwin for floras in general, and by Guppy for the British flora.

It may be pointed out also that in the case of Clare Island, geographical and meteorological conditions are against the introduction of plants by water. In the first place, the seeds of land-plants reach the sea mainly by the agency of rivers. The enormous number of seeds carried by a considerable stream flowing through a region with a dense plant population is[4] evident from Guppy's study of the Thames as an agency of plant-dispersal. But as regards Clare Island, a glance at a map shows us that along the whole Mayo shore the rivers are insignificant, owing to the fact that the watershed lies close to the coast. Between the Moy and the Corrib no river of any importance enters the ocean; and on the mainland adjoining Clare Island the streams are especially small. Again, while the current setting into and out of Clew Bay with each tide no doubt carries flotsam to or past the island, the prevailing wind, westerly (north-west to south-west) for some 183 days

[1] H. B. Guppy, *loc. cit.*, chap. xiii.

[2] A. F. W. Schimper: Plant-Geography (English ed.), p. 28. 1903.

[3] The high percentage is due to the fact that seeds likely to float were especially studied.

[4] H. B. Guppy: The River Thames as an Agent in Plant-Dispersal. Journ. Linn. Soc. (Botany), xxix, pp. 333-346. 1893.

during the year,[1] greatly diminishes the chance of seeds being floated to the island. Further, while it is easy to conceive of seeds stranded on sandy beaches being blown up by the wind to places where they might germinate, and possibly eventually establish the species, it is otherwise in the case of a rock-bound island like that under consideration. That seeds either floating at the base of the rocks or cliffs, or left stranded in the interstices of the boulders, should be lifted by the agency of wind or wave and deposited above the lower limit of terrestrial vegetation (which on Clare Island varies from about 10 feet in the most sheltered spots to 100 feet above high-water mark), is a suggestion of a highly speculative character. Finally, assuming that all these improbabilities come to pass, we have still to face the very slight chance which our immigrant seeds have of being lodged in a suitable habitat, and of succeeding in obtaining a footing.[2]

The one sandy beach on the island faces east, and is therefore unlikely to receive floating seeds, since the wind is generally blowing off-shore. An examination of the drift left by the tide during east winds in spring and autumn gave a negative result; nor did the summer flora of the beach contain any plants which suggested recent arrivals by sea—unlike, for instance, the sandy beaches at the mouth of the River Liffey, where one may find plants of oat, potato, &c., brought down by the river from the city of Dublin, and washed or blown up the beach, where they have germinated.

It would therefore seem that the non-buoyancy of the seeds of the bulk of the flora of the island at once precludes some 90 per cent. of the vegetation from the possibility of having arrived at the island by sea; while as regards the remainder, the absence of considerable streams on the adjacent mainland, the prevalence of westerly winds, and the cliff-bound character of the coast, greatly diminish the chance of their introduction by water.

But that a few species did reach the island by sea is of course probable. Perhaps *Arenaria peploides* and *Crithmum maritimum* are the most likely plants to have arrived in this manner. The seeds of both could easily reach the sea; they can float for months, unharmed by salt water; and the possibility of their being cast by wave or wind where they might effect a lodgment is in their case at a maximum. I do not say that these plants arrived by sea; but as regards them we are not met with so overwhelming an array of difficulties as confronts us in the case of the bulk of the flora.

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[1] I am obliged to Mr. W. J. Lyons, who is studying the meteorology of Clare Island, for a tabular view of the Clare Island winds during the last four years. It shows that west winds (N.W. to S.W.) reach a maximum in July and August (amounting to an average of 21 days per month), and minima in April (12 days per month), and October (9½ days per month).

[2] See *ante*, p. 59.

Transport by Wind.

In the wind we have an agent which has been generally awarded the premier place as a means of plant-dispersal. Ekstam,[1] discussing the Spitzbergen and Nova Zembla floras, places the wind first as an agent of seed-dissemination, the bird second, awarding to water a very subordinate place; and De Candolle remarks: "Le vent est la cause la plus générale et la plus ordinaire de dissémination des espèces sur toute la surface d'un pays."[2]

Many seeds have attached to them structures which render them especially suited for distribution by means of the wind; yet, as has been observed by many writers, this extreme ease of dispersal does not usually result in wider or more thorough distribution.

"In Compositae," says Bentham,[3] "several species of *Eclipta*, *Elephantopus*, *Anthemis*, *Lapsana*, &c., without any pappus at all, have a much more wide-spread distribution than the great majority of Senecios, for instance, with their light seed and broad pappus."

Or, to take a local example, *Typha latifolia*, which produces hundreds of thousands of tiny seeds, with a higher capacity for remaining afloat in the air than those of any other plume-seeded British species, is a less universal plant in pools and streams than *Sparganium ramosum*, which bears in much smaller numbers large and comparatively heavy seeds, quite incapable of wind-dispersal (and generally considered to be spread by being eaten by water-fowl).

An exception is instanced by Bessey,[4] who finds, from a study of the Nevada flora, that the plants with seeds suited for wind-dispersal are more widely distributed than those with fleshy or globular fruits, which are restricted in their range.

It is quite true, as Kronfeld[5] points out, that certain recent American introductions, such as *Erigeron canadense*, *Stenactis bellidiflora*, and *Galinsoga parviflora*, have rapidly achieved a wide dispersal in Europe by means of their pappus-seeds; but other recent arrivals can be quoted, such as *Matricaria discoidea*, which, without such means of dispersal, have spread equally fast.

Nevertheless, there can be no doubt of the high efficacy of the wind in dispersing seeds, though, as yet, we know little of the distance over which this

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[1] O. Ekstam: *loc. cit.*, p. 59; and Einige blütenbiologische Beobachtungen auf Novaja Semlja. Tromsö Museums Aarshefter, xviii, p. 191. 1897.

[2] A. de Candolle, *tom. cit.*, p. 613.

[3] G. Bentham: Anniversary Address, *loc. cit.*, p. lxix.

[4] C. E. Bessey: Plant Migration Studies. University Studies, Univ. of Nebraska, v, pp. 1–27. 1905.

[5] M. Kronfeld: Studien über die Verbreitungsmittel der Pflanzen. Theil. 1. Windfrüchtler. Leipzig: Engelmann, 1900. Abstract in Justs Bot. Jahresbericht, xxix 2 (1901), pp. 637–8.

can be effectually carried out (see *infra*). In another section of the present paper (pp. 72–80) are given the results of some experiments made to determine the relative efficiency for dispersal of the seeds of some British plants.

Seeds which are capable of wide dissemination by wind are found in many different natural orders, and in plants of very varying stature, and of a wide range of habitat. They occur in forest trees, and in herbs only a few inches in height: in plants which grow in dry ground and in water; on mountains and on plains. The seeds owe their effectiveness for dispersal to a variety of causes. In the British flora the most conspicuous group of wind-borne seeds is found in the Compositae, and mostly among the thistle group. Here dispersability is due to the feathery shuttlecock-like pappus—the modified calyx-limb—which crowns the seed. Feathery appendages of a simpler nature, which act in the same way, are found in plants of various other orders—for instance, in the Pasque-flower (Ranunculaceae), the Hare's-foot Trefoil (Leguminosae), the Mountain Avens (Rosaceae), the various Willow-herbs (Onagraceae), and so on. A membranous or coriaceous wing, regularly or irregularly disposed around the seed, is also sometimes effective, as in the Elm (Urticaceae), Ash (Oleaceae), Scotch Fir (Coniferae), or Cow-Parsnep (Umbelliferae). Or again, the very small size and lightness of seeds may promote dispersal, as in the case of the Orchids, Rushes, and Broom-rapes; though, as shown below, reduction of size is in the Phanerogams not carried far enough to render this device very efficient, as it is in the Cryptogams.

The seeds which possess characters rendering them specially capable of being dispersed by the wind may be classed as

1. Plume seeds.
2. Wing seeds.
3. Powder seeds.[1]

While no doubt can exist as to the efficacy of plumed and winged seeds for conveying the coming generation well beyond the influence of the parent plant—especially when these seeds are borne at some height above the ground—the tendency of the majority of recent writers is to discount their efficacy in long-distance dispersal. To quote a few observations and opinions:—

Over half a century ago, before Darwin's and Wallace's advocacy of long-

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[1] A more minute classification, with examples, of wind-dispersed seeds will be found in G. E. Mattei: Aeronautica Vegetabile. Bull. orto. bot. univ. Napoli, i, fasc. 3, pp. 311–331 (figures), 1902. (Abstract in Bot. Jahresbericht, xxxii, abt. 2, p. 491). Also in P. Vogler Über die Verbreitungsmittel der schweizerischen Alpenpflanzen. Flora, lxxxix, pp. 1–137. 1901.

distance dispersal, De Candolle,[1] from a careful review of the evidence, expressed his disbelief in the efficacy of wind-carriage as a means of dissemination across considerable obstacles.

Bentham, writing eighteen years later of the plumed seeds of the Compositae, which are of all other groups best fitted for wide dispersal, says[2]: "The most violent winds will not carry them above two or three miles: the moment the pappus gets into a damper atmosphere it collapses, and when once the seed has fallen to the ground it is very rarely again raised by the wind."

Kerner,[3] from a series of observations on the seeds deposited on the moraines and glaciers of the Alps, comes to the conclusion that the crossing from one to the other side of a valley is the most that the wind-borne seeds achieve among the mountains. He suggests that light seeds are caught in upward currents in hot weather, and remain high in the air during the day, but in the evening fall close to the point of ascent. Humboldt[4] quotes a similar observation by Boussingault, grass and straws being carried up some thousands of feet. Vogler and Pittier also place importance on these vertical air-currents in the mountains.[5] But this phenomenon would require a stronger and more continuous ascending current, due probably to more intense insolation, than we ever get in these islands, coupled with an absence of horizontal currents.

Dewey,[6] in a good general account of the means of dispersal of plants, writes: "The distance which this class of seeds may be carried by the wind may easily be exaggerated, being ordinarily not more than two or three miles, or in hurricanes perhaps ten or fifteen."

Willis and Burkill,[7] in a very interesting paper on the plants found growing on the tops of the pollard willows in the Cambridge district, find that while about three-fourths of the eighty species observed were plants specially adapted for dispersal by wind or birds, nevertheless the seeds were rarely carried by their distributing mechanism to a distance of more than

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[1] A. de Candolle: Géographie Botanique Raisonnée, ii, pp. 613–14. 1855.

[2] G. Bentham: On the Compositae (*supra cit.*), p. 573.

[3] A. Kerner: Der Einfluss der Winde auf die Verbreitung der Samen im Hochgebirge. Zeitschrift des Deutschen Alpenvereins, ii, pp. 144–172. Epitomized in Gardeners' Chronicle, 1872, pp. 143–144; and in Nature, vi, pp. 164–165. 1872.

[4] A. von Humboldt: Tableaux de la Nature (English ed.), ii, pp. 33, 34. 1849.

[5] P. Vogler, *loc. cit.*

[6] L. H. Dewey: Migration of Weeds. Yearbook of the Dept. of Agriculture, U.S.A., 1896, p. 267.

[7] J. C. Willis and I. H. Burkill: Observations on the Flora of the Pollard Willows near Cambridge. Proc. Cambridge Phil. Soc., viii, pp. 82–91. 1895.

a few hundred yards. Their results correspond with those obtained by Loew[1] from similar observations in Germany.

To take a case from the Tropics. Ridley[2] finds that the winged seeds of tall forest-trees in the Malay Peninsula are carried by strong winds only from 10 to 60 yards from the parent. Plumed fruits and seeds are more efficient, and powder-seed still more so. He points out that in tropical insular floras plants which possess winged seeds constitute only 2 per cent. of the flora, and plume-seeded species are also extremely rare. The proportion of powder-seed plants in oceanic islands is usually very large, even if cellular plants are excluded: "Powder-seed has the most rapid transit probably of any form of seed, and is most widely diffused."

Vogler,[3] in a searching paper on the dispersal of plants in the Alps, advocates long-distance dispersal. He considers wind-carriage of seeds for hundreds of kilometres a possibility, and carriage of from 3 to 20 kilometres of practical importance in seed-dispersal. It may be pointed out that most of the examples on which he bases his conclusion are *leaves*, such as those of the Beech, which have been carried high up the mountains or over considerable distances. Similar cases are quoted by Beauverd.[4] But withered leaves are much less perishable than most flying seeds. Leaves may be blown along the ground for considerable distances easily and without injury, and in windy weather may make a whole series of flights: the ring or group of hairs that form the flying mechanism of the larger wind-dispersed seeds are, on the contrary, easily injured, and easily entangled; and their efficiency is probably almost always confined to a single flight in dry weather, as Bentham long since pointed out. Vogler's other instances relate to the transport of comparatively heavy bodies by hurricanes or whirlwinds. Such phenomena, while they undoubtedly occur, and may even be frequent in alpine regions, have probably very little practical bearing, though they show that wide dispersal of even heavy seeds by the wind is not beyond the range of possibility. Stauffacher's case, quoted by Vogler *loc. cit.*, p. 90, in which new plants appeared in an isolated valley where they had not been seen before, is, to my mind, vitiated by the impossibility of proving the negative which he affirms. Seeds buried in the soil, which unquestionably retain their vitality

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[1] E. Loew: Anfänge epiphytischer Lebensweise bei Gefässpflanzen Norddeutschlands. Verhandl. d. bot. Vereins der Prov. Brandenburg, xxxiii, pp. 63–71. 1892.

[2] H. N. Ridley: On the Dispersal of Seeds by the Wind. Annals of Botany, xix, pp. 351–363. 1905.

[3] Paul Vogler, *loc. cit.*

[4] Gustave Beauverd: Quelques cas de dissémination des graines par le vent. Bull. Herb. Boissier, (2), i, pp. 633, 634. 1901.

for long periods of time (see p. 93), might be present, even if plants could not be found. Of the disappearance and reappearance of plants in certain stations many strange instances are on record.

While it may be freely admitted, then, that the frequent and violent squalls and storms in mountain regions may transport even heavy seeds far up and down the slopes, these occurrences are probably even there exceptional, and have very little bearing on the question of dispersal across undulating or level country. The presence of lofty buildings similarly produces eddies and miniature whirlwinds, and aids seed-dispersal in towns. Prof. Gwynne Vaughan has told me that in Chancery Lane, on a summer day, with a light wind, a couple of years ago he has seen the air full of seeds of *Epilobium angustifolium*, probably brought by eddies from the waste ground at the Strand, where this plant appeared in quantity.[1] Had buildings been absent, a much smaller number of these seeds would have been lifted sufficiently to enable them to travel so far. Over flat country, and especially over water, such upward eddies must be still fewer and less powerful; this point is discussed on a subsequent page (p. 72).

In hot regions, the results of tornadoes, sand-storms, and kindred phenomena prove that seed-transport over many miles is possible there; but the lesson drawn from these hardly applies to our latitudes.

Plume Seeds.

The most striking examples are to be found among the Compositae. Indeed, in beauty and delicacy, the pappus of the Thistles and their allies surpasses any other wind-dispersal mechanism found in the vegetable kingdom. The question whether the pappus or other flying-mechanism has been evolved by natural selection as an aid to dispersal does not concern us here. It is by many writers considered so; but it may be noted that Bentham[2] says:—"That the pappus, indeed, is really and solely a provision for the transport of the seed will scarcely be maintained, when we consider, first, that in the great majority of more or less unisexual Compositae the pappus is much more developed on the male or sterile achenes than on the female fertile ones, and that in a large number of Cynaroideae, and even in many Cichoriaceae, the pappus separates so readily from the achene that the down we see floating in such quantities over a field of thistles has, for the most part, left the achene enclosing the seed behind." And Goebel remarks:—"Many arrangements which have hitherto been considered

[1] See Journal of Horticulture, lv, p. 122. 1907.

[2] Compositae, *supra cit.*, p. 573.

merely as a parachute-apparatus on the ripe fruit are in my view to be considered as a transpiration-apparatus for the ripe fruit, and these subsequently can be used for distribution, but are not necessarily for this."[1] Guppy, as already mentioned p. 60), is inclined to treat dispersal-mechanisms as by-products, so to speak, in the plant's life-history. The reader dipping into the subject of the pappus may also consult the papers of Taliew,[2] Hirsch,[3] and Steinbrinck.[4]

The pappus reaches its most beautiful development in some of the Cynarocephaleae, such as the common Spear Thistle. Here the comparatively large and heavy seed is surmounted by a beautiful shuttlecock of stiff spines, eight times the length of the seed, each spine clothed with short branches, which greatly increase its efficacy; while the seed alone falls 12 feet in less than one second, the presence of the pappus reduces this velocity to about $\frac{1}{15}$th (12 feet in 14 seconds). The pappus alone takes 28 seconds to fall the same distance. An attempt to calculate the efficacy of the pappus and deduce the velocity of fall in the allied *C. arvensis* is made by Dandeno[5]; but his result is only about half the observed rate. The lightness of these parachute-seeds is shown by Bessey's calculation that a Dandelion seed weighs ·00044 gramme, or about one-millionth of a pound.[6]

In the case of this and many other Composites, the hairs of the pappus are stiff and elastic; but in the Sow-thistles (Sonchus), as well as in very efficient flying seeds of other orders (*e.g.*, Epilobium), the hairs are lax, and cling easily to any surface except a very smooth one—thus supplying a second means of dispersal, such as is possessed by seeds furnished with hooks or barbs. Frieb[7] believes that animal-dispersal is effective in the case of many pappus-bearing species; and Kronfeld[8] points out that in some cases, *e.g.*, Taraxacum—the pappus assists water-dispersal by keeping the achene afloat.

But in the Compositae we are again faced by the fact that apparently distribution bears no proportion to ease of dispersal. We may arrange a

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[1] Goebel: Organography of Plants (English ed.), ii., pp. 570, 571. 1905.

[2] W. Taliew: Ueber das hydroskopische Gewebe der Compositen-Pappus. Kazan, 1894 (in Russian). Abstract in Bot. Centralblatt, lxiii., pp. 320–324. 1895.

[3] Arnold Hirsch: Ueber den Bewegungsmechanismus der Kompositenpappus. 1901. Abstract in Bot. Centralblatt, lxxxix., p. 248.

[4] C. Steinbrinck: Zum Bewegungsmechanismus der Kompositenpappus. Berichte Deutsch. Bot. Gesellschaft, xix., pp. 514–515. 1901.

[5] J. B. Dandeno: The Parachute Effect of Thistle-down. Science (N.Y.), N.S., xxii., pp. 568–572. 1905.

[6] C. E. Bessey: Weight of Dandelion-down. Science (N.Y.), N.S., xx., p. 119. 1904.

[7] R. Frieb: Der Pappus als Verbreitungsmittel der Compositenfrüchte. Oest. Bot. Zeitschrift, Wien, li., pp. 92–96. 1901.

[8] Moriz Kronfeld: Über einige Verbreitungsmittel der Compositenfrüchte. Sitz. k. Akad. der Wissensch., Wien, Math.-Nat. Klasse, xci., Abth. i, pp. 414–428. 1885.

series of species whose seeds bear every gradation of pappus, from an elaborate parachute down to an almost microscopical ring of bristles; yet as many common and widespread species will be found at one end of the series as at the other (see also p. 63). Neither does any phylogenetic relationship exist among the pappus-bearing species. "Constant or nearly so in each species, with very few exceptions," says Bentham,[1] "the pappus will often, in a most natural genus, so vary from species to species, as to make it a most difficult task to decide whether it should be neglected altogether" as a diagnostic character.

As already mentioned, many of the plume-seed plants rely on structures simpler than the pappus to aid them in wind-dissemination—such as the long feathery awn in *Clematis Vitalba* and *Dryas octopetala*; but there is no need to go into the forms displayed in different species, or their morphological significance. Their relative efficiency, which is the point that mainly concerns us, is discussed later on.

Wing Seeds.

Regarding these not much need be said. Even when a very expanded wing is present, as in *Pinus sylvestris, Heracleum Sphondylium,* or *Ulmus montana*, its efficiency as an agent of dispersal cannot compare with the pappus. This is shown by the results given below (p. 77). Except in very high winds, winged seeds cannot be carried more than a short distance from the parent (see also p. 66, *supra*).

In one important respect the behaviour of these flat bodies in wind is different from that of the plumed seeds. In accordance with mechanical laws, they tend to turn their flat surface towards the direction of greatest resistance. When falling in still air, therefore, or in air moving uniformly, while the course of the seed is usually a zigzag or spiral, the flattened surface tends to maintain a horizontal position all the time—which is also the position which is most effective in restraining the velocity of fall. But if the wind is gusty, and the seed is subjected to forward and backward jerks, then each of these puffs will tend to cause the flattened seed to present its surface to the direction in which it is impelled. In consequence, its edge will tend to be directed towards the ground, and the velocity of fall will be increased accordingly. When the motion of the air is irregular, then, the efficiency of such seeds for dispersal is reduced.

Powder Seeds.

"In the dispersal of seeds and fruits by wind over long distances," remarks Ernst,[2] "structural adaptations to flight are of less importance

[1] Compositae, *supra cit.*, p. 354.

[2] A. Ernst: The New Flora of Krakatau, p. 66.

than reduction in weight." In this connexion see the remarks of H. N. Ridley quoted on p. 66. Very minute seeds provide the most effective of all devices for plant-dispersal. It is in the spores of Cryptogams that we find minuteness and lightness developed to the highest degree, rendering them infinitely more fitted for wide dispersal than even the most complicated and efficient of parachute-seeds.

The behaviour of small particles falling in air differs from that of larger bodies, inasmuch as, with continued reduction in size, the impelling force (the action of gravity) becomes rapidly smaller in comparison with the decrease of resistance offered by the air, so that very small velocities result. A mathematical expression for the velocity of fall of microscopic spheres in a viscous medium was deduced by Stokes,[1] and is known to physicists as Stokes's Law :—

$$V = \frac{2}{9}\frac{\rho - \sigma}{\mu} g a^2,$$

where V = the terminal velocity,
ρ = the density of the sphere,
σ = the density of the medium,
g = the acceleration due to gravity,
a = the radius of the sphere,
μ = the viscosity of the medium.

In recent years several series of experiments have been carried out with a view of providing a practical verification of Stokes's Law. Zeleny and McKeehan[2] have experimented with Lycoperdon, Polytrichum, and Lycopodium spores. The velocities of fall which they observed were about one-half of those given by the formula. It has been suggested by Buller,[3] and more recently by Miss Stoney,[4] that the shape of the spores of Lycopodium, which are four-sided and have sculptured walls, may account for their retardation. A. B. Basset[5] has suggested a mathematical explanation of this want of agreement. Subsequently Zeleny and McKeehan have announced[6] that further experiments with small spheres of paraffin wax, a black wax, and mercury, give results which are in close agreement with those obtained from Stokes's formula. Buller[7] experimented with the spores

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[1] G. G. Stokes: On the Effect of Internal Friction of Fluids on the Motion of Pendulums. Cambr. Phil. Trans., ix, part 2, pp. 8–106, 1856. Abstract in Phil. Mag. i, pp. 337–339. 1851.

[2] J. Zeleny and L. W. McKeehan; An Experimental Determination of the Terminal Velocity of Fall of Small Spheres in Air. Paper read before the Amer. Assoc. for the Advancement of Science. Abstract in Science, N.S., xxix., p. 469, 19th March, 1909; and The Terminal Velocity of Fall of Small Spheres in Air. British Association Report for 1909, pp. 407, 408. 1910.

[3] Nature, lxxx., pp. 186–187. 1909.

[4] *Ibid.*, lxxxii., p. 279. 1910.

[5] *Ibid.*, lxxxiii., p. 521. 1910.

[6] *Ibid.*, lxxxii., p. 158. 1909.

[7] A. H. R. Buller: Researches on Fungi. chap. xv. London, 1909.

of the Hymenocyte fungus *Amanitopsis vaginata,* which are spherical and smooth, and about one-third the diameter of Lycopodium spores. The average terminal velocity of fall obtained was 6·07 mm. per second, which is 46 per cent. greater than that deduced from Stokes's Law. The author suggests that the excess over the calculated velocity may be due to surface slip. Professor J. A. McClelland has suggested to me that the method of calculating the density of the spores may be at fault.

The effect of the great reduction in size of spores of Cryptogams is to give them a very low rate of fall in comparison with the seeds of Flowering Plants, and a consequent power of very wide dispersal by air-currents. Buller[1] finds the velocity of fall of the spores of Hymenomycetes to range from 0·3 to 6·0 mm. (= $\frac{1}{85}$ to $\frac{1}{4}$ inch approximately) per second—a velocity only about $\frac{1}{70}$ tc $\frac{1}{450}$ of that of a Dandelion seed, one of the more efficient of plume-seeds. Further, these spores are in many Cryptogams produced in vast numbers. A large example of the Giant Puff-ball (*Lycoperdon bovista*) is estimated to discharge 7,000,000,000,000 spores, and a Common Mushroom (*Psalliota campestris*) of 8 cm. diameter to contain 1,800,000,000.[2] So that, as was said at the beginning, these spores are to be reckoned as a common constituent of atmospheric dust; and it is no exaggeration to say that they are probably carried by the wind to the most remote corners of the globe.

None of the seeds of the Flowering Plants attain such small dimensions as the foregoing; but nevertheless a number are exceedingly minute and light. For instance, a seed of *Habenaria conopsea* weighs ·000008 gram, and one of *Parnassia palustris* ·00003 gram.[3] Furthermore, "to enable these seeds to float in the air for as long a time as possible, they are more or less flattened, and their centre of gravity is so placed that they always present the broad side to the direction of descent." But most of the minute seeds among our native plants—for instance, those of the smaller Caryophyllaceae and Cruciferae, the Poppies, &c.—are roundish in shape, and devoid of special adaptations for wind dispersal; they fall with comparatively high velocities, as will be seen later. To pursue this line of thought, it may be remarked that despite the advantage as regards dispersal afforded by small seeds, as compared with large, these are not the rule in our flora. Clement Reid[4] reckons 17·6 per cent. of the phanerogamic flora of the British Islands as having "small seeds," and 24·5 as having "large seeds," the balance of 57·9 having seeds of intermediate size. The low percentage of small-seeded species would seem to show that the size of seeds is determined by factors other than ease of dispersal.

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[1] A. H. R. Buller: The Production, Liberation, and Dispersion of the Spores of Hymenomycetes. Brit. Assoc. Report for 1909, pp. 675, 676. 1910.

[2] Buller: *loc. cit.* [3] Kerner: Nat. Hist. of Plants, ii., p. 851. [4] *Tcm. cit.*, p. 21.

The Efficiency for Dispersal by Wind of the Seeds of some British Plants.

The mechanics of wind-transport, or, at least, of so much of them as have a practical bearing on the question of seed-dispersal, are very simple. If the motion of the air were uniform, then a seed once started on a wind-journey would have no motion relative to the air but the vertical motion due to gravity. In all seeds efficient for wind-dispersal this motion is uniform practically from the moment of liberation of the seed, the resistance of the air neutralizing almost at once the acceleration due to gravity.

Were there no wind the course of the seed would be downward from the point of detachment from the plant, either in a straight line, or in some zig-zag or spiral course, according to the shape of the appendages. Were the wind a uniform horizontal air-current, the course of the seed would be a straight line (or zigzag, &c., as aforesaid), sloping from the place of detachment of the seed down to the ground, the angle of slope depending upon the strength of the wind and on the rate of fall of the seed, the resulting course of the seed and its actual velocity being displayed graphically by the diagonal of a "parallelogram of velocities." This being so, it is clear that for any given kind of seed, with a fixed rate of fall, the distance to which it will be transported depends on the velocity of the wind, and on the presence or absence of upward or downward eddies that may prolong or curtail its flight. And the majority of seeds fall so fast in comparison with the velocity of any wind which they are likely to encounter that this question of eddies becomes of great importance, as it is only by their aid that any kind of long-distance dispersal can be hoped for.

While the motion of the air over rough land, especially near the ground, is very irregular and full of eddies, occasioned by irregularities of the surface (see p. 67, *ante*), it does not follow that the same holds when the wind is blowing across uniform surfaces such as water. On the contrary, there seems every reason to believe that at sea upward or downward eddies are unimportant under usual conditions. Experiments on this point which I attempted by liberating small parachutes at sea from the mast of the Fisheries steamer "Helga" were unsuccessful, owing to the eddies caused by the ship, which drew the parachutes at once down into the water. But observation of the passage of the smoke of steamers, and also of the dense smoke of kelp-burning across many miles of sea, in both light and strong winds, gave but slight indication of eddies. On another occasion thistle-down was watched half a mile from the shore blowing seaward, and in every case its course was practically a straight line.

Mr. R. G. K. Lempfert, of the Meteorological Office, has kindly given

me information on this subject. He emphasizes the fact that sea winds are much more steady than those over land, instancing the diagrams bearing on this question given in a recent report by W. N. Shaw on "Details of Wind Structure," &c.[1] He adds that it is unlikely that the wind will become absolutely steady over the open sea; and remarks, "Of course every upward motion must be compensated somewhere by a downward motion; but I suppose it is quite possible that an individual seed might by good luck make use of more upward motions than downward ones, and so get transported over a considerable distance."

It is to be noted that eddies, therefore, will tend equally to shorten and to lengthen flight, bringing in a *possibility* of extended flight, but leaving the average the same. Also that the longer the flight the greater the chance of upward and downward eddies equalizing each other, tending to make the length of flight approximate to the theoretical distance which would be attained in a horizontal air-current.

Again, the narratives of airmen, as recorded in the press, refer to strong downward eddies experienced when travelling seaward over steeply-shelving shores, which suggests a high mortality among seeds drifting seaward. All of these facts point to the conclusion that without a high initial elevation attained by means of eddies over the land, it is not probable that flying seeds will, under any kind of ordinary conditions, succeed in crossing considerable stretches of water. We are again driven towards the "occasional" theory, and have to call in whirlwinds and tempests to give what assistance they can.

The actual distance which a wind-borne seed of any species will travel thus depends on several factors, some of them determinate, others indeterminate. The conditions under which a seed is launched forth include the height above ground at which it is liberated, but just as important are the exact situation and surroundings of the particular plant bearing the seed. The greater the height above ground at which a seed is borne, the further will it probably be carried; but particular conditions affecting local air-currents may place a low herb in as favourable a position for seed-dispersal as an adjacent forest tree.

The next factor, and one which is determinate, is the rate at which a seed falls.

The most important factor to be reckoned with, and one which is in each case quite indeterminate, is the wind itself. During those stormy periods when seed-dispersal is most likely to reach its maximum of efficiency, the motion of the air—at least over rough land—is most turbulent. One seed, liberated

[1] Advisory Committee for Aeronautics. Reports and Memoranda, No. 9. 1909.

from the parent plant, will be at once dashed to earth, while another will be whirled a hundred feet up into the air; and all will be projected forward, and arrested, and flung to this side and that, in a very irregular manner.

But whether in a steady wind or in the turmoil of a storm, the flying seed is all the time subject to the influence of gravity, and, relative to the air in which it is at any moment suspended, it is falling at a rate which is uniform for each species, and which is easily measured, being (except in certain cases already referred to, see p. 69) the same rate at which the seed would fall in still air. And over and above all accidents of original position or of wind or weather, this rate of fall truly measures the *relative* capacity of the seeds of different species for dispersal by wind. All the seeds are equally open to the chances and dangers offered by the wind, and these tend in the long run to equalize themselves. As against them, the advantage or disadvantage of original position probably counts for little, especially for long-distance dispersal. But the rate of fall for each species acts steadily throughout, and is thus the determining factor. If the seeds of species A fall at half the rate of those of species B, the chance of the A seeds reaching any boundary that we may set are approximately double those of the B seeds; or to express it differently, the chances are that double the number of A seeds will be carried to any given distance, as of B seeds.

As pointed out on previous pages, the characters which render seeds capable of dispersal by wind range themselves under three main heads:—(1) the possession of a plume of hairs or bristles; (2) the possession of a flattened wing; (3) reduction in size. Some discussion of these three types has been given already (pp. 67–71); it remains to put certain examples of each to a practical test. Not much experimental work on the fall and carriage of seeds appears to have been carried out. The best discussion of the subject will be found in Dingler's[1] essay. He divides wind-borne seeds into twelve types, varying from powder seed to parachute and winged seeds; and reducing these to conventional forms, he calculates their theoretical velocities of fall, and compares these with the velocity of fall of actual examples of each type as measured by experiment. But as most of the seeds experimented on belong to foreign species, his results do not directly assist the present inquiry.

In order to test the relative capacity for wind-dispersal of the seeds of some British plants, an apparatus was devised by which the seeds were allowed to fall freely through still air for a certain distance (12 feet), and the time occupied measured by a stop-watch. At the top, the seeds were liberated by means of a small tilting platform worked from the base of the

[1] Hermann Dingler: Die Bewegung der pflanzlichen Flugorgane, ein Beitrag zur Physiologie der passiven Bewegungen in der Pflanzenwelt. Pp. 10 + 342. Taf. i.–viii. München, 1889.

apparatus, where their arrival was observed on a sheet of black or white paper strongly illuminated. The behaviour of the seeds in their downward course could be watched by an observer stationed at the top. Freshly gathered seed was used wherever possible; in only a few cases was seed a season or more old employed. Comparison made as to the rate of fall of old and new seed of a number of species showed no appreciable difference between the two. This result corresponds with that obtained in his flotation experiments by Guppy, who found very little difference in buoyancy between fresh and dried seeds. Twenty to forty seeds, taken in almost all cases at different dates from several different plants, or from different portions of the same plant, were tested in the case of each species. Care was taken to see that the pappus or wing (when present) was complete and uninjured, and that the seed was mature; in a few doubtful cases the seeds were afterwards germinated. To the naked eye, a difference in the size and shape of the seed or of the pappus or wing was often obvious, producing even in seeds selected for their perfect pappus a variation in the velocity of fall sometimes amounting to as much as 50 per cent.; in the majority of cases the results were uniform as regards seeds of any one inflorescence; but the degree of expansion of the pappus was found to vary greatly even in seeds quite mature and in the course of being shed naturally, and this sometimes caused a variation of as much as 100 per cent. in the velocity of fall; in such cases the seeds tested were those in which the pappus was most expanded. It was found that warming the seeds before a fire immediately before the experiment tended to expand the pappus and increase the efficiency. This would happen in nature in hot sunlight.

Where the plume is stiff as in most of the pappus-bearing Compositae, there is but little variation in the rate of fall; but where it is lax, as in the Willow-herbs, Willows, and Cotton-grasses, the variation is much greater, and a number of different gatherings ought to be tested—more in some cases than I had at my disposal—before one can feel assured that the maximum efficiency has been found. Probably, in order to obtain the practical maximum efficiency of seeds matured and liberated under the most favourable conditions, we might safely add 5 per cent. to the figures given below for stiff-pappus seeds, and 10 per cent. for the lax-pappus seeds.

In some minute seeds also, a large variation in the rate of fall was found. In some of the Orchidaceae, for instance, this amounted to as much as 100 per cent., depending apparently on variation in the disposition of the loose netted testa. The difference in the proportion of the figures below for a 12-foot and a 40-foot fall, may in some cases be due to the fact that different batches of seed were experimented on in the two cases.

For the testing of the more rapidly falling seeds—those of many powder-seeded species, for instance—a much longer fall, amounting to forty feet, was given, to ensure more accurate results, and also because in these cases acceleration due to gravity extends over an appreciable period. For this purpose, one of the stairways at the Royal College of Science for Ireland was utilized.[1]

In the following lists, the actual times taken to fall the distances measured are recorded, since, in the case of many even of the smallest seeds destitute of appendages, acceleration is undoubtedly no negligible factor (as it is with the more efficient plume and wing seeds), and, in consequence, we are not dealing with a uniform rate of fall, and cannot deduce the time taken to fall one distance from the time taken to fall another.[2]

Plume Seeds.

Time taken to fall twelve feet.

		Seconds.
Ranunculaceae—	Clematis Vitalba,	5·4
Leguminosae—	Trifolium arvense,	5·0
Rosaceae—	Dryas octopetala,	6·5
Onagraceae—	Epilobium hirsutum,	19·0
	E. montanum,	20·0
	E. palustre,	23·7
Compositae—	Eupatorium cannabinum,	16·0
	Aster Tripolium,	8·0
	Solidago Virgaurea,	7·7
	Erigeron acre,	8·8
	Inula salicina,	13·5
	I. crithmoides,	4·5
	Pulicaria dysenterica,	10·0
	Senecio vulgaris,	12·8
	S. sylvaticus,	17·3
	S. Jacobaea,	10·0
	Carlina vulgaris,	4·5
	Carduus pycnocephalus,	5·0
	Cnicus lanceolatus,	12·4

[1] I have to thank Mr. John Adams, M.A., for kind assistance in this latter series of experiments.

[2] To convert the figures in the following lists into miles per hour (approximately), invert them and multiply by 8 where a 12-foot fall is referred to, or by 27 for a 40-foot fall. The result will be almost correct for slow-falling seeds; but for fast-falling seeds the results will be too small, since the figures in the list represent something less than the terminal velocity of fall.

PLUME SEEDS—*continued.*

		Seconds.
COMPOSITAE—*cont.*—	C. arvensis,	14·0
	Crepis biennis,	3·8
	C. paludosa,	3·5
	C. taraxacifolia,	4·2
	Hieracium boreale,	8·0
	H. umbellatum,	8·4
	Hypochaeris radicata,	11·3
	Leontodon autumnalis,	7·5
	L. hirtus,	3·0
	Taraxacum officinale,	8·5
	Lactuca virosa,	16·4
	Sonchus oleraceus,	12·7
	Tragopogon pratensis,	5·8
PLUMBAGINEAE—	Armeria maritima,	1·4
AMENTIFERAE—	Salix pentandra,	15·2
	S. aurita,	19·4
	S. repens,	22·6
TYPHACEAE—	Typha latifolia,	34·0
CYPERACEAE—	Eriophorum angustifolium,	16·2

WING SEEDS.

		Time (seconds) taken to fall	
		12 feet	40 feet
ACERACEAE—	Acer Pseudo-platanus,	—	9·2
UMBELLIFERAE—	Angelica sylvestris,	3·0	—
	Pastinaca sativa,	—	5·3
	Heracleum Sphondylium,	2·0	6·4
OLEACEAE—	Fraxinus excelsior,	—	10·0
SCROPHULARIACEAE—	Rhinanthus Crista-galli,	—	5·4
POLYGONACEAE—	Rumex nemorosus,	1·5	—
	R. crispus,	—	4·0
	R. obtusifolius,	—	5·0
ULMACEAE—	Ulmus montana,	—	21·1
CONIFERAE	Pinus sylvestris,	6·7	—
LILIACEAE—	Narthecium ossifragum,	6·0	17·0

POWDER SEEDS AND MISCELLANEA.

		Time (seconds) taken to fall 12 feet	40 feet
PAPAVERACEAE—	Papaver dubium,	1·5	4·4
CRUCIFERAE—	Erophila vulgaris,	3·7	—
	Sisymbrium Sophia,	1·5	4·6
	Capsella Bursa-pastoris,	1·5	5·0
	Brassica Rapa *var.* Briggsii	—	2·0
VIOLACEAE—	Viola arvensis,	—	3·1
CARYOPHYLLACEAE—	Arenaria verna,	2·0	—
	A. serpyllifolia,	1·8	6·0
	Sagina procumbens,	3·5	—
LINACEAE—	Radiola linoides,	4·0	—
HYPERICACEAE—	Hypericum pulchrum,	2·4	6·0
	H. hirsutum,	2·0	6·4
LEGUMINOSAE—	Lathyrus pratensis,	—	1·2
SAXIFRAGACEAE—	Parnassia palustris,	5·5	—
COMPOSITAE—	Arctium minus,	—	2·2
	Matricaria discoidea,	2·0	—
CAMPANULACEAE—	Jasione montana,	2·8	7·2
ERICACEAE—	Dabeocia polifolia,	2·0	5·5
	Calluna vulgaris,	3·2	—
	Erica Tetralix,	3·5	—
	E. cinerea,	1·5	—
PRIMULACEAE—	Samolus Valerandi,	2·8	—
SCROPHULARIACEAE—	Verbascum Thapsus,	—	5·0
	Scrophularia nodosa,	1·6	5·2
	Bartsia Odontites,	1·7	5·4
OROBANCHACEAE—	Orobanche minor,	7·5	25·6
	O. Hederae,	6·0	—
ORCHIDACEAE—	Epipactis palustris,	22·0	—
	Orchis incarnata,	12·0	—
	Habenaria conopsea,	12·0	—
LILIACEAE—	Scilla verna,	—	2·5
JUNCACEAE—	Juncus effusus,	3·6	—
	J. balticus,	2·2	7·0
	J. glaucus,	2·8	—
CYPERACEAE—	Carex vulpina,	—	4·8
	C. glauca,	1·5	—
	C. flava,	—	5·3
GRAMINEAE—	Deschampsia caespitosa,	—	16·8
	Dactylis glomerata,	1·5	4·5
	Glyceria festucaeformis,	2·5	—
	Bromus asper,	—	5·2

It will be seen that as a whole the plume seeds experimented with are better adapted for wind-dispersal than either the wing seeds or powder seeds. Of the plume seeds, the place of honour belongs, not to the group with elaborate parachutes, but to *Typha latifolia*, which is followed—at some distance—by the Epilobiums and Willows; these in buoyancy slightly exceed the best of the Compositae, which form a long series extending down to species quite devoid of parachute apparatus. *Eriophorum angustifolium* is nearly equal in efficiency to the most buoyant of the Compositae, and in relation to the same group, such seeds as *Clematis Vitalba, Dryas octopetala*, and *Trifolium arvense* occupy a low place, and are possibly chiefly useful in promoting dispersal by animals.

As regards wing seeds, the best of them, such as *Ulmus montana* and *Pinus sylvestris*, cannot compare with even the second or third grade of the plume seeds. Ash and Sycamore are again far behind Elm and Pine; while, in the case of wing seeds such as the Docks, the appendages must be much more useful in promoting dispersal by animals than in aiding wind-dispersal by checking the velocity of fall.

Coming to the powder seeds, we find that mere reduction in size is not carried far enough in the Flowering Plants to produce an efficient dispersal device. The small hard roundish seeds that occur in so many species fall with a high velocity. They have a high specific gravity—all which were tested sinking at once in water—and they possess no device for restraining their rate of fall. Elongated seeds, such as those of Hypericum and Juncus, have a rather lower rate of fall (occasioned in part by a less specific gravity). The great elongation in the case of Narthecium has a marked effect in this direction. It is only in Orchidaceae, where minuteness is combined with looseness of tissue, that (among Phanerogam powder seeds) a really low rate of fall is found; but even these seeds cannot compete as regards buoyancy with the more efficient of the plume seeds. A few of the larger roundish seeds, such as those of *Brassica Rapa, Lathyrus pratensis*, and *Scilla verna*, tested for comparison, have a very high velocity, falling 40 feet in between 1 and 3 seconds.

To get an idea of what are the possibilities of seeds reaching Clare Island by the agency of wind, let us take a very favourable case. A seed with a high index of efficiency—say, *Epilobium montanum*, which takes 20 seconds to fall 12 feet (an efficiency even higher than that of any Composite parachute seed)—is liberated at a spot within 5 miles of the island, with a favourable gale blowing at 50 miles per hour. The seed would take only 6 minutes to traverse the horizontal distance; but during that time its fall would amount to 216 feet. This represents the height to which the seed must be raised by

a lucky preponderance of upward gusts over downward ones if it is to cross the channel safely. It will be only one seed out of a large number which will in all probability encounter such good fortune. But if tens of thousands of seeds are given such a chance occasionally during tens of thousands of years, a probability of colonization may be granted by the most severe critic. The high efficiency of this seed for wind-dispersal is the outstanding constant factor which allows us to concede to it a fair chance of success. Many seeds furnished with a tolerably large pappus or wing have only about one-fifth the capacity for maintaining themselves in the air which is possessed by the species chosen; to such as these only a possibility of transport to the island by wind can be conceded. What are we to say of the chances of many of the round-seeded species, whose seeds fall ten to forty times as fast as those of the Epilobium?

Transport by Birds.

The inquiry as to the efficacy of the agency of flying creatures in reference to the flora of Clare Island practically limits itself to the case of birds. Bats are so rare in the district as to be a negligible factor; and as regards flying insects, while they have often been suggested as possible transporters of small seeds, and in a few cases (*e.g.* locusts)[1] shown to be so, there is a lack of evidence so far as native insects are concerned. As regards birds, they are unquestionably a potent agent in plant-dispersal.

Instances of birds being taken carrying in their crops or intestines, or on their feet or plumage, the seeds of various plants, are given by almost all writers on plant-distribution. To quote a few modern instances, Guppy[2] took 828 seeds, representing at least ten species, from the stomachs and intestines of thirteen ducks. Ekstam[3] found the crops of Ptarmigan in Spitzbergen in August filled with vegetable matter, including seeds and bulbils of many species. Holmboe[4] obtained seeds of fifty-three species of plants from the alimentary canal of eighteen species of birds. Or again, from one pound of dried excrement of *Corvus americanus* taken from the ground under the crow-roost at Arlington, U.S.A., 4764 seeds were obtained, belonging to over half a dozen species. This material represented the deposit lying on four square feet of ground out of about fifteen acres occupied by the roost. The seeds displayed a very high capacity for germination. Many of

[1] Darwin: Origin of Species, 6th ed., p. 511.

[2] H. B. Guppy, Science Gossip, N.S., i, p. 145. 1894.

[3] O. Ekstam: Einige blütenbiologische Beobachtungen auf Spitzbergen. Tromsö Museums Aarshefter, xx, p. 52. 1897.

[4] Jens Holmboe: Notizen über die endozoische Samenverbreitung der Vögel. Nyt Magazin Naturvidenskaberne, xxxviii, pp. 305–320. 1900. Abstract in Bot. Centralblatt, lxxxviii, p. 81.

the seeds were probably disgorged rather than excreted.[1] In a subsequent paper[2] on the *rôle* of the American Crow in agriculture, confirmation of this disgorging habit, and much further information concerning the food of the crow, will be found.

Yet, when we sift the evidence available, we find it difficult to arrive at any definite conclusion regarding the actual *rôle* of birds in practically effecting the local dispersal of plants. The *possibilities* of bird-dispersal are very large indeed. While the efficacy of wind and water are strictly limited by questions of seed-buoyancy, we have in the bird an agent which is capable of transporting, in one way or another, the seed of any British plant. Even the Oak, one of the heaviest-seeded of native species, is spread in this way.[3] But the great body of evidence necessary for definite pronouncements as to what birds actually do in this direction is not yet existent, and in the meantime we need to avoid the danger of using isolated instances as general facts.

Take, for instance, the case cited by W. O. Focke.[4] A pigeon was killed by some preying animal in his garden in the winter, and in the spring from among its feathers appeared a number of seedlings of *Vicia Faba*. "In this observation he detected the normal method of the dispersal of the Leguminosae by birds."[5] One feels, on the contrary, that this was quite an abnormal occurrence—that a bird which had just swallowed uncrushed a number of perfect seeds should be killed, and then abandoned, on a spot where the conditions (in this case wholly artificial) permitted the seedlings to obtain a footing. Focke himself considered such means of dispersal quite exceptional—"man entschliesst sich jedoch schwer dazu, zu glauben, dass dieser Weg der Verbreitung ein normaler sei" (*loc. cit.*). Indeed, this observer in another place draws attention to the short range of normal endozoic dispersal, and considers that such dispersal is usually much more local than is often asserted:—"Die meisten Arten [der Pflanzen] werden nämlich viel weniger weit verschleppt als man glauben sollte."[6] But it may be noted that Clement Reid observed an instance similar to that which has been just discussed.[7]

Furthermore, as a practical aid towards the solution of our particular problem, it is not enough that a Teal is found, on dissection, to have eaten a

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[1] W. B. Barrows: Seed-planting by Birds. Report of the Secretary of Agriculture, U.S.A., 1890, p. 283.

[2] W. B. Barrows and E. A. Schwarz: The Common Crow of the United States. U. S. Dept. of Agriculture, Division of Ornithology, &c., Bull. no. 6, pp. 24, 72, &c. 1895.

[3] Clement Reid, *tom. cit.*, p. 29; and Nature, liii, p. 6. Nov., 1895.

[4] Naturw. Verein Bremen, Abhandl., v, p. 650. 1876.

[5] Guppy, Naturalist in Pacific, ii, p. 150.

[6] W. O. Focke: Die Verbreitung beerentragender Pflanzen durch die Vögel. Naturw. Verein Bremen, Abhandl., x, p. 140. 1889.

[7] *Tom. cit.*, p. 30.

number of Carex seeds. That only demonstrates a possibility, and almost everything is possible. We need to know what is the usual food of the Teal, at different times of year and in different circumstances, and which of the seeds which it eats are capable of subsequent germination. We would like to know what is the food of the Teal, and what its movements, in the particular district we are considering; though even this will not, after all, help us to determine what would be more important for our inquiry, namely, whether there were Teal in the district, and what they ate, and how they moved, say, 20,000 years ago, or after the close of the Ice Age, when possibly the island was being re-colonized by vegetation. The animal world is so dependent on the plant world that, if we attempt to deal with a time when the distribution of plants was different from what it is at present, we must remember that the distribution of animals is sure to have been different also.

Seeds are transported by birds in two different ways :—

1. By being devoured, and subsequently ejected.
2. By adhering to feathers or feet.

The first or endozoic method concerns those birds which do not crush the seeds in eating them; and concerns the harder seeds and fruits, which are protected by an impervious coat from the action of the digestive juices; though it should be noted that, as pointed out by Altum[1] and others, some birds (*e.g.* the Mistle-Thrush and Rook) cast up in their pellets, prior to digestion, the harder portion (*i.e.* stones, &c.) of fruits. The reader may also consult a correspondence on the subject in Nature, 1898.[2] (See also p. 81, *supra.*) The second or ectozoic category concerns chiefly seeds which possess barbed or hooked bristles, downy hairs, a sticky surface, or other characters which cause them to adhere easily; small seeds which may be mixed with mud which adheres to the feet of birds may also be included.

Many birds feed largely on seeds, others again on juicy fruits; and it would appear from American observations that many of the most pronounced insect-feeders also devour much vegetable matter. The importance of birds as plant-dispersers depends largely on whether they crush and digest the seeds they eat or not. On this point, Barrows[3] remarks—"The seed-eaters are not the seed-planters; on the contrary, the insectivorous birds more often sow seeds than the true seed-eaters." "Seeds which *simply contain* nourishment are eaten and destroyed, while seeds which *are contained in nourishment* are eaten and survive."

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[1] B. Altum: Zur Verbreitung der Pflanzen durch Vögel. Monatsschr. Deut. Ver. Schutz der Vogelwelt, xxiii, pp. 13–17. 1898.

[2] John Lowe, E. M. Langley, Howard Fox: Nature, lix, pp. 77, 149. 1898.

[3] W. B. Barrows: Seed-planting by Birds, *loc. cit.*, p. 281.

Kerner's experiments regarding the condition in which birds expel seeds which they eat may be quoted here.[1] Seventeen species of birds, belonging to many different families (and also a few mammals), were fed with seeds and fruits of 250 different species of plants, and the seeds were, after ejection, examined and sown. As a result, he divides his series of birds into three groups. The first, which includes, among others, the Pigeon, several Finches, Titmouse, and Duck, grind up even the hardest fruits and seeds in their "gastric mills." "No seed capable of germination was found under ordinary circumstances in the excrement of these birds."[2] But by forcibly overfeeding some of the birds, a few seeds capable of germination were obtained. In the second group, which consisted of the Raven and the Jackdaw, hard-coated seeds and fruits passed through the intestine uninjured, while all soft-coated ones were destroyed. The third group included the Blackbird, Song-thrush, and Robin. Of the seeds which passed through the intestines of these birds (some seeds were refused, and others were thrown up after having been swallowed) over 80 per cent. germinated. Kempsi,[3] again, experimenting with mammals and birds with a view of determining their *rôle* in weed-dispersal, finds many cases of germination, but considers that many birds, such as Doves, Quails, Larks, Finches, and Sparrows, are more efficient as seed-destroyers than as seed-dispersers.

The German Government, also, is publishing[4] a series of papers on birds' food, especially as regards insects and weed-seeds, which are a storehouse of detailed information, though we cannot yet generalize from them as regards our local species.

From the above observations it would appear that many of our common birds can disseminate seeds by eating them, though the list is far from complete. If we knew what seeds were included in the normal diet of the commoner birds of our district, we would be in a strong position as regards a pronouncement on the question of the part played by the local birds in seed-dispersal. But as regards the vegetable food of birds, our information is still most incomplete. That certain of the more conspicuous birds eat the more conspicuous fruits, such as berries, is of course a matter of common

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[1] A. Kerner: Nat. Hist. of Plants, ii, pp. 862–864.

[2] This result differs from that obtained by Guppy (Science Gossip, N.S., i, p. 146, Sept., 1894, and "Naturalist in Pacific," ii, pp. 369, 513), who found that seeds of Sparganium, Potamogeton, and Cyperaceae eaten by ducks germinated readily. Again, Kerner states as a result of his experiments that germination is usually retarded by passage through birds, while Guppy, Barrows (*loc. cit.*), and others find that it is hastened.

[3] E. Kempsi: Über endozoische Samenverbreitung und speziell die Verbreitung von Unkräutern durch Tiere auf dem Wege des Darmkanals. Rostock, 1906. (Abstract in Justs Bot. Jahresbericht, xxxiv, 3, pp. 264–265).

[4] Arbeiten aus der biologischen Abtheilung für Land- und Forstwirtschaft.

knowledge; but it is otherwise respecting the smaller birds and the myriad smaller fruits and seeds. The best collection of observations on this subject in our own islands is that made by Newstead,[1] which includes over 1,100 records relating to 128 species of British birds, and derived mostly from post-mortem examinations in Cheshire. The seeds, &c., found in the birds were determined as far as possible; but any attempt to discover the probability of germination after ejection by the bird lay outside the scope of the inquiry, which was directed mainly towards the economic value of birds. This series of observations, it is to be hoped, will prove the nucleus of a solid body of fact which will at length let us see clearly the relation between our native birds and the dispersal of plants. In the meantime, Newstead's and the other existing records—many of the latter being isolated observations—tell us part of the food of part of the avifauna during part of the year; and a few facts may be excerpted. Finches and their allies are large eaters of seeds, particularly of species of Brassica; the Bullfinch has a very general diet of seeds. But as regards the Finches, Newstead's conclusion coincides with that formed by Kerner, that all the seeds are crushed and digested. Many waterside birds, again, appear to feed on the seeds of Carex (Guppy also found a number of Wild-Ducks filled with the seeds of Cyperaceae, Sparganium, and Potamogeton); and Polygonum seeds are devoured by birds of various families. Hawthorn seeds are eaten extensively by the Thrush and Finch families; Finches and other birds frequently eat rose-seeds. And so on. But it will be seen that, to assist any definite conclusions in our particular inquiry, much fuller information would be required. All we can say at present regarding our special problem is that there is very little doubt that many of the local birds eat the seeds of many of the local plants, some of which occur on the island, and some of which do not; and that these seeds are, in a number of cases, ejected in a condition which makes germination possible.

As regards the second mode by which birds may convey seeds—by the seeds becoming entangled in or attached to their feathers or legs,—while we are without local evidence bearing directly on our problem, well-known observations on the point have been made by various naturalists. Thus, from a 6½-ounce pellet of mud taken off the wounded leg of a Red-legged Partridge, Darwin germinated 82 specimens of plants belonging to at least five species. This well-known instance was of course an exceptional occurrence; it was the broken leg, not any normal feature, that brought about the collection of

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[1] Robert Newstead: The Food of some British Birds. Journal of the Board of Agriculture, xv, No. 9, Supplement. 1908.

seeds. To show the richness of pond-mud which birds might carry on their feet from place to place, he germinated 537 plants from a sample of it weighing 6¾ ounces.[1]

Kerner lists 21 species "whose fruit or seeds I found most frequently in the mud taken from birds"; but remarks that "the number of species of plants which is dispersed in this manner is, it is true, but small. For the most part they are waterside, and of these chiefly small annual species."[2]

About 10 per cent. of all flowering plants bear fruits or seeds armed with hooks or hairs by which they may easily become attached to any rough surface; and, unquestionably, birds carry many seeds in this manner. Again, Guppy[3] lists nearly 20 British phanerogams which have been observed to become sticky when wetted, and which, on drying, adhere, often very firmly, to any contiguous surface. This character must also tend towards the dispersal of seeds by birds. But how far this occasional transport of seeds actually affects the distribution of plants is, to a large extent, a matter of speculation.

The local information which we can apply to the particular case of the Clare Island flora is very scanty. The present avifauna of the island and of the district is comparatively limited; but it may have been larger when much of the adjoining mainland supported pine forests and deciduous woods, and when groves of trees flourished on the island. As regards purely local movements, the ornithologists have little to tell us. We do not know what species of birds fly frequently to and fro between the island and the mainland, nor at what seasons.

In July I have observed a flock of about one hundred Rooks on the island. They flew about the higher parts, and left in the evening for the mainland. Whether similar incursions occur regularly we do not know, but in summer and autumn Rooks may be constantly seen on the island. The nearest rookery is at Louisburgh.

W. E. Collinge's recent inquiry[4] into the food of the Rook throughout the year, in England and Wales, shows that the present food of this bird consists mainly of cultivated grain. Surprisingly few other seeds were found; in twelve birds, out of 631 examined, were a few seeds of Charlock and dock; in sixteen, seeds of knot-grass, goose-grass, &c.; eighty-four contained "remains of fruit," mostly acorns, with a few currants and gooseberries. No germination tests were carried out. From this it will be seen that the Rook is at present, in England and Wales, a very poor

[1] C. Darwin: Origin of Species, 6th ed., pp. 512, 386–387.
[2] A. Kerner: *loc. cit.*, ii, p. 868.
[3] Guppy: Naturalist in Pacific, ii, p. 567, 568.
[4] W. E. Collinge: The feeding-habits of the Rook. Report to the Council of the Land Agents' Society. London: 1910.

seed-disperser: but it is held by the author that its present grain-eating propensity is due to the too great abundance of the bird; so we cannot, with safety, apply the English figures to the West of Ireland, where the Rook is less abundant. Much less can we assume that in past times grain formed so large a proportion of its food.

The great bird colonies of the island consist of Guillemots, Razorbills, Puffins, Kittiwakes, Herring-Gulls, and Shags, with a few Black Guillemots, Great Black-backed Gulls, &c.; none of these can be looked on as efficient agents of seed-dispersal. It is true that Lagerheim[1] found that, in Arctic Europe, gulls are greedy consumers of berries such as those of Empetrum; but we have no evidence of this habit locally, nor should we expect such in view of the rarity of ground berries, and the easier conditions of existence as regards food-supply. Perhaps the Chough, which replaces the Jackdaw on the island, is a more hopeful subject; but we have no definite local information concerning its food.

The most important of all bird-movements—namely, the seasonal migrations—may be eliminated so far as Clare Island is concerned. The island lies outside the main migration routes. From the tens of thousands of records of migrating birds given by Barrington,[2] Clare Island is conspicuous by its absence. The present light-keepers confirm the fact of the singular absence of migrating birds at the lighthouse throughout the year.

In any case, a large body of evidence goes to show that migrating birds travel with empty stomachs and clean externally. On this point the Danish observations, referred to on p. 90, may be quoted. But it ought to be stated that there are not wanting observations which suggest that this may not be a universal rule. Thus Duval-Jouve,[3] examining the migratory swimming birds exposed in the market at Strasbourg, "trouve presque toujours des débris de plantes accolées contre le poitrail, et plus souvent encore aux pattes," and lists twelve species of marsh- or water-plants identified.[4] And an anonymous writer states[5] that, in Sicily, birds on both the northern and southern migrations bring many seeds, in their crops and also on their feet. He lists some of the species found with each bird, and says that it is customary to sow the contents of the alimentary canal of Quails, and thus to obtain unfamiliar plants.

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[1] O. Ekstam: *loc. cit.*, p. 51.

[2] R. M. Barrington: The migration of birds as observed at Irish lighthouses and lightships. London and Dublin. [1900.]

[3] Bull. Soc. Bot. France, xi, p. 265. 1864.

[4] In this case there seems to be a lack of evidence that the seeds may not have become attached by contact with the ground or with packing, &c., after death.

[5] Zugvögel als Pflanzenverbreiter. Österr. Forst- und Jagdzeitung, xxi., p. 140. 1903. Abstract in Bot. Centralblatt, xcii, p. 561.

To come back to the main question, we have to admit that we are not in a position to say definitely whether birds could have introduced that very large proportion of the flora of Clare Ireland which could not owe its presence to wind or water. Out of 393 species inhabiting the island, not more than 15 are at all likely to have been introduced by water, nor more than 50 by wind. We must also deduct about 55 species which were or may have been introduced directly or indirectly by man. It seems unlikely that the total balance, numbering about 270 species, belonging to many different orders, and possessing seeds and seed-vessels of all sizes, shapes, and characters, were brought over by the rather scanty avifauna, even though the distance from the mainland is not great.

We must remember at the same time that many species arrived on the island probably in early times, when the local distribution of plants was different from what it is at present. Thus, I doubt if anyone would claim that *Saxifraga Geum* was introduced directly by either natural or artificial agency from Kerry, or *Silene acaulis* from Sligo; but they might have been introduced, say, by birds, from former neighbouring colonies which are long since extinct. By the majority of naturalists, discontinuous distribution is regarded as being generally relict distribution, not incipient colonization due to long-distance dispersal (see *ante*, p. 56).

A case which came under my own notice may be quoted,[1] as it shows both how conspicuous a part birds may play in plant-dispersal, and how little right one has to generalize from a particular instance. Near Frankford in King's County a colony of Black-headed Gulls was breeding in the centre of a large peat-bog, about half a mile from the surrounding farm-land. The guano and trampling of the birds had in some spots destroyed the bog-vegetation, and in its place a coarse herbage sprang up, which comprised—

Ranunculus acris.	Veronica Chamaedrys.
Capsella Bursa-pastoris.	V. arvensis.
Cerastium triviale.	Prunella vulgaris.
C. glomeratum.	Plantago major.
Sagina procumbens.	Atriplex *sp.*
Trifolium repens.	Polygonum Persicaria.
Epilobium obscurum.	Rumex Acetosella.
Daucus Carota.	Juncus effusus.
Bellis perennis.	Holcus lanatus.
Senecio vulgaris.	Poa annua.
Hypochaeris radicata.	

Not one of these plants was native on the bog, while all were common on

[1] Praeger, Irish Topographical Botany, p. xxxviii, 1901.

the farm-land; and although one or two of them are fitted for wind-dispersal, the probability is that all were brought by the birds—probably by means of seeds adhering to their feet or plumage, as the Black-headed Gull is only very sparingly a vegetable feeder. This case may seem to show the ease with which plants may be introduced by the movements of birds. But the conditions when studied are seen to be very special. In the first place, the great concentration on a very small area of ground must be considered. Assuming that only a hundred pairs of breeding birds formed this colony, the feeding of the young involved some hundreds of thousands of journeys direct from the farm-land, where grubs and worms were obtainable, to an area only a few perches in extent. Again, the guano was probably as beneficial to the growth of the weed-flora as it was inimical to the bog-vegetation, so that the seeds arrived on ground unoccupied by a pre-existing competitive flora. A little consideration will show how different the case of this bird-colony is from a case such as that afforded by Clare Island, where we have to rely on the casual visits of the members of a scanty avifauna. But, on the other hand, that scanty avifauna has had a very long period in which to do its work.

Probability of a Land-bridge.

It has been seen that examination and analysis of the vegetation of Clare Island show that only an insignificant fragment of it could have arrived by water, and that wind-dispersal could not reasonably be held responsible for the balance. If the plants arrived across a channel of sea, birds must be held accountable for the introduction of the bulk of the indigenous flora. Birds, no doubt, have played an important part; and we may without hesitation put down a number of the hard-seeded plants to their credit. But there still remains a large portion of the flora; and local conditions, such as the cliffy character of the shore and the prevalence of westerly winds, tend to discount the efficacy in this case of other accidental or occasional dispersal. It has been seen also (pp. 5–9) that analysis of the flora of this and the adjoining islands seems to show a general invasion by the mainland plants, for the island flora exhibits no predominance of species specially fitted for over-sea dispersal, every section of the mainland flora being represented as far as the habitats existing on the islands allow.

Neither does the list of common mainland plants absent from the group of islands show a predominance of species unfitted for over-sea dispersal. This list (given on p. 10) is seen to contain indifferently representatives of all the modes of dispersal—plants whose seeds float unharmed in sea-water (*Sium angustifolium*, *Bidens cernua*, *Alnus glutinosa*, *Sparganium simplex*,

Potamogeton perfoliatus, Carex remota); plants with plumed seeds adapted for air-carriage (*Epilobium hirsutum, Crepis paludosa, Salix caprea, Typha latifolia*); powder-seeded plants (*Erophila vulgaris, Sagina apetala, Habenaria bifolia, Equisetum sylvaticum*); plants with seeds which may be distributed by being eaten by birds (*Rubus Idaeus, Rosa tomentosa, Viburnum Opulus*); or by adhering to their feet or feathers (*Geum urbanum, Epilobium hirsutum, Asperula odorata, Bidens cernua, Typha latifolia,* and the powder-seeded species).

Another argument which may be used against the introduction of the flora of Clare Island or of the adjoining islands across water, or indeed across any barrier, is the fact that the flora of all of these islands is actually richer than that of most, if not all, equal areas of the adjoining mainland. Had the flora any difficulty to encounter in its passage to the islands, we should undoubtedly expect it to be reduced in variety. The comparative richness of the island floras is the result of the greater variety of conditions prevailing there. It seems, however, probable that the mainland flora was as rich as, or more likely richer than, that of the islands before the period of the main growth of the bogs. I would suggest that the vast blanket of peat which is spread over so much of the mainland locally exterminated many plants there; while on the islands, where peat never formed to so great an extent, these species have survived.

The doubtful factor as regards the migration of the flora is the question of the practical efficacy of "accidental" means of dispersal. These have been discussed tolerably fully above; and they do not seem to me, in this case, to offer sufficient chances for the arrival of the large proportion of the flora which, in the present state of our knowledge, we should have to put down to their account. I am therefore inclined to think that overland migration is accountable for the introduction of the bulk of the flora. The zoological and geological evidence bearing on this point is discussed elsewhere by other writers.

Within the last few years the results of two important investigations respecting the origin of island floras, one in our own latitudes and one in the Tropics, have been published. Both are suggestive in connexion with the smaller investigation dealt with in these pages; and it may be permissible to refer to them.

The Case of the Faeröes.

The case of the Faeröes is an interesting one, and one which appeals to us, since the flora approximates to that of the northern portion of our own islands. This island-group lies about 180 miles W.N.W. of the Shetlands,

270 miles S.E. of Iceland, and 360 miles west of Norway; their collective area is about 480 square miles; their surface is mountainous; and they support a population of 15,000. The flora is very closely related to that of Scotland, the nearest land; less nearly to the Scandinavian flora; and least to that of Iceland. This appears from the thorough investigations in recent years of Danish botanists, whose results have been published in a volume of over a thousand pages.[1] In this volume the origin of the vegetation is discussed first by Ostenfeld and afterwards by Warming; and it is interesting, as showing the difficulties involved, to find that while Ostenfeld believes that the flora migrated over a former land-bridge, Warming holds that over-sea migration is responsible for it.

As regards the age of the flora, both writers consider that it is post-Glacial. This decision follows from the presumption that the whole of the flora was destroyed during the Glacial Period.[2] They also agree that dispersal by sea has been ineffective, Ostenfeld pointing out that a strong extension of the Gulf Stream, coming from the open Atlantic, flows between the Faeröes and Scotland, effectually cutting off dispersal from the latter country, and bringing nothing but an occasional West Indian fruit. "The ocean currents in these parts," he concludes, "are of no consequence whatever in the matter in question" (p. 116). As regards birds, also, both authorities maintain that they likewise have been ineffective. Evidence is given that the migratory flight of birds over the Faeröes is not considerable; and an extensive series of observations in Denmark, involving thousands of migrants, shows that the birds migrate on empty stomachs, and are almost always clean externally when they travel.

There is left the wind; and the choice lies between this and a former land-bridge. Warming expresses the view that the wind is responsible for the introduction of almost the whole flora; while Ostenfeld prefers the alternative. We need not consider here the geological evidence, but may say that valuable testimony is adduced both in favour of and against the hypothesis of a post-Glacial land-connexion. But turning to the botanical evidence, Ostenfeld bases his conclusions on the non-efficacy of the wind. The direction of the wind at the Faeröes, in percentages for the year, is:—

	N.	NE.	E.	SE.	S.	SW.	W.	NW.	CALM.
Days.	12	14	8	10	10	17	13	5	11

[1] Botany of the Faeröes, based upon Danish investigations, 1901–1908.

[2] On the possibility of the survival of at least part of the flora of northern areas during the Ice Age, see SCHARFF: On the Origin of the European Fauna. Proc. R. I. Acad., (3) iv, pp. 488, 489. 1897.

Ostenfeld lays stress on the prevalence of winds useless for seed introduction, and on the fact that, in contradistinction to truly insular floras, only a small section of the Faeröese plants are adapted for wind-dispersal. (Out of 277 species, 71[1] have small seeds, and only 27 have flying apparatus—total 35·5 per cent. of the flora.) In view of these facts, he cannot admit the efficacy of the wind for bringing in the mass of the flora; and he is driven to the adoption of the land-bridge hypothesis.

Warming, advocating wind-dispersal, quotes several remarkable recent instances of the wind-carriage of plants and even of stones, notably one of the transport of Erica and Calluna plants across the Kattegat.[2] But these cases are clearly, and indeed admittedly, exceptional. He points out that the S., S.E., and E. winds of the Faeröes amount to 28 per cent.; and he thinks that the flora includes "not many species which have seeds large enough, and heavy enough to prevent them being carried along by a gale." This last statement includes the whole crux of the problem, and is referred to, in the light of certain experiments, in the succeeding paragraph. He states that he is "fully convinced that the whole of the flora—at least, all the more highly organized land-plants—have immigrated, after the glacial period, across the sea, and from the nearest countries, lying east, especially Great Britain" (p. 681). It need only be added that Wille and Börgesen, for instance, are in agreement with Warming's view; while Nathorst and Drude, as well as Forbes and Geikie, are advocates of a Faeröese land-connexion.

Harking back for a moment to the experiments on the actual rate of fall of seeds (see pp. 76–78, *ante*), let us see what is the chance, as shown by these experiments, of seeds being carried to the Faeröes from the nearest land—namely, Shetland. Let us again take a very favourable case—seed of the highly efficient *Epilobium montanum*, liberated with a 50-mile-an-hour gale blowing continuously and directly in the right direction. The amount which this seed would need to be raised by abnormal means to keep it afloat during its journey of 3 hours and 36 minutes from nearest point to nearest point would amount to 1·45 mile. But most of even the pappus seeds are not nearly so efficient as *Epilobium montanum*. The many plants with seeds of the Papaver type could not get across unless the seed was raised during the passage by a total amount of at least 22 miles. Yet many of the Faeröese plants have seeds which fall faster than these, and which would require considerably greater assistance.

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[1] This equals 26 per cent. of the flora—which may be compared with the figure (17·6 per cent.) arrived at by Clement Reid (Hist. British Flora, p. 21) for the much less insular area of the British Isles; but we do not know how far the definition of a "small seed" agreed in the two cases.

[2] See E. Warming: Über Grönlands Vegetation. Engler's Bot. Jahrbücher, x, 1888–9, p. 407.

In view of these facts, it seemed difficult to endorse Warming's view already quoted, that few Faeröese plants "have seeds large enough and heavy enough to prevent them being carried along by a gale."

The Case of Krakatau.

The interesting case of the flora of Krakatau has been made widely known by the publication of Ernst's recent book, and its translation into English.[1] The vegetation of this island and an adjacent islet, as well as a considerable portion of the land-surface of Krakatau itself, was wiped out by a terrific eruption in 1883, which submerged portion of the island, and covered the remainder with a layer of hot pumice and ash averaging thirty mètres in thickness. Verbeek's party, visiting the island two months later, could find no trace of vegetation left. In 1886 Treub found on the island fifteen Phanerogams and eleven Ferns, divided into two almost independent groups, the strand flora and the flora of the interior, the inland flora consisting of numerous Ferns (eleven species) and in small quantity eight Phanerogams. The island was again visited by Treub and others in 1897, when fifty-six Phanerogams and twelve vascular Cryptogams were found, the ground being now in some places completely covered with vegetation. The visit of Ernst and his party in 1906 showed that the number of Phanerogams had risen to 92, and that a dense vegetation was re-established. It is held by Treub and Ernst that the entire new flora immigrated since the eruption, by means of water, air, or flying creatures. The only loophole of escape from this conclusion has been pointed out by Scharff[2]—namely, that it was not (nor indeed could it be) proved that vegetable germs had not survived the eruption. It is quite true that Treub, as a result of his visit in 1886, is positive on this point. "En premier lieu il est indispensable de prouver que la flore actuelle doit être considérée comme nouvelle et qu'elle n'est pas issue des restes de la végétation luxuriante qui occupait l'île avant l'éruption. Rien n'est plus facile d'ailleurs que de fournir cette preuve. Lors de l'éruption les arbres terrasés ou brisés par de violentes rafales ont dû être à moitié carbonisés, vu le température extrêmement élevée qui a certainement regné sur toute l'île. En suite Krakatau a été couvert, depuis le sommet jusque bien au de là du niveau de la mer, d'une couche de cendres et de pierre ponce brulantes. Cette couche a une épaisseur variant entre *un* mètre et

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[1] A. Ernst; The New Flora of the volcanic Island of Krakatau. Cambridge, 1908.

[2] R. F. Scharff: On the Evidences of a former Land-bridge between northern Europe and North America. Proc. R. I. Acad., xxviii, Sect. B., pp. 8–9. 1909.

soixante mètres. Dans ces conditions-là il est clair qu'aucun vestige de la flore n'a pu subsister après le cataclysme. La graine la plus persistante et le rhizome le mieux protégé ont dû perdre à jamais toute vitalité."[1]

Nevertheless, we must remember that a rich vegetation had been shedding its seeds on the island uninterruptedly until the catastrophe destroyed it[2]; that floods, landslips, and other agencies must previously have buried countless seeds, some to a considerable depth; that seeds long buried in the soil are often capable of germination as soon as opportunity arises;[3] and that the rains (reckoned at 98 inches per annum, falling mainly in four months), which rapidly denuded the beds of ash, cutting "deep valleys and gorges" within two months (p. 4), must also have cut into the old surface, which had been left in some places even devoid of volcanic covering (p. 4), though usually buried; many seeds might thus become exposed and scattered, which might germinate, for heat does not readily penetrate downward, and seeds can survive a high temperature.[4]

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[1] M. Treub: Notice sur la nouvelle flore de Krakatau. Ann. du Jardin Bot. de Buitenzorg, vii, 1888, pp. 214, 215.

[2] For instances of the vast number of seeds which the soil may contain the reader may consult H. C. Long (Common Weeds of the Farm and Garden, p. 26. London, 1910), who took 1,050 seedling weeds off one square yard of well-weeded garden soil, and who quotes E. Korsmo's observations (Kampen mod Ugraesset, 1906) of 1755, 10,332, and 33,574 seeds capable of germination, each contained in the soil of one square mètre of agricultural land. From an Irish sample, Adams has calculated 4,012,360 weed seeds as contained on an acre of ground (Irish Nat., xiv, p. 80. 1905.)

[3] Long ago, A. P. de Candolle (Physiologie Végétale, ii, 620. 1832) concluded that seeds buried sufficiently deep in the soil to be protected from the action of air and moisture would have their vitality much prolonged. Later C. de Candolle (Bibl. Universelle, Archives des Sciences Phys. et Nat. (3), xxxiii, pp. 497–512. Genève. 1895) and Giglioli (Nature, lii, pp. 544, 545. 1895) have shown that seeds can display very remarkable resistance to severe conditions enduring many years. In this connexion see also Duvel (U.S. Dept. Agriculture, Bureau of Plant Industry, Bull. 58, p. 80. 1904). Good instances of the vitality of seeds after many years' burial will be found in the Irish Naturalist for 1904 and 1905, in communications by J. Adams and others. The cases quoted by Clement Reid (*l.c.*, p. 32) as instances of the rapid immigration of plants, in which Poppies and Corn Marigolds appeared in quantity in ground laid bare in the making of new railways near Cromer and Brockenhurst, would appear to be certainly due to this cause. A case similar to this last, and, no doubt, correctly ascribed to long-buried seeds, is mentioned by Messrs. Sutton and Sons (Lawns, p. 9. 1909) where a large rabbit-warren in Oxfordshire was dug and levelled, no extraneous material being used, with the result that in the first year a dense growth of *Brassica Sinapis* appeared, followed in the succeeding season by a crop of *Lychnis vespertina*. On the other hand, Ewart's tests in Australia of six hundred different sorts of old seeds, from herbarium and similar sources, showed, on the whole, a very low vitality. (Quoted in G. H. Clark and J. Fletcher: Farm Weeds of Canada, p. 13. 2nd ed. 1909.) Duvel's experiments (J. W. T. Duvel: The Vitality of Buried Seeds. U.S. Dept. of Agriculture, Bureau of Plant Industry, Bull. 83. 1905) in burying seeds suggest that this failure may have been due to temperature and moisture fluctuations. He buried seeds of 109 species in porous flower-pots at various depths at Arlington, U.S.A., and found that after a year, while the average germination was reduced to about one-half, that of the seeds buried 36–42 inches was half as high again as that of the seeds buried 6–8 inches. This result has an obvious bearing on the point under discussion. Peter records the springing up of a great variety of field plants after the removal of a forest which had occupied the ground for forty-six years. (Quoted in Strasburger's Text-book of Botany, 3rd English ed., p. 322. 1908.)

[4] For the literature of this subject—the resistance of seeds to high and low temperatures—see

However this may be, there can be no doubt that many of the plants of the new flora immigrated from the surrounding islands, which lie to the north, east, and south, at distances of about 20 to 80 kilometres. Analyzing the total new Phanerogamic flora, Ernst arrives at the conclusion that

39 to 72 per cent. have been introduced by sea-currents;
10 to 19 per cent. have been introduced by birds;
16 to 30 per cent. have been introduced by air-currents.

The migration of strand plants by sea is a well-known and often-studied phenomenon in the Tropics. A rich vegetation extends to the verge of these warm seas; and fruits and seeds of many kinds form a conspicuous part of the abundant piled-up jetsam of the beaches. As regards bird-dispersal, the figure arrived at is based to a considerable extent on observed facts of endozoic distribution in other places, but no information is given as to the avifauna of Krakatau or its movements. When we compare the distance of the adjoining lands, and the speed of birds, with the known rate of digestion (about ½ to 3 hours), we see that there is not a large margin of time left; but a bird flying to Krakatau just after a meal might easily drop seeds on the island. As regards wind-dispersal one would like further information concerning those plants which are not powder-seeded. There seems no reason to doubt that the Cryptogamic flora was wind-borne, and also some Phanerogams, such as Orchids, with very minute seeds.

The Krakatau example has been referred to at some length because it is unique as an observed example of the rapid re-colonization of an isolated land area. But even if we accept the theory that the whole of the new flora was of extraneous origin, we must be very chary of applying its lessons to a case such as that of Clare Island. In Krakatau we have a spot in the Tropics, surrounded by a luxuriant vegetation (though at a distance that would prove a serious obstacle in our latitudes), which, in a very short period, has simply overwhelmed the island once more. But the only time when Clare Island may, by depopulation, have offered a more or less bare and competition-free habitat to immigrants was after the Glacial Period, when the conditions were rigorous, and the flora of the adjoining tracts probably as decimated as that of the island itself, and when, as I have pointed out (p. 59), in spite of a reduced flora, the pressure of competition was probably not less than under normal conditions. What was accomplished in a year on Krakatau may well have taken centuries on Clare Island, and even then would have been accomplished by agents working under very different conditions.

J. W. T. Duvel: The Vitality and Germination of Seeds. U.S. Dept. of Agriculture, Bureau of Plant Industry, Bulletin 58, p. 25. 1904. Seeds are found to withstand temperatures ranging from 100° C. to −250° C.

Perhaps a nearer parallel to the incoming of the Clare Island flora after the Ice Age, if we accept a Glacial extinction of the flora, may be found in Spitzbergen; the results of Ekstam's[1] researches there are that he hypothecates a land-bridge to the eastward (as Nathorst[2] did before him), suggesting that a few Scandinavian species which occur on Spitzbergen, but not on Nova Zembla to the eastward, may have been brought direct by birds.

The whole question of plant-migration across barriers centres round the oft-debated point of the efficacy of "accidental" or "occasional" dispersal: the advocates on the one side taking their stand on the lack of direct evidence and the lack of actual observation of the accomplishment of long distance dispersal by these means; the other side demanding any other explanation of certain facts of distribution, and pointing out the immense period of time available for colonization by "accident." The older students of distribution, led by Darwin and Wallace, argued that such dispersal *must* have taken place, calling to witness the fauna and flora of oceanic islands, and pointing out the undeniable wide possibilities. Later naturalists, adhering to Forbes's view that overland migration was the rule, sought for actual instances of over-sea dispersal, but finding none, or next to none, were tempted to condemn the whole "occasional" hypothesis—what was not taking place now did not take place in the past. But, came the reply, we cannot hope to see these things actually happening—to find condensed into the limited period of our own experience what has been spread over tens of thousands of years. Nature, as A. R. Wallace has said,[3] can afford to wait. Man, dressed in a little brief scientific experience, cannot thus discount the influence of the ages.

In August was the Jackal born;
The Rains fell in September;
"Now such a fearful flood as this,"
Said he, "I can't remember!"

In the absence of any body of direct evidence, we are driven to an attempt to estimate probabilities; and here again we are at fault, for we have not the facts and figures which would allow of even an approximate estimate being made. So the question resolves itself into a matter of opinion, based on a general survey of the case; and from such opinion we cannot eliminate the personal equation.

But we must remember that there is all the difference in the world between possibilities and probabilities; and it seems to me that in many

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[1] O. Ekstam: Spitzbergen, *loc. cit.*, p. 56.

[2] A. G. Nathorst: Studien über die Flora Spitzbergens. Englers Bot. Jahrbücher, iv, pp. 432–448. 1883.

[3] Geographical Distribution of Animals, i, p. 32.

cases of presumed accidental dispersal each possibility involved is to be represented by so small a fraction that, if a few of these possibilities are superimposed one on the other, as in the case of Focke's hawk-slain pigeon (*ante*, p. 81), there is but little possibility left. One may invoke a formula to express this thought; it cannot be denied that

$$\text{A possibility} \times \text{a possibility} \times \text{a possibility} \ldots = 0\,!$$

Even the multiplication of whatever resulting fraction there may be by the big time-factor that it is permissible to draw on, will not, in many cases, give us a very hopeful result.

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The nomenclature used is that of "Cybele Hibernica," 1898, and "Irish Topographical Botany," 1901.

DESCRIPTION OF PLATES.

Plate I.

Looking west along the Croaghmore scarp, from near the east end. The "1,200-foot path" is seen traversing the middle of the picture. The steep slope which it crosses is grassy, with much *Silene acaulis* and *Saxifraga decipiens.* The base of the rocks above the path is clothed with great bosses of *Silene acaulis* and *Hymenophyllum unilaterale* plus *Mnium hornum.* The rocks above are hung with *Saxifraga umbrosa, Sedum Rhodiola, Hieracium anglicum, H. hypochaeroides, Oxyria digyna,* &c. The numerous bosses of vegetation near the top of the picture are formed mainly of grasses and *Silene acaulis.* Photographed June, 1910.

Plate II.

Vegetation map of Clare Island.

Plate III.

Plantago sward. Fig. 1 shows the *maritima*-type, the vegetation consisting of at least 75 per cent. of *P. maritima,* with reflexed leaves about 1 inch long.

Fig. 2 illustrates a type in which *P. Coronopus* is about as abundant as *P. maritima,* and *Festuca ovina* forms a noticeable ingredient. Both photographs were taken near Beetle Head, at the west end of Clare Island. Photographed June, 1910.

Plate IV.

Fig. 1.—The wood at Portlea is the best developed piece of woodland remaining on Clare Island. *Betula pubescens* is predominant, one old tree attaining a height of 10 feet. The other trees and the shade plants which occur are listed on pp. 19–20. The boulder-beach of Portlea appears in the middle distance, with drift-capped cliffs of Carboniferous sandstone beyond. Photographed September, 1909.

Fig. 2.—Shows the luxuriance of vegetation where shelter from wind is afforded. The spot where this photograph was taken lies close to the lower left-hand corner of fig. 1. Photographed June, 1910.

Plate V.

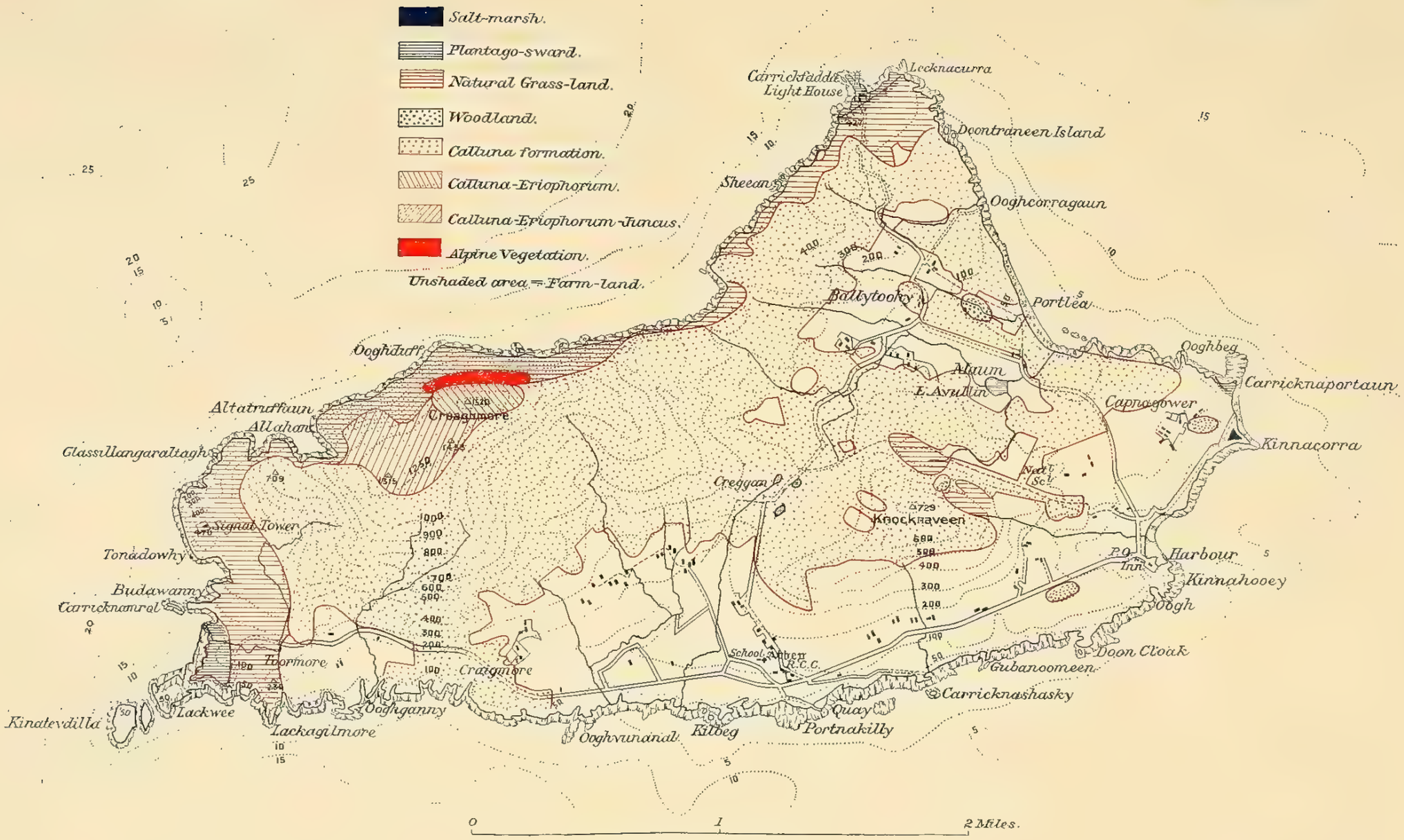
Fig. 1.—The only habitat of *Erica mediterranea* on Clare Island is a slope of Boulder-clay facing north-east and dropping to the sea, near Portlea. No peat is present in the soil. Frequent slips of the material occur after rains, destroying many plants. *Cephalanthera ensifolia* and *Listera ovata* have their only island station close by. For a note of the insects which fertilize the flowers of *E. mediterranea* here, see p. 30. Photographed June, 1910.

Fig. 2.—*Silene acaulis* at 1,200 feet on Croaghmore. The blossoms are being devoured by *Arion ater*, which swarms on the cliff. Photographed June, 1910.

Plate VI.

Fig. 1.—Characteristic bosses of *Silene acaulis*, and of *Hymenophyllum unilaterale* plus *Mnium hornum*, at 1,200 feet on Croaghmore. *Saxifraga umbrosa* near the top of the picture. Photographed June, 1910.

Fig. 2.—*Saxifraga decipiens* at 1,000 feet on Croaghmore. A strong young plant, colonizing rock laid bare by a recent fall. Photographed June, 1910.



Vegetation Map of Clare Island.

CLARE ISLAND SURVEY.—PRAEGER: PHANEROGAMIA.

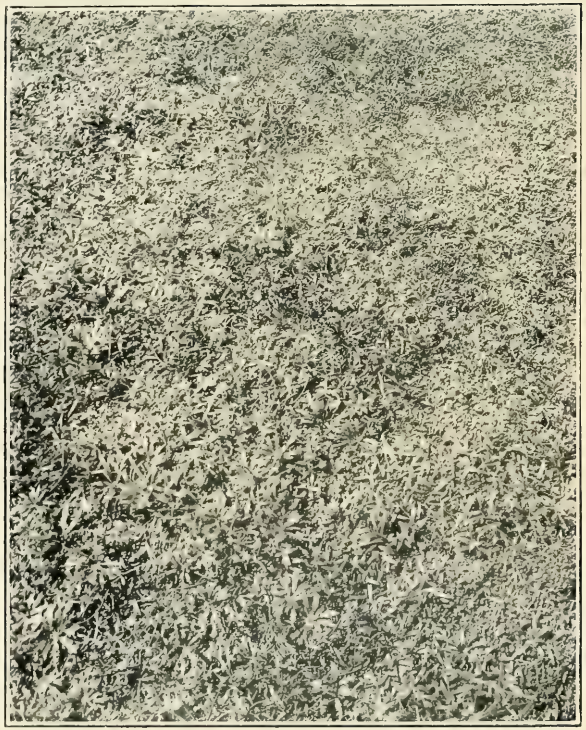


Fig. 1

Fig. 2 *R. Welch, Photo.*

Types of Plantago Sward.

Fig. 1. The "Wood" at Portlea. Trees 6 to 10 feet high. *R. Welch, Photo.*

Fig. 2. Osmunda regalis near Portlea, 6 feet high. *R. Welch, Photo.*

Fig. 1. Erica mediterranea on Boulder-clay, near Portlea *R. Welch, Photo.*

Fig. 2. Silene acaulis on Croaghmore, 1,200 feet. *R. Welch, Photo.*

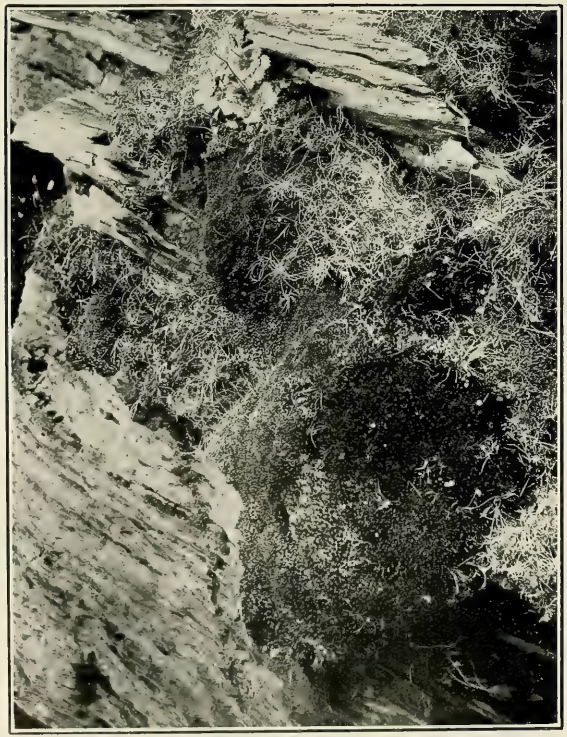


Fig. 1. Bosses of Silene acaulis, Hymenophyllum unilaterale, and Mnium hornum, Croaghmore.

Fig. 2. Saxifraga decipiens, Croaghmore.

11-12.

MUSCI AND HEPATICAE.

By H. W. LETT.

Read January 22. Published February 22, 1912.

CONTENTS.

1. THE AREA.

[To avoid a repetition of the introduction of the description of the area, which concerns alike the Mosses and the Hepatics, the reports on these two groups have been run into one.

It is to be noted that, for the sake of distinction, Achill Island and the peninsula of Curraun Achill, which are separated from each other by a very narrow strait, are spoken of in this report as constituting a part of the mainland. "The island" invariably means Clare Island.]

The investigation of the Bryophytes has been carried out over the whole of Clare Island, and on the mainland from Achill Head by Curraun, Mulranny, Newport, Westport, Croaghpatrick, and Louisburgh, to Roonagh.

There are no glens on Clare Island; and the surface is, as a rule, greatly exposed. The wide southern slopes of Croaghmore have a peaty soil, which supports Calluna, Juncus, and some patches of Sphagnum, but few Mosses or Hepatics. The difficulty of the great northern cliffs of Croaghmore, owing to their precipitous character, renders them inaccessible except along a couple of sheep-tracks, where, however, collections were made. There are four streamlets on the landward slopes; the reaches of these next their sources are remarkably poor in Mosses and Hepatics; and it is only along the portions at a low elevation near their discharge into the sea that any Mosses or Hepatics occur, and there only in well-sheltered nooks and corners. The rain when it falls is quickly carried off by these little channels, which, for

the time, become miniature torrents, and sweep their margins clear of every green thing.

When the prevailing wind from the west is blowing, all places in the lee of the towering mass of Croaghmore are in comparative shelter. It is quite easy to mark out this sheltered region on the map of the island; it extends from a spot north-west of Creggan Lough to Portlea. Take the one-inch Ordnance map of Clare Island, latest edition, place a finger on the letter "E" of the name, and draw the finger to the right to the word "Portlea" on the east, and if your finger has been rubbed with moist peat you will roughly mark on the map a band that is the richest in the island both in species and quantity of Mosses and especially of Hepatics. The part thus marked starts with the wettest bit of Clare Island, which lies around and to the N.N.W. of Creggan Lough, and in it Sphagnaceae are more abundant than elsewhere on the island.

To the north of the band just described, or between the east shoulder of Croaghmore and the light-house, there are several low hills which run in ridges north-west to south-east, and which have small valleys or ravines between them. These depressions also are well sheltered, and in places are partially shaded; but our plants do not abound in them, owing to the cutting away of the peat-surface for fuel during a long series of years, the traces of which are very evident.

However, in the depression nearest to Croaghmore, and due east of it, which, moreover, is the widest of these depressions, and where the peat is still very deep, the faces of the banks left by the peat-cutters which face north-east, when they have been undisturbed for a few years, become overgrown with a profusion of Mosses and Hepatics. And along the streamlet that drains this part, just below where it crosses the road at the houses of Ballytoohy, there are many well-sheltered nooks and corners along both banks, and especially near a pretty little waterfall, that yielded quite a number of species.

There is a large amount of rock-surface, exclusive of the inaccessible cliffs and the rocks close to the sea; but it supports very few Mosses. The saxicolous species, contrary to what might be expected, are very scarce. The Congested Districts Board in dividing—or, as the natives call it, "striping"—the land into new denominations by the erection of stone walls for fences, have not yet increased the growth of Mosses and Hepatics on these boundaries. Perhaps the future botanist may one day find them covered with these plants. The only locality on the island where at present they grow in any quantity on rocks is on the steep east and north-east faces of Knocknaveen, the highest point of which is 729 feet.

The absence of Mosses and Hepatics from what would appear to be suitable habitats cannot be accounted for by the atmosphere of the island being charged with salt during gales from the west, for several Mosses were noticed, the most frequent of which was *Mnium hornum*, which is found everywhere on the island, from sea-level to the top of Croaghmore, the discoloured but flourishing foliage of which, deeply tinged with a tawny hue, gives evidence of the harmless effect of the salt on its tissues.

At the extreme west end of the island, near the Signal Tower, there is a small morass, which must be in an atmosphere impregnated with salt, and south of this station, but much lower down, at Toormore, are some vertical rocks, facing north, which also are under the influence of the salt in the air, and in both spots there are several species, and some of them very delicate forms, which yet are none the worse of it.

Searches round the several small loughs were disappointing. Lough Avullin, now only half its former size, owing to the deepening of its outflow, has muddy shores, thickly set with rushes and grasses, where neither a Moss nor a Hepatic was found. Creggan Lough has a neighbourhood abounding in various species of Sphagnum, and this locality may be set down as the head-quarters of the Sphagnaceae on the island. Several small Hepatics were also found on the shore of this lough. The shores of Lough Leinapolbauty and Lough Merrignagh, which are close by Creggan Lough, on the east side of the road, are occupied with wide mats of Sphagnum and *Polytrichum commune*, among which some *Hypnum revolvens* occurs. Lough-na-phuca is near the west extremity of the island, and about 200 yards from the sea. It is very small, and is barren of Mosses and Hepatics.

No arboreal species of either class was met with on the island, there being very few trees. A few poplars, &c., have been recently planted here and there, and there are a few thickets composed of bushes of Ulex, Corylus, and Salix on a steep bank between Lough Avullin and Knocknaveen. Four species were found on the stems of these last, but they were not, strictly speaking, arboreal. And along a streamlet that falls into the sea at Portlea, there is an ancient shrubbery of Betula, Salix, Corylus, &c., with a solitary Quercus, on the stems and branches of which several Mosses and Hepatics grow. These there is reason to regard as the survivors of the Mosses and Hepatics that abounded on the trees and ground of the primeval forest, the bleached stumps of which stud the ground near Maum and other places, and conjure up the idea of what a congenial habitat their presence formerly provided for our little plants. The bryophytic flora of the island has been considerably changed with the cessation of the forest growth on it. And there can be no doubt that a number of species which originally flourished on

the island are no longer to be found on it. The few descendants of some of the trees of the forest that now struggle for existence in the little glen near Portlea are the only representatives of what existed under the original conditions on the island, and the associated Mosses and Hepatics, some of which were not collected elsewhere on the island, are the scanty survivors of plants that formerly occupied every nook and cranny that then were sheltered by the forest, but now lie exposed to every storm and hurricane. The obvious conclusion is that decay and recession have been at work amongst the species of Mosses and Hepatics on the island, consequent on the degeneration and cessation of the forest growth.

The large number of our plants that have been found on the nearest portions of the mainland, but which have not been met with on the island, have survived there, while the same have been no longer able to continue their existence on the island owing to the change of the environment. The only associates of the forest growth that now survive on the sites of the forests are a few Sphagnaceae.

The irregular summit of Knocknaveen has for a long time been, and still is, used by the inhabitants for peat-cutting, and consequently has not many of our plants, the principal being several species of Sphagnum, Hypnum, and Polytrichum.

On the sands on Achill Island, at the mouth of Achill Sound, and at Mulranny, several interesting species were gathered. There is only one small bit of sandy shore on the island. It is north of the harbour and Grania-Uaile's Castle. In it were found a few arenicolous Mosses. The sand-dunes near Louisburgh, and some miles to the south-west, have scarcely any Mosses and no Hepatics on them, all that were observed being *Hypnum lutescens*, *Isothecium myosuroides*, *Tortula ruralis* var. *arenicola*, *Stereodon cupressiforme*.

The omnipresence and abundance of peat, the small amount of land under cultivation, and the frequent occurrence of outcropping rocks would lead a botanist on a first visit to expect a rarer and richer flora of Bryophytes than is actually met with on either the island or the neighbouring mainland.

The spots on the mainland where the greatest number of Mosses and Hepatics were found are:—The east slope of Croaghaun Mountain round Lough Acorrymore, and the north-east side of Slievemore, along the sharp ridge which extends from about 300 feet altitude above Dugort village to the summit at 2200 feet (Mr. Pearson writes of this as "rich collecting ground"); the wooded steep ground at Glendarary, in Sraheens; and round Knockacurraun Lough, in the heart of the Curraun peninsula. The neighbourhood of Lough Nakeeroge, which, from its position, would seem an ideal

abode for Bryophytes, has, strange to say, very few of them. Round this lough the ground is much shaded by the cliffs from the direct rays of the sun, the air is moist, and there is shelter from stormy winds; these are data which generally determine where Mosses and Hepatics will establish themselves and flourish, but they avoid this spot.

In the centre of the Curraun peninsula lies the beautifully situated Lough Knockacurraun at an elevation of 600 feet above sea-level; on all sides but one it is surrounded by hills that reach 1000 feet higher. And here along the west and south margins of the lough the stones and rocks are covered with a profusion of Mosses and Hepatics, several of which are rare. These grow at the edge of the water, which in summer and winter alike is always at the same level, and they are except for a few hours about midday out of sunshine, and at the same time are perfectly sheltered from any wind.

One of these plants, *Radula lindbergii*, which is a new record for Ireland, was also found on the island at Toormore in a spot very different from its peaceful habitat here in Curraun.

2. FIELD-WORK.

Previous to this survey no bryologist is known to have visited Clare Island, while the only portion of the mainland included in the area which had been worked for Mosses and Hepatics was Achill Island, which, from 1901 to 1908, had been examined with fairly satisfactory results. The visits, the results of which are herein scheduled, were—

H. W. Lett—	Achill Island,	1901-8,	6 weeks.
,,	do.	1909,	1 week.
,,	do.	1910,	1 week.
,,	Westport and Louisburgh,	1910,	2 weeks.
,,	Clare Island,	1909,	2 weeks.
,,	do.	1910,	1 week.
W. H. Pearson—	Achill and Curraun,	1909,	2 days.
,,	Newport,	1909,	1 day.
D. McArdle—	Achill,	1909,	1 day.
,,	Clare Island,	1909,	5 days.
,,	Louisburgh,	1909,	2 days.
C. H. Waddell—	Westport,	1909,	6 days.
,,	Croaghpatrick,	1909,	1 day.
,,	Achill,	1909,	1 day.

D. A. Jones J. C. Wilson J. B. Duncan S. J. Owen	Achill Island,	1911,	1 week.
R. Ll. Praeger—	Croaghmore, Croaghpatrick,	On several occasions during the survey.	
„	Westport,		

The numbers of species and varieties collected by each of those who took part in the field-work were as follows :—

	Mosses.	Hepatics.
H. W. Lett,	220	115
W. H. Pearson,	0	54
D. M'Ardle,	82	48
C. H. Waddell,	171	52
D. A. Jones & Co.,	119	81
R. Ll. Praeger,	45	28

In the identification of species much valuable assistance was rendered by Messrs. H. N. Dixon, W. Ingham, J. A. Wheldon, W. H. Pearson, and S. M. MacVicar.

3. THE FLORA.

The numbers of species that were found during the survey are distributed as follows :—

	Mosses.	Hepatics.
Found only on Clare Island,	20	16
„ „ the mainland,	71	37
„ on both island and mainland,	130	74
Total found on island,	150	90
„ „ in the area surveyed,	221	127

Seven species of Hepatics, *Dilaena flotoviana*, *Aneura multifida* var. *submersa major*, *Radula lindbergii*, *Marsupella jorgensenii*, *Marsupella pearsoni*, *Marsupella aquatica*, and *Cephalozia striatula*, collected during the survey, are new records for Ireland. *Scapania nimbosa* is a new record for West Mayo; this plant has been found hitherto in Ireland in only one other station, viz. Brandon Mountain in South Kerry, where, as also on Slievemore, it is very scarce. *Riccia sorocarpa* is also a new record for Mayo, and like the preceding has been found hitherto in but one Irish station, near Dingle in S. Kerry, and in both localities it is very scarce.

The Mosses of most frequent occurrence on the island are—*Mnium hornum*, *Leucobryum glaucum*, *Glyphomitrium polyphyllum*, *Campylopus atrovirens*, *Campylopus flexuosus*, *Campylopus pyriformis*, *Stereodon cupressiforme*, *Isothecium myosuroides* (this last plant was much more common than *cupressiforme*, whose place it occupied on stones and at the bottom of fences), *Hypnum velutinum*, *Grimmia hypnoides*, *Acrocladium cuspidatum*, *Hylocomium squarrosum*.

The Hepatics of most frequent occurrence on the island are—*Pellia epiphylla*, *Frullania tamarisci*, *Scapania resupinata*, *Lepidozia setacea*, *Diplophyllum albicans*, *Metzgeria furcata*, *Jungermania ventricosa*, *Jungermania incisa*.

On the summit of Croaghmore (1520–1430 feet) the following were collected amongst the Ling and *Juncus squarrosus*:—

Sphagnum acutifolium.
Polytrichum urnigerum.
commune.
Campylopus flexuosus.
Dicranum scoparium.
var. orthophyllum.
Grimmia hypnoides.
Mnium hornum.
Gymnocybe palustris.
Scapania resupinata.
Kantia trichomanis.
Frullania tamarisci.
Aneura sinuata.
Thuidium tamariscifolium.
Isothecium viviparum.
Plagiothecium undulatum.
Hypnum purum.
Stereodon cupressiforme.
var. ericetorum.
Hylocomium parietinum.
loreum.
squarrosum.
proliferum.
Diplophyllum albicans.
Jungermania ventricosa.
lyoni.
incisa.

On the summit of Slievemore (2204 feet), which is the nearest high elevation on the mainland, the Mosses and Hepatics found were the following:—

Grimmia hypnoides.
Gymnocybe palustris.
Dicranum scoparium.
Campylopus pyriforme.
atrovirens.
Ceratodon purpureum.
Sphagnum rubellum.
Hylocomium loreum.
parietinum.
proliferum.
squarrosum.

The first of the above is the prevailing moss on this summit. Mr. Praeger was misled into stating in his very interesting paper on the Flora of Achill in the "Irish Naturalist" for November, 1904, that the predominating mosses

on Slievemore summit are *Hylocomium squarrosum* and *Antitrichia curtipendula.* The last-named was not found by Messrs. D. A. Jones and party in 1911, or by myself in 1908 and 1909, when it was specially looked for on Slievemore.

Along the ridge up Slievemore, described above, grow *Radula aquilegia, Mastigophora woodsii, Blepharozia ciliaris, Marsupella jorgensenii, Hylocomium umbratum, Dicranum uncinatum, Dicranum scottii, Dicranum fuscescens, Scapania ornithopodioides, Scapania nimbosa,* and several Lejeunias.

Lejeunias are very scarce on Clare Island, where they seem to be unable to contend with the climate and environment.

No Gymnomitrium has been found in the area, and only one Andreaea in very small quantities on Slievemore and near Louisburgh.

On Slievemore Mr. Pearson and H. W. Lett found two great clumps of *Scapania ornithopodioides* with which there was scarcely a stem of anything else mixed; one measured 2 feet by 9 inches, and the other 3½ feet by 18 inches, the individual stems being all of luxuriant growth.

The Newport and Westport district, situated on the limestone, and with a good deal of wood, was disappointing, the arboreal and calcicole species being remarkable by their absence. *Hypnum crassinerve* is the only species of the latter group that was found, and *Riccia sorocarpa* was collected by Mr. Praeger at Belclare, near Westport. Knockranny wood, along the stream to the east of Westport, was not more productive.

The plants of Croaghpatrick are few, and nothing rare was found upon it. In the Louisburgh district the flora is also poor in numbers, and is made up chiefly of what were collected in the wood at Old Head, amongst which was the rare *Radula holtii,* which had been collected in 1901, not far off, on Bengorm, in this botanical division, by H. W. Lett.

The Hypnaceae are scarce on the island; and of *Marchantia polymorpha* only one colony was seen; it was in a little gully near the sea-shore south of Knocknaveen.

4. ORIGIN OF THE FLORA.

The few miles which Clare Island is distant from the mainland do not create any difficulty in holding that the Mosses and Hepatics were all introduced to the island by the wind carrying their spores across the separating strait. The only introduced species met with in the whole area was *Lunularia cruciata,* which Mr. Pearson found in abundance on rocks near the quay at Newport, where it is doubtless, as it is in its other Irish habitats, an escape from some greenhouse in the neighbourhood.

5. LIST OF THE FLORA.

The nomenclature used for the purposes of this paper is that of Dr. Braithwaite's Sphagnaceae and his British Moss Flora, and of Lett's List of Species of British Hepatics.

In this present list, the names with "I" prefixed are those of plants collected only on Clare Island, and names with "M" prefixed are those of plants collected only on the mainland (including Achill as already stated). The others are those of plants found on both Clare Island and the mainland.

Mosses.

Sphagnum cymbifolium.
papillosum.
M *var.* confertum.
rigidum.
var. compactum.
molluscum.
subsecundum.
var. contortum.
obesum.
M viride.
M squarrosum.
M *var.* imbricatum.
acutifolium.
var. rubellum.

Sphagnum acutifolium,
I *var.* tenellum.
M gracile.
purpureum.
I quinquefarium.
fuscum.
luridum.
laetevirens.
subnitens.
intermedium.
I *var.* pulchrum.
cuspidatum.
I *var.* falcatum.
plumosum.

M Andreaea petrophila.
M rothii.
M *var.* falcata.
M Georgia pellucida.
M Catharinea undulata.
Polytrichum subrotundum.
aloides.
urnigerum.
piliferum.
juniperinum.
strictum.

Polytrichum attenuatum.
gracile.
commune.
Fissidens viridulus.
I bryoides.
osmundoides.
adiantoides.
I decipiens.
taxifolius.
Leucobryum glaucum.
M Archidium alternifolium.
M Pleuridium subulatum.

M Ditrichum homomallum.
flexicaule.
Dicranella heteromalla.
M *var.* interrupta.
I cerviculata.
M Anisothecium rubrum.
M rufescens.
squarrosum.
Blindia acuta.
M Didymodon denudatus.
var. alpinum.
Campylopus pyriformis.
fragilis.
M subulatus.
schwarzii.
flexuosus.
var. paradoxus.
atrovirens.
I *var.* epilosus.
M introflexus.
brevipilus.
Dicranum majus.
scoparium.
var. orthophyllum.
spadiceum.
alpestre.
bonjeani.
var. rugifolium.
M fuscescens.
M *var.* congestum
scottii.
M uncinatum.
Dichodontium pellucidum.
var. fagimontanum.
Ceratodon purpureus.
M Pottia heimii.
M truncatula.
M intermedia.
M Tortula aloides.
I marginata.
muralis.
M subulata.
M Tortula angustata.
M laevipila.
M montana.
M ruralis.
var. arenicola.
M Mollia crispa.
M tortilis.
viridula.
I tenuis.
aeruginosa.
verticillata.
crispula.
litoralis.
brachydontia.
M flavovirens.
M tenuirostris.
nitida.
tortuosa.
fragilis.
Barbula curvirostris.
rubella.
M *var.* ruberrima.
M lurida.
brevifolia.
fallax.
I *var.* brevifolia.
M rigidula.
cylindrica.
M *var.* vinealis.
revoluta.
convoluta.
M *var.* sardoa.
unguiculata.
Leersia extinctoria.
M contorta.
Grimmia apocarpa.
maritima.
pulvinata.
trichophylla.
M elliptica.
M patens.
acicularis.

Grimmia aquatica.
M affinis.
M *var.* gracilescens.
heterosticha.
fascicularis.
hypnoides.
canescens.
Glyphomitrium polyphyllum.
Anoectangium mougeotii.
Pleurozygodon aestivus.
M Zygodon stirtoni.
viridissimus.
M conoideus.
M Orthotrichum anomalum.
M *var.* cylindricum.
M diaphanum.
Weissia americana.
I ulophylla.
M *var.* intermedia.
M crispula.
phyllantha.
M Splachnum ampullaceum.
M pedunculatum *var.* sphaericum.
M Tetraplodon bryoides.
M Amblyodon dealbatus.
Funaria fascicularis.
obtusa.
attenuata.
hygrometrica.
M Pohlia acuminata.
nutans.
albicans.
M Bryum filiforme.
I concinnatum.
inclinatum.
intermedium.
M bimum.
I pallescens.
caespiticium.
argenteum.
I murale.
alpinum.
Bryum pallens.
ventricosum.
capillare.
Philonotis fontana.
I *var.* falcata.
M calcarea.
Breutelia chrysocoma.
Aulacomnion palustre.
Mnium hornum.
M cuspidatum.
M rostratum.
I undulatum.
subglobosum.
punctatum.
M *var.* elatum.
Thuidium tamariscifolium.
M delicatulum.
Amblystegium filicinum.
I fluviatile.
serpens.
M riparium.
chrysophyllum.
M protensum.
stellatum.
glaucum.
I falcatum.
M sendtneri.
revolvens.
I exannulatum.
I fluitans.
I kneiffii.
I scorpioides.
Hypnum palustre.
M cordifolium.
sarmentosum.
M stramineum.
purum.
striatum.
M pallidirostre.
praelongum.
M swartzii.
M crassinervium.

M Hypnum tenellum.
rusciforme.
I *var.* atlanticum.
M confertum.
velutinum.
pseudoplumosum.
M *var.* homomallum.
viride.
M *var.* majus.
rutabulum.
rivulare.
M *var.* chrysophyllum.
albicans.
lutescens.
sericeum.
Isothecium myosuroides.
viviparum.
M Pterogonium ornithopodioides.
M Heterocladium heteropterum.
M Hylocomium umbratum.
M brevirostre.
proliferum.
parietinum.
triquetrum.
squarrosum.
Hylocomium loreum.
Ctenidium molluscum.
M Hyocomium flagellare.
M Stereodon cupressiforme.
M *var.* tectorum.
uncinatulus.
ericetorum.
elatus.
filiformis.
resupinatus.
M callichrous.
M Isopterygium elegans.
M pulchellum.
Plagiothecium undulatum.
denticulatum.
silvaticum.
Acrocladium cuspidatum.
Pterygophyllum lucens.
Porotrichum alopecurum.
M Neckera complanata.
I crispa.
M Climacium dendroides.
M Fontinalis antipyretica.
M squamosa.
Hedwigia albicans.

The following are the rarer Mosses in the foregoing list, with the localities and names of the collectors :—

Sphagnum papillosum, var. *confertum*.—Achill (Jones & Co.).
S. intermedium, var. *pulchrum*.—Clare I. (Lett).
Andreaea rothii, var. *falcata*.—Slievemore (Jones & Co.).
Dicranella heteromalla, var. *interrupta*.—Slievemore (Jones & Co.).
Campylopus subulatus.—Dugort (Lett, Jones & Co.).
C. introflexus.—Dugort (Jones & Co.).
Dicranum bonjeani, var. *rugifolium*.—Clare I. (Lett, McArdle).
D. fuscescens, var. *congestum*.—Croaghpatrick (Praeger).
D. uncinatum.—Slievemore (Lett).
Fissidens decipiens.—Clare I. (Lett).
Barbula rubella, var. *ruberrima*.—Slievemore (Jones & Co.).

B. convoluta, var. *sardoa*.—Dugort (Jones & Co.).

Grimmia affinis, var. *gracilescens*.—Slievemore (Lett).

Zygodon stirtoni var.—Westport (Lett).

Z. conoideus.—Sraheens (Lett).

Amblyodon dealbatus.—Dugort (Jones & Co.).

Hylocomium umbratum.—Slievemore (Lett); recorded from only one other Irish locality (Co. Kerry).

Pterogonium ornithopodioides.—Shores of Lough Knockacurraun (Lett).

Stereodon cupressiforme, var. *uncinatulus*.—Slievemore (Lett); an addition to the Irish flora.

HEPATICS.

M Anthoceros punctatus.
M Riccia sorocarpa.
I Marchantia polymorpha.
Preissia commutata.
I Asterella hemispherica.
Conocephalus conicus.
M Dilaena flotoviana.
M Metzgeria furcata.
I *var.* prolifera.
conjugata.
hamata.
M Aneura palmata.
multifida.
I *var.* submersa major.
M major.
latifrons.
sinuata.
pinguis.
M Blasia pusilla.
Pellia epiphylla.
M endiviaefolia.
calycina.
M Codonia ralfsii.
Fossombronia angulosa.
M Colura calyptrifolia.
M Lejeunia microscopica.
M minutissima.
ulicina.
M hamatifolia.
Lejeunia ovata.
serpyllifolia.
M *var.* cavifolia.
heterophylla.
patens.
I Phragmicoma mackaii.
I Radula complanata.
lindbergii.
I carringtonii.
M aquilegia.
M holtii.
M Madotheca platyphylla.
Frullania tamarisci.
var. cornubica.
germana.
dilatata.
M fragilifolia.
microphylla.
M Pleurozia purpurea.
Diplophyllum albicans.
M dicksoni.
Scapania resupinata.
M laxifolia.
purpurascens.
nemorosa.
intermedia.
M aspera.
speciosa.
undulata.

Scapania subalpina.
M uliginosa.
M ornithopodioides.
M nimbosa.
irrigua.
curta.
umbrosa.
Marsupella emarginata.
M aquatica.
M jorgensenii.
M pearsoni.
Mylia taylori.
I anomala.
M Clasmatocolea cuneifolia.
Plagiochila asplenioides.
I *var.* humilis.
spinulosa.
var. inermis.
M flagellifera.
punctata.
M tridenticulata.
I exigua.
M Adelanthus decipiens.
M dugortiensis.
Lepidozia reptans.
pinnata.
setacea.
trichoclados.
M Blepharozia ciliaris.
M Mastigophora woodsii.
Blepharostoma trichophylla.
Herberta adunca.
Gymnocolea inflata.
Lophocolea bidentata.
I *var.* aquatica.
lateralis.
I spicata.
I heterophylla.
Harpanthus scutatus.
I Jungermania bantriensis.
var. mülleri.
Jungermania ventricosa.
porphyroleuca.
incisa.
lyoni.
gracilis.
M minuta.
pumila.
riparia.
M badensis.
M exsecta.
Anastrepta orcadensis.
Aplozia crenulata.
I gracillima.
I sphaerocarpa.
I Southbya obovata.
Alicularia scalaris.
Chiloscyphus polyanthos.
I *var.* rivularis.
Saccogyna viticulosa.
Kantia trichomanis.
sprengelii.
arguta.
M Cephalozia curvifolia.
francisci.
bicuspidata.
I lammersiana.
connivens.
lunulaefolia.
catenulata.
divaricata.
I stellulifera.
I striatula.
leucantha.
Odontoschisma sphagni.
Bazzania trilobata.
tricrenata.
deflexa.
pearsoni.
M Anthelia julacea.

The following are the rarer Hepatics in the foregoing list, with the localities and names of collectors :—

Riccia sorocarpa.—Belclare, near Westport (Praeger). The only other Irish locality for this is near Dingle.

Anthoceros punctatus.—Near Dugort (Lett). Rare.

Marchantia polymorpha.—Clare I. (A. D. Cotton). Not seen anywhere within the area except in this one locality, near Kill.

Asterella hemisphaerica,—Clare I. (Lett). Rare.

Dilaena flotoviana.—Achill I. (Jones & Co.). Not before found in Ireland. Very rare.

Aneura multifida var. *submersa major.*—Clare I. (Lett). Not hitherto recorded from any Irish locality.

Aneura sinuata.—Clare I. (Lett). Rare.

Blasia pusilla.—Curraun Achill (Lett). Not observed in any other locality.

Pellia endiviaefolia.—Achill (Lett and Jones & Co.). Rare.

Metzgeria hamata.—Clare I. (Lett), and Achill (Jones & Co.).

Codonia ralfsii.—Amongst sand-dunes at the north-east of Achill I. (Lett). Very rare.

Fossombronia angulosa.—On Clare I. near Maum (Lett); and on Achill I. near Dugort (Jones & Co.). Very rare.

Colura calyptrifolia.—Slievemore (Lett). Very scarce.

Lejeunia microscopica.—Slievemore (Pearson and Lett).

Radula lindbergii.—On vertical rocks at Toormore, Clare I., and on stones round Lough Knockacurraun (Lett). Not hitherto recorded from Ireland.

R. holtii.—Wood at Old Head near Louisburgh (McArdle). This plant, which was first found at Killarney by Lindberg, was found in West Mayo on north side of Bengorm, at Skirragohiffern, in 1901, by Lett. Very rare.

R. carringtonii.—Clare I. (Lett, McArdle, and Praeger). Rare.

Diplophyllum dicksoni.—Dugort (Jones & Co.). Very rare.

Scapania intermedia.—Clare I. (Lett). Very rare.

S. compacta.—Slievemore (Jones & Co.). Rare.

S. subalpina.—Clare I. and Slievemore (Lett). Rare.

S. ornithopodioides.—Slievemore (Lett). Very rare.

S. nimbosa.—Slievemore (Jones & Co.). A few stems amongst the preceding species. This station and Brandon mountain in Kerry are the only localities where these two fine Hepatics have hitherto been found in Ireland.

Scapania irrigua.—Slievemore (Lett; Jones, & Co.). Very rare.

Marsupella jorgensenii.—Slievemore (Pearson and Lett). This is an addition to theflora of Ireland. Extremely rare.

M. pearsoni.—Slievemore (Jones & Co.). Another addition to the flora of Ireland. Extremely rare.

M. aquatica.—Slievemore (Pearson and Lett). This also is an addition to the flora of Ireland. Very rare.

Mylia anomala.—Clare I. (Lett). This is a new record for West Mayo. Very rare.

Clasmatocolea cuneifolia.—Slievemore (Lett; Jones & Co.). Very rare.

Plagiochila exigua.—Clare I. (Lett). Rare.

Adelanthus dugortiensis.—New species, 1903. Found on Slievemore by Lett, and rediscovered at same place, 1911, by Jones' party.

Lepidozia trichoclados.—Clare I. (Lett).

Mastigophora woodsii.—Slievemore (Lett).

Lophocolea bidentata, var. *aquatica.*—Clare I. (Lett). Rare.

Harpanthus scutatus.—Slievemore (Pearson and Lett). Rare.

Jungermania bantriensis var. *mülleri.*—Clare I. (Lett). Very rare.

J. badensis.—Dugort (Jones & Co.). Very rare.

J. orcadensis.—Clare I. and Slievemore (Lett). Very rare.

Southbya obovata.—Clare I. (Lett and M'Ardle). Rare.

Chiloscyphus polyanthos, var. *rivularis.*—Clare I. and Slievemore (Lett). Very rare.

Kantia sprengelii.—Clare I. and Slievemore (Lett). Very rare.

Cephalozia stellulifera.—Clare I. (Lett).

C. leucantha.—Clare I. and Slievemore (Lett and M'Ardle). Rare.

C. lunulaefolia.—Clare I. (Lett). Extremely rare.

C. striatula.—Clare I. (Lett). Not hitherto recorded as found in Ireland. Extremely rare. Found growing in cushions of *Campylopus brevipilus.*

Bazzania pearsoni.—Slievemore (Pearson and Lett). A new record for the division of West Mayo. Rare.

Anthelia julacea.—Croaghpatrick (Praeger). This plant was not found elsewhere. Rare in the district.

6. BIBLIOGRAPHY.

(Arranged chronologically.)

MACKAY, James Townsend:

Flora Hibernica. Dublin, 1836.

In this well-known work, there is not a record of any Moss or Hepatic from a Co. Mayo locality.

MOORE, David:

A Synopsis of the Mosses of Ireland. Proc. R. I. Acad., Ser. 2, vol. i (Science), pp. 329–474, 1872.

The only record in this paper which refers to the area included in the present report is *Pottia heimii* from Westport.

Report on Irish Hepaticae. Proc. R. I. Acad., Ser. 2, vol ii (Science), pp. 591–672, 1876.

In this paper there are seven records of Hepatics from Co. Mayo, but the only one which comes near our area is "*Jungermania incisa*, Mweelrea." The others are from Nephin and further north in the county.

LETT, H. W.:

Mosses new to Ireland. Irish. Nat., vol. x., p. 196, 1901.

Records first discovery of *Dicranum uncinatum* in Ireland, the locality being Nephin in Co. Mayo.

List of all the species of Hepatics found in the British Islands. Pp. viii, 199. Printed for the Author, 1902.

Records 92 species found in Co. Mayo.

Mosses new to Ireland. Irish Nat., vol. xi, p. 149, 1902.

Records *Hylocomium umbratum* as found on Slievemore.

A new Hepatic. Journ. of Botany, vol., xlii, pp. 201–203, 1904.

Notices *Adelanthus dugortiensis*, Douin and Lett, a new Hepatic from Achill Island.

Mc Ardle, David:

A list of Irish Hepaticae. Proc. R. I. Acad., vol., xxiv, Sect. B., pp. 387–502, 1904.

Contains many records of Hepatics found in the area included in the Clare Island Survey, of which 58 are by the writer of the present report.

Praeger, R. Lloyd:

The Flora of Achill Island. Irish Nat., vol. xiii, pp. 265–289, 1904.

Mentions (p. 273) two Mosses as predominating on the summit of Slievemore.

13

FUNGI.

By CARLETON REA, B.C.L., M.A., and SIR HENRY C. HAWLEY, Bart.

Plate I.

Read January 22. Published March 6, 1912.

CONTENTS.

1. Preface.

The present report deals with the fungi observed by ourselves and others who were so good as to assist us, on Clare Island and the adjoining mainland. Though we both visited the district several times, we had no opportunity of working together, and our chief collecting was done in different areas and at different seasons, Carleton Rea exploring the Westport district, with excursions as far as Castlebar, Achill, and Belclare, while H. C. Hawley made Clare Island his headquarters, doing some collecting also about Achill Sound, Louisburgh, Belclare, and Westport. In view of these considerations, and the fact that the fungus floras of Westport and of Clare Island, the two areas chiefly studied, differ widely in character, we have thought it well to present our report in two sections, the one dealing with the island flora, and drawn up by H. C. Hawley, the other treating of the flora of the mainland, and presented by Carleton Rea.

The work of the Clare Island Survey was carried out in what, so far as Fungi are concerned, was a quite unexplored area. From the whole of the county of Mayo, indeed, only two species were on record when Adams and Pethybridge published their "Catalogue" in 1910.[1] In fact, in the same publication less than 100 species are assigned to the whole province of Connaught, out of 1,400 species recorded for Ireland. This arises from the

[1] A Census Catalogue of Irish Fungi. Proc. R. I. Acad., xxviii., Sect. B, No. 4.

fact that the greater part of the work on Fungi that has been done in Ireland has been carried out in the neighbourhoods of Dublin, Belfast, and Cork.

The total number of species and varieties which we are able to record from the Clare Island district is 802. As the detailed lists show, 295 species and 12 varieties prove to be new to the Irish Fungus Flora. Of these, eleven species are new to the flora of the British Islands; one new genus—Candelospora, Hawley—and one new species—*Hygrophorus* (*Limacium*) *squamulosus* Rea—are described.

It has been said that the lists from Clare Island and the mainland respectively differ widely in character. This is not surprising when we take into account the different types of ground which the two areas present. The island, some six square miles in area, is bare and wind-swept. A large proportion of it is under heather; the remainder consists of tilled land and poor pasture, with a few small patches of low scrub. While the western parts of the mainland in many parts resemble the island, it is not so about Westport, where most of the collecting was done. The ground here is in comparison sheltered and fertile; there is a fair amount of wood, mostly of mixed type, and the trees in places attain fine dimensions. The character of the fungus flora in these areas, so far as we have been able to explore it, is shown in the following table:—

Group.	Clare Island.	Mainland and Achill Island.
Plasmodiophoraceae	0	1
Phycomycetae	9	9
Hemiascomycetae	1	0
Euascomycetae	82	110
Hemibasidii	5	3
Protobasidiomycetae	26	31
Autobasidiomycetae	136	485
Fungi Imperfecti	24	28
	283	667

It will be noticed that the chief difference between the two lists occurs in the Autobasidiomycetae, where the numbers for the mainland and Achill Island are more than three and a half times as great as those for Clare Island. The following is the proportion of the species and varieties in the leading genera of this group met with in the two lists, and the numbers first mentioned are

from our mainland list: Hydnum eight against one, Poria seven against two, Polyporus eight against one, Boletus fourteen against two, Lepiota six against two, Tricholoma fifteen against one, Mycena thirty-eight against twelve, Omphalia eight against five, Entoloma eleven against five, Leptonia five against two, Nolanea four against one, Pholiota six against one, Inocybe ten against two, Naucoria eight against four, Galera five against three, Tubaria four against one, Hypholoma nine against one, Psathyra eight against two, Coprinus eleven against seven, Cortinarius forty-eight against eight, Hygrophorus twenty-three against fifteen, Lactarius twenty-seven against one, Russula thirty-two against two, and Lycoperdon six against one. The following important genera are absent from the Clare Island list: Fomes, Polystictus, Amanita, Amanitopsis, Armillaria, Clitocybe, Collybia, Pleurotus, Volvaria, Pluteus, Clitopilus, Hebeloma, Gomphidius, Cantharellus, and Nyctalis, although members of these genera are recorded in our mainland list. Over ninety species are recorded for Achill Island; and it is probable that if the fine wood at Glendarary on this island was efficiently worked, a large number of species would be obtained. Our visits have been few and far between, but it is clear that if the fungi of the extreme west of Ireland were diligently worked at many seasons of the year, a large number of additional species would be added to the still somewhat small list included in the "Census Catalogue of Irish Fungi." It is a remarkable fact that, although we so constantly worked in woods where Beeches were the dominant trees, we never found any examples of *Hypoxylon coccineum* (Bull.) Fr.

CLARE ISLAND.

2. Introduction.

The following list makes no pretension to be complete. It is based almost entirely on the results of three short visits paid by the writer. These were made from 20 to 27 August, 1909; for about a week from October 3, 1910; and from April 27 to May 4, 1911. Before the survey began its work, the only fungus recorded from the island appears to have been *Ustilago longissima*, found by Mr. R. Ll. Praeger on Glyceria. I have aimed at providing a record of the species prevalent on the island in the years 1909 to 1911. This is not the place to speak of the special difficulties of the recorder of fungi, but it may be safely said that, within certain limits, the mycologic flora of any given determinate area is sure to be a fluctuating one. The species of fungi have not only very wide areas of distribution, but they have great facilities for extending their areas at short notice; and there are sure to be some species dying out as they exhaust their special matrix,

and others arriving as their appropriate matrix is provided for them. To take an instance: some few not very thriving Sycamores have been planted in the hotel garden. These are at present free from the attacks of Rhytisma. But, if they live, they may at some future date add another fungus to the island list.

The list, as a consideration of it will show, is at present especially incomplete as regards such things as coprophilous fungi and minute Fungi Imperfecti.

As to the nature of the island, being separated from the mainland by only 3 miles of water, it may, from a mycological point of view, almost be regarded as an outlying portion of it. The greater part of the surface is barren heath or bog. Trees are almost everywhere absent. The nearest approach to woodland consists of two small areas of scrub on the N.E. side of the island, where stunted Birch, Hazel, and Sallow predominate. The rest of the area may be roughly divided into—(1) the more or less exposed pastures; (2) the cultivated area with its rather rank vegetation and weeds. No part of the island proved absolutely destitute of fungi. Right up to the cliff edge at the west end, the Plantago sward yielded *Bovista nigricans* and *Pleospora herbarum*. The sea-shore produced several species. One species at least was parasitic on lichens coating the most exposed rocks, and probably others occur on the same hosts. Another fungus was dredged up from the bottom of Clew Bay.

It would be of little value to attempt to account for the differences between our list for the island and that for the Clew Bay district on the mainland. The great determining factor, of course, is the presence or absence of woodland. No Pine or Beech grow on the island at the present time, and there is only one Oak. It was hoped at one time that a comparison with E. Rostrup's list of fungi occurring in the Faeröes might have proved interesting, as, while differing much in latitude, the Faeröes have much in common with Clare Island, *e.g.*, the absence of trees and the prevalence of wind and moisture during most of the year. But doubts as to the completeness of either list have rendered the undertaking rather disappointing. As E. Warming says (Botany of the Faeröes, vol. ii, p. 661), 168 species can scarcely adequately represent the mycological flora of the islands. Yet the few collectors, of whom Warming was one, seem to have shown remarkable acuteness in detecting minute species. Exactly one-fourth of the 168 species belong to the Fungi Imperfecti against one-thirteenth of the Clare Island list. Why are there only 20 Autobasidiomycetae recorded against 136 in our area, 2 Clavariae and 2 Hygrophori only against 14 and 15 respectively? Perhaps this is partly due to the fact that none of the collectors seems to

have been on the Faeröes later than September 4; Rostrup himself, the only professed mycologist, was not there later than September 2, and that as far back as 1867. Still it is worth while drawing attention to this apparent lack of pasture species in the Faeröes as compared with Clare Island, and to the great abundance of smuts recorded there.

Of the 168 species of the Faeröes, only 38 have been noted so far in Clare Island. The lists may be thus compared:—

	Clare Island.	Faeröes.
Phycomycetae,	9	8
Hemiascomycetae,	1	1
Euascomycetae,	82	54
Hemibasidii,	5	17
Protobasidiomycetae,	26	26
Autobasidiomycetae,	136	20
Fungi Imperfecti,	24	42
	283	168

The arrangement of the species in the following list is very nearly that adopted in Adams and Pethybridge's "Census Catalogue of Irish Fungi" (Proc. R.I. Acad., xxviii, sect. B, No. 4). The chief differences are that the species are no longer arranged alphabetically in the genera, and that the sixth edition of Engler's Syllabus has been followed in place of the fifth. In this list are enumerated two hundred and eighty-three species; one hundred and one of these are additions to the Irish Census Catalogue, and one hundred and thirty-five are not included in our list of the fungi found on the mainland and Achill Island. Eight of them are first records for the Britannic fungus flora, namely, *Ostracoblabe implexa*, Bonn. et Flah., *Urceolella aspera* (Fr.) Boud., *Rosellinia anthostomoides* Berl., *Epicymatia balani* Winter, *Phomatospora argentina* Spegg, *Diaporthe exasperans* Nitschke, *Diatrypella exigua* Wint., and *Coprinus Friesii* Q.; and one genus and species is new to science, *Candelospora ilicicola* Hawley. Two of the above are also recorded below for the mainland.

For assistance in collecting, I am indebted especially to Messrs. A. D. Cotton, J. Adams, R. Lloyd Praeger, and Miss Lorrain Smith of the British Museum; for help in determining species, again to Miss Lorrain Smith, and also to Messrs. W. B. Grove, C. Crossland, and A. D. Cotton. The last-named I have to thank for all the records of marine fungi.

3. List of Species.

* = New to Ireland. † = New to Britain. †† = New to science.
§ = Referred to in Notes at end of List.

PHYCOMYCETAE.

Mucor Mucedo (*L.*) *Fr.*
Cystopus candidus (*Pers.*) *Lév.*
Phytophthora infestans (*Mont.*) *de B.*
Plasmopora densa (*Rabh.*) *Schroet.*
*Peronospora Ficariae *Tul.*
* grisea (*Unger*) *de B.*
calotheca *de B.*
effusa (*Grev.*) *Rabh.*
†§Ostracoblabe implexa *Bonn. et Flah.*

HEMIASCOMYCETAE.

Protomyces macrosporus *Unger.*

EUASCOMYCETAE.

Penicillium glaucum *Link.*
Podosphaera oxyacanthae (*DC.*) *de B.*
Erysiphe cichoracearum *DC.*
* Pisi *DC.*
Galeopsidis *DC.*
Trochila Ilicis *Fr.*
Rhytisma salicinum (*Pers.*) *Fr.*
Heterosphaeria Patella (*Tode*) *Grev.*
Hypoderma virgultorum *DC.*
Peziza badia (*Pers.*) *Fr.*
Humaria granulata (*Bull.*) *Sacc.*
* subhirsuta (*Schum.*) *Mass.*
Ascobolus argenteus *Boud.*
Sclerotinia sclerotiorum *Lib.*
Lachnum virgineum (*Batsch*) Karst.
†§Urceolella aspera (*Fr.*) *Boud.*
Hymenoscypha cyathoidea (*Bull.*) *Phill.*
* dumorum (*Rob.* et *Desm*) *Schroet.*
*Erinella Nylanderi *Rehm.*
apala (*B. et Br.*) *Mass.*
Helotium citrinum (*Hedwg.*) *Fr.*
scutula (*Pers.*) *Karst.*
*§ terrigenum *Cke. et Phill.*
* rhodoleucum *Fr.*
Coryne sarcoides (*Jacq.*) *Tul.*
Mollisia cinerea (*Batsch*) *Karst.*
atrata *Karst.*
*Belonidium deparculum (*Karst.*) *Mass.*
Calloria fusarioides (*Berk.*) *Fr.*
Patellaria atrata (*Hedwg.*) *Fr.*
*§Microglossum atropurpureum (*Pers.*) *Karst.*
Geoglossum ophioglossoides (*L.*) *Sacc.*
Leotia lubrica (*Scop.*) *Fr.*
Helvella lacunosa *Afzel.*
* pezizoides *Afzel.*
Nectria sanguinea *Fr.*
* mammoidea *Phill. et Pl.*
Hypocrea rufa (*Pers.*) *Fr.*
Cordyceps militaris (*L.*) *Link.*
entomorrhiza (*Dicks.*) *Fr.*
*Rhopographus pteridis (*Sow.*) *Wint.*
*Phyllachora junci (*Fr.*) *Fuck.*
*Sordaria decipiens, *Wint.*
*Sporormia intermedia *Auersw.*
Chaetosphaeria tristis (*Tode*) *Schroet.*
†Rosellinia anthostomoides *Berl.*
Clavariarum (*Tul.*) *Schroet.*
Melanomma pulvis-pyrius (*Pers.*) *Fuck.*
*Trematosphaeria pertusa (*Pers.*) *Fuck.*
* mastoidea (*Fr.*) *Wint.*
*Lophiostoma caulinum (*Fr.*) *de Not.*
* Arundinis (*Fr.*) *Ces. et de Not.*

*Platystomum compressum (*Pers.*) *Sacc.*
Stigmatea Rumicis (*Desm.*) *Schroet.*
Mycosphaerella brassicicola (*Duby*) *Lindau.*
* Tassiana (*de Not.*) *Johann.*
* Ascophylli *Cotton.*
†§Epicymatia Balani *Winter.*
Tichothecium pygmaeum *Körb.*
*Didymosphaeria diplospora (*Cke.*) *Rehm.*
Leptosphaeria Doliolum (*Pers.*) *Ces. et de Not.*
acuta (*Moug. et Nestl.*) *Karst*
* derasa (*B. et Br.*) *Auersw.*
* Michotii (*Westend.*) *Sacc.*
culmifraga (*Fr.*) *Ces. et de Not.*
* Chondri (*Rostr.*) *Rosenv.*
*Pleospora vulgaris *Niessl.*
herbarum (*Pers.*) *Rabh.*
*Ophiobolus acuminatus (*Sow.*) *Duby.*
†§Phomatospora argentina *Spegg.*
*Clypeosphaeria Notarisii *Fuck.*
Valsa lata (*Pers.*) *Nitschke.*
* heteracantha *Sacc.*
*Diaporthe pulla *Nitschke.*
† exasperans *Nitschke.*
* salicella (*Fr.*) *Sacc.*
*Melanconis stilbostoma (*Fr.*) *Tul.*
*Cryptospora corylina (*Tul.*) *Fuck.*
Diatrype stigma (*Hoffm.*) *de Not.*
†Diatrypella exigua *Wint.*
Hypoxylon multiforme *Fr.*
Xylaria hypoxylon (*L.*) *Grev.*

HEMIBASIDII.

Ustilago nuda (*Jens.*) *Kellerm et Swingle.*
Avenae (*Pers.*) Jens.
* violacea (*Pers.*) *Fuck.*
* utriculosa (*Nees*) *Tul.*
longissima *Sow.*

PROTOBASIDIOMYCETAE.

Melamspora farinosa (*Pers.*) *Schroet.*
* orchidi-repentis *Kleb.*
Lini (*Pers.*) *Tul.*
Hypericorum (*DC.*) *Schroet.*
pustulata (*Pers.*) *Schroet.*
Melamsporidium betulinum (*Pers.*) *Kleb.*
*Uromyces Poae *Rabh.*
Trifolii (*Hedwg.*) *Lév.*
Puccinia Caricis (*Schum.*) *Rebent.*
Phragmitis (*Schum.*) *Körn.*
obscura *Schroet.*
suaveolens (*Pers.*) *Rostr.*
* Centaureae *Mart.*
Violae (*Schum.*) *DC.*
Menthae (*Pers.*)
* Sonchi *Rob.*
* Chrysosplenii *Grev.*
Saxifragae *Schlecht.*
Baryi (*B. & Br.*) *Wint.*
graminis *Pers.*
Phragmidium Fragriastri (*DC.*) *Plow.*
violaceum *Wint.*
Triphragmium Ulmariae *Link.*
Coleosporium Euphrasiae (*Schum.*) *Wint.*
Sonchi (*Pers.*) *Lév.*
Senecionis (*Pers.*) *Fr.*

AUTOBASIDIOMYCETAE.

Dacryomyces stillatus *Nees.*
deliquescens (*Bull.*) *Duby.*
Tomentella fusca (*Pers.*) *Schroet.*
Corticium Sambuci (*Pers.*) *Fr.*
* lividum (*Pers.*) *Fr.*
Thelephora anthocephala (*Bull.*) *Fr.*
Cyphella Pimii *Phill.*
Solenia anomala *Fr.*
*Hymenochaete fuliginosa *Lév.*
Typhula gyrans (*Batsch*) *Fr.*
*Clavaria amethystina (*Bull.*) *Fr.*
* muscoides (*L.*) *Fr.*
persimilis *Cotton.*

Clavaria cinerea (*Bull.*) *Fr.*
* umbrinella (*Berk.*) *Sacc.*
cristata (*Pers.*) *Fr.*
* Kunzei *Fr.*
fusiformis (*Sow.*) *Fr.*
* luteo-alba *Rea.*
dissipabilis *Britz.*
straminea *Cotton.*
vermicularis (*Scop.*) *Fr.*
* fumosa (*Pers.*) *Fr.*
acuta (*Sow.*) *Fr.*
*Grandinia crustosa (*Pers.*) *Fr.*
Hydnum niveum (*Pers.*) *Fr.*
Merulius corium (*Pers.*) *Fr.*
Poria vaporaria (*Pers.*) *Fr.*
vulgaris *Fr.*
Polyporus elegans (*Bull.*) *Fr.*
Boletus luridus (*Schaeff.*) *Fr.*
scaber (*Bull.*) *Fr.*
Lepiota granulosa (*Batsch.*) *Fr.*
amianthina (*Scop.*) *Fr.*
Tricholoma panaeolum *Fr.*
Laccaria laccata (*Scop.*) *Berk.*
Mycena olivaceo-marginata *Mass.*
* luteo-alba (*Bolt.*) *Fr.*
* flavo-alba (*Bull.*) *Fr.*
rugosa (*Bull.*) *Fr.*
pullata *Berk. et Cke.*
peltata *Fr.*
filopes (*Bull.*) *Fr.*
vitilis (*Bull.*) *Fr.*
rorida *Fr.*
stylobates (*Pers.*) *Fr.*
tenerrima *Berk.*
capillaris (*Schum.*) *Fr.*
*Omphalia sphagnicola *Berk.*
* oniscus *Fr.*
§ umbellifera (*L.*) *Fr.*
fibula (*Bull.*) *Fr.*
integrella (*Pers.*) *Fr.*
*Entoloma prunuloides *Fr.*
* Bloxami *Berk.*
Entoloma jubatum *Fr.*
costatum *Fr.*
sericeum (*Bull.*) *Fr.*
Leptonia lampropoda (*Scop.*) *Fr.*
* asprella *Fr.*
Nolanea pascua (*Pers.*) *Fr.*
Eccilia griseo-rubella (*Lasch.*) *Fr.*
Claudopus variabilis (*Pers.*) *W. G. Smith.*
*Pholiota pumila *Fr.*
Inocybe rimosa (*Bull.*) *Fr.*
eutheles *B. & Br.*
*Naucoria tabacina (*DC.*) *Fr.*
* Myosotis *Fr.*
pediades *Fr.*
semi-orbicularis (*Bull.*) *Fr.*
Galera tenera (*Schaeff.*) *Fr.*
hypnorum (*Schrank.*) *Fr.*
* mycenopsis (*Hoffm.*) *Fr.*
*Tubaria stagnina *Fr.*
*Crepidotus Phillipsii *B. & Br.*
Psalliota campestris (*L.*) *Fr.*
*Stropharia merdaria *Fr.*
stercoraria *Fr.*
semiglobata (*Batsch.*) *Fr.*
Hypholoma dispersum *Fr.*
hydrophilum (*Bull.*) *Fr.*
Psilocybe ericaea (*Pers.*) *Fr.*
* uda (*Pers.*) *Fr.*
bullacea (*Bull.*) *Fr.*
semilanceata *Fr.*
foenisecii (*Pers.*) *Fr.*
*Psathyra semivestita (*B. & Br.*) *Sacc.*
* fibrillosa (*Pers.*) *Fr.*
Anellaria separata (*L.*) *Fr.*
Panaeolus phalenarum (*Bull.*) *Fr.*
* retirugis (*Batsch*) *Fr.*
papilionaceus (*Bull.*) *Fr.*
campanulatus (*L.*) *Fr.*
Psathyrella gracilis (*Pers.*) *Fr.*
atomata *Fr.*
Coprinus atramentarius (*Bull.*) *Fr.*

*Coprinus fimetarius (*L.*) *Fr.*
micaceus (*Bull.*) *Fr.*
* Hendersonii *Berk.*
radiatus (*Bolt.*) *Fr.*
† Friesii *Q.*
plicatilis (*Curt.*) *Fr.*
Bolbitius tener *Berk.*
*Cortinarius triumphans *Fr.*
anomalus *Fr.*
uliginosus *Berk.*
torvus (*Bull.*) *Fr.*
* biformis *Fr.*
iliopodius (*Bull.*) *Fr.*
paleaceus (*Weinm.*) *Fr.*
* obtusus (*Weinm.*) *Fr.*
Paxillus involutus (*Batsch.*) *Fr.*
Hygrophorus pratensis (*Pers.*) *Fr.*
virgineus (*Wulf.*) *Fr.*
* fornicatus *Fr.*
ovinus (*Bull.*) *Fr.*
laetus (*Pers.*) *Fr.*
ceraceus (*Wulf.*) *Fr.*
coccineus (*Schaeff.*) *Fr.*
miniatus *Fr.*
puniceus *Fr.*
obrusseus *Fr.*
conicus (*Scop.*) *Fr.*
calyptraeformis *Berk. et Br.*
chlorophanus *Fr.*
psittacinus (*Schaeff.*) *Fr.*
unguinosus *Fr.*
Lactarius pyrogalus (*Bull.*) *Fr.*
Russula nigricans (*Bull.*) *Fr.*
adusta (*Pers.*) *Fr.*
Marasmius oreades (*Bolt.*) *Fr.*
ramealis (*Bull.*) *Fr.*
Androsaceus rotula (*Fr.*) *Pat.*
Lycoperdon perlatum *Pers.*
Bovista nigrescens *Pers.*
Scleroderma vulgare *Hornem.*

FUNGI IMPERFECTI.

I. *Sphaeropsidales.*

*Phoma longissima (*Pers.*) *Westend.*
* obtusata (*Fr.*) *Sacc.*
* suspecta *Mass.*
*Septoria Epilobii *West.*
* Hederae *Desm.*
* scabiosicola *Desm.*
* Convolvuli *Desm.*
*Cytospora Salicis (*Cord.*) *Rabh.*
*Hendersonia arundinacea (*Desm.*) *Sacc.*

II. *Hyphomycetae.*

Oospora microsperma *B. & Br.*
*Aspergillus dubius *B. & Br.*
Botrytis cinerea (*Pers.*) *Fr.*
Sepedonium chysospermum (*Nees.*) *Fr.*
§Candelospora *gen. nov.*
††§Candelospora ilicicola *Hawley.*
Torula herbarum *Link.*
ovalispora *Berk.*
*Periconia pycnospora *Fres.*
Menispora ciliata *Cord.*
Cladosporium herbarum *Link.*
*Helminthosporium rhopaloides *Fres.*
*Brachysporium apicale (*B. et Br.*) *Sacc.*
*Acrothecium simplex *B. & Br.*
*Isaria arachnophila (*Ditm.*) *Sacc.*
*Harpographium graminum *Cke. et Mass.*

4. Notes on the List.

Ostracoblabe implexa Bonn. et Flah.

Found on old shells dredged from the floor of Clew Bay. The locality was almost certainly in shallow water (5–7 fathoms) off Mulranny.

Urceolella aspera (Fr.) Boud.

Said by Mons. Boudier (Ic. Myc., iv, p. 313) to be common all the year round on dead stems of Osmunda. His name is adhered to, as the place it should occupy under Engler and Prantl's arrangement is doubtful.

Helotium terrigenum Cke. et Phill.

Phillips in his "British Discomycetes" united this with *H. pileatum* Karst., and Mons. Boudier does not refer to *H. terrigenum* in his "Discomycetes d'Europe"; but as there appears room for doubt whether the two are identical, I have followed Massee ("British Fungus Flora," iv, p. 238) in retaining the name *terrigenum*, with the description of which species my fungus agrees well.

Microglossum atropurpureum Karst.

My specimens were variable in size and shape, often distorted, sometimes soft and tremelloid after rain, generally blackish above, rather date-brown below. The spores measured $23-40 \times 6-7\ \mu$, were guttulate but not septate; it is probable that when mature they would become so. Miss Lorrain Smith records this from the Isle of Arran (Trans. Brit. Myc. Soc., 1909, p. 220), but with spores only up to $33\ \mu$ long. Durand (Ann. Myc., 1908, p. 414), who united *Geoglossum microsporum* Cke. et Peck and *G. tremellosum* Cke. with *atropurpureum* (Pers.), gave the spores of Persoon's plant as $25-35 \times 3-4\ \mu$ and 10-septate. It is probable they are variable, and vary as they mature. But if Durand's statement is accepted as correct, these plants must only be regarded doubtfully as immature *atropurpureum* (Pers.).

Epicymatia Balani Wint.

First described by Winter in a note to an article by Hariot (Journ. de Bot. 1887, p. 233) as occurring on *Brachytrichia Balani* at St. Malo. The Clare Island specimens were on crumbling tests of *Balanus balanoides*, more or less overgrown and permeated by *Rivularia atra*. As to this and the

closely allied, if not identical, *Pharcidia marina* Bomm., cf. Trans. Brit. Myc. Soc., 1908, p. 98. This species might perhaps be placed in the genus Mycosphaerella.

Phomatospora argentina Spegg.

Clearly separated from the common *P. Berkeleyi* by the larger asci and spores. The latter measured 12 – 13 × 3·5 – 4·5 μ. It was collected by Mr. A. D. Cotton on dead stems of *Betu maritima*, on the Bills, a group of small rocks some nine miles north-west of Clare Island. This species does not seem to have been recorded outside South America before, but it only differs in small points from the continental *Phomatospora ovalis* (Pass.) Sacc. with which it may be identical. It may be interesting to record that on these few stems also occurred *Pleospora vulgaris*, an undetermined Sphaeropsid, and some scattered conidia of a Fusarium type.

Omphalia umbellifera Fr.

On the hillsides a dwarf form occurs, altogether of a bright golden yellow, which was referred here. Spores 8 – 10 × 3·5 – 4 μ.

Hygrophorus obrusseus Fr.

The specimens to which I have given this name, and which were rather plentiful on the slopes of Knocknaveen, differed from typical *obrusseus* in the greenish sulphur-yellow of every part except the apex, which was often tinged sienna. They also with age often become grey or brownish in patches on the pileus, suggesting *H. intermedius* Pass. Spores 8 – 10 × 4·5 – 5 μ. Smell not mealy. Also noticed on the slopes of Croaghpatrick on the mainland.

CANDELOSPORA gen. nov.

Hyphae steriles repentes. Conidiophoris erectis, septatis, hyalinis, irregulariter ramosis vel etiam simplicibus, supra penicillatim divisis. Conidiis singulis in *ultimis* ramulis ortis, hyalinis, multiseptatis.

This genus differs from Mucrosporium in its penicillate branching, and in its conidia produced singly at the tips of the branchlets.

Candelospora ilicicola Hawley.

Conidiophoris gregariis, circa 100 μ altis, 7 μ crassis, varie ramosis vel etiam simplicibus, ramis ad apices plerumque tris divisis, ultimis ramulis

minutis. Conidiis triseptatis, cylindricis, obtusis, 50 – 60 × 6 – 7 μ, capitulum in muco involutum formantibus.

Habitat.—Ad folia emortua, *Ilicis Aquifolium.*

Forming small scattered white tufts over the upper side of the leaf. The fertile hyphae seem often quite over-weighted with the large irregularly-shaped heads of mucus containing the relatively large conidia. When free of the mucus, the conidia stand up side by side like so many candles. Part of type specimen deposited in the British Museum, South Kensington.

MAINLAND AREA.

5. Introduction.

In the autumn of 1910 I was requested to join in the investigation of the fungi growing in the neighbourhood of Westport in connexion with the Clare Island Survey, but owing to domestic affairs I was unable to proceed there before the 16th November. On my arrival at Westport I found from two to three inches of snow on the ground, although I had been assured before my departure that night frosts were not to be expected in the west of Ireland before Christmas. The snow thawed rapidly, but in some places it remained for a considerable time, especially on the higher ground. During this visit I searched the park and woods adjoining Westport House, Belclare and Prospect House woods, Cloonagh Wood, Derrygorman woods, the Old Deer-park wood, and other woods at Mount Browne; Knocknanny wood close to Westport railway station; and the woods near to Kilboyne House, Castlebar. Most of the woods were of a mixed character, consisting of Beech, Oak, Pine, Sycamore, Holly, and Alder. The Kilboyne House woods, some four or five miles south of Castlebar, are made up, almost exclusively, of scrub Hazel, about 8 to 12 feet in height, intermixed with lower Blackthorn bushes, and the intervening ground rough with large stones. These woods proved to be very unproductive and unworthy of another visit. During my stay at Westport, which continued until the 23rd November, about 180 species of fungi were observed, of which nearly thirty were additions to the "Census Catalogue of Irish Fungi." In 1911 I visited Westport in company with my wife and Miss Gulielma Lister, F.L.S., from 3rd to 12th October. In addition to the woods already enumerated, which we revisited, we investigated Brackloon wood on two days, Achill Island, and Croaghpatrick. Brackloon wood is an ideal wood for fungi; it consists of a mixture of Oak, Beech, Pine, Sycamore, Holly, and Alder, whilst the ground is covered with an abundance of leaf-mould, and many interesting species were observed there. Both of

my visits to Westport were made after an exceptionally dry time. In 1910 the months of September and October were the driest that had been known there for many years. The general prevailing dampness of the atmosphere is so great that all tree-stumps are quickly covered over with a dense felt of mosses; and dead wood, fallen branches, fungi, and leaves rapidly decay and produce many ascophores of *Chlorosplenium aeruginosum* (Oed.) de Not, *Coryne sarcoides* (Jacq.), *Xylaria hypoxylon* (Linn.) Grev., and *Ustulina vulgaris* Tul., whilst the old hollow trunks of Beech and other trees are carbonized and stained black by the mycelia of these two last species. Few specimens could be found in the woods facing north, and hardly any dead leaves remained beneath the Holly trees. In 1911 still drier conditions had prevailed, and hardly any rain had fallen at Westport during the months of May, June, July, and August, and only a small quantity towards the latter half of September. We found, however, a good growth of fungi in Brackloon woods, the Old Deer-park wood at Mount Browne, Knocknanny Wood, and the pine wood on Achill Island, but scarcely any in the woods adjoining the Westport House demesne, Prospect House woods, Belclare, and Cloonagh wood. In 1898 my wife and I spent a fortnight in the south-west of Ireland at Glengariff and Killarney, and we were then, as on the recent visit, struck by the numerous species of Cortinarius that were to be found there and the typical mode of their growth, which made it much easier to determine the species of this genus than is generally the case elsewhere. On both of my visits Mr. R. Lloyd Praeger kindly assisted in the collection of specimens during the course of two week-ends. We are also indebted to Miss A. Lorrain Smith, F.L.S., Miss Gulielma Lister, F.L.S., Miss E. M. Wakefield, Mr. A. D. Cotton, F.L.S., Mr. J. Adams, M.A., and Mr. J. Ramsbottom, B.A., for kind help in the determination and collection of specimens. In 1910 J. Adams and G. H. Pethybridge published in the Proceedings of the Royal Irish Academy, vol. xxviii., section B, No. 4, "A Census Catalogue of Irish Fungi," and they there set out a list of Irish fungi published by various writers (of very varying reliability in their determinations) up to that date. This is the only general guide that we possess as to the occurrence of fungi in Ireland. The appended list includes 667 species and varieties, of which number over 232 are additions to the Irish fungus flora, and almost all of them are first records for the sub-province of Mayo, C2 of the census catalogue list. Five are additions to the British fungus flora, namely, *Urceolella incaratina* (Quél.) Boud, *Gloniopsis Mülleri* (Duby) Sacc., *Anthostoma saprophilum* E. & E., *Diaporthe exasperans* Nke., and *Coprinus Friesii* Quél., and one is new to science—*Hygrophorus squamulosus* Rea. For the benefit of future workers in the district I give the distribution of the species in detail.

6. List of Species.

* = New to Ireland. † = New to Britain. †† = New to science. § = Referred to in notes at the end of the list. A = Achill Island. B = Belclare and Prospect House Woods. Br = Brackloon Wood. C = Croaghpatrick. Cl = Cloonagh Wood. D = Old Deer-park Wood, Mount Browne. Dr = Derrygorman Wood. K = Knocknanny Wood. L = Louisburgh. P = Westport Park and adjoining woods. W = Westport (Hawley). In each case the adjoining pastures are included under the letter used.

PLASMODIOPHORACEAE.

*Spongospora scabies (*Berk.*) *Mass.*—Mulranny (A. D. Cotton).

PHYCOMYCETAE.

Mucor Mucedo (*Linn.*) *Fr.*—K.
*Spinellus fusiger (*Link.*) *van Tiegh.*—K, P.
Sporodinia Aspergillus (*Scop.*) *Schröt.*—K.
Pilobolus crystallinus (*Wiggers*) *Fr.*—B, Br, D, K.
Cystopus Lepigoni *de Bary.* — L (Adams).
Phytophthora infestans (*Mont.*) *de Bary.*—B (Hawley).
Plasmopara nivea (*Unger*) *Schröt.*—W.
Peronospora calotheca *de Bary.*—B, K. On *Galium.*
* grisea *de Bary.*—L (Adams).

EUASCOMYCETAE.

*Exoascus turgidus *Sadeb.*—B, L.
Propolis faginea (*Schrad.*) *Karst.*—D, K.
Heterosphaeria patella *Grev.*—B.
Phacidium multivalve (*DC.*) *Kze. & Schm.*—K, P.
Trochila ilicis *Fr.*—Br, D, K, L.
Coccomyces coronatus (*Schum.*) *de Not.*—Br, K, P.
Rhytisma acerinum (*Pers.*) *Fr.*—A, B, D, K.
Sphaerospora trechispora (*B. & Br.*) *Sacc.*—L (Adams).
Lachnea stercorea (*Pers.*) *Gill.*—D, K, P.
scutellata (*Linn.*) *Sacc.*—D, K, L.
*Sarcosphaera arenicola (*Lév.*) *Lindau.*—L (Hawley).
Plicaria cerea (*Sow.*) *Fckl.* D.
* succosa (*Berk.*) *Rehm.*—B, W.
Humaria granulata (*Bull.*) *Sacc.*—B, D, K, P.
* Oocardii (*Kalchbr.*) *Cke.* — L (Hawley).
Geopyxis cupularis (*Linn.*) *Sacc.*—W.
*Macropodia macropus (*Pers.*) *Fckl.*—Br.
Otidea leporina (*Batsch*) *Fckl.*—B (Hawley).
cochleata (*Linn.*) *Fckl.*—Br.
Ascobolus furfuraceus (*Pers.*) *Fr.*—B, Br, D, K, L, P.
Chlorosplenium aeruginosum (*Oed.*) *de Not.*—A, B, Br, D, K, L, P.
Rutstroemia firma (*Pers.*) *Karst.* (*Ciboria ochroleuca* (*Bolt.*) *Mass.*)—Cl, P.

Dasyscypha Willkommii *Hart.* (*calycina Fckl.*)—D, P.
leuconica (*Phill.*) *Mass.*—D.
Lachnum virgineum (*Batsch*) *Karst.*—B, Br, K.
ciliare (*Schrad.*) *Rehm.*—B, Br, D, P.
niveum (*Hedw. fil.*) *Karst.*—A, B, K.
sulfureum (*Pers.*) *Rehm.*—P.
Hymenoscypha hyalina (*Pers.*) *Schröt.*—A, Br, K.
* dumorum (*Rob. & Desm.*) *Schröt.*—A. (Hawley).
Helotium claroflavum (*Grev.*) *Berk.*—D, K, W.
citrinum (*Hedw.*) *Fr.*—A, Br.
* aureum (*Pers.*) *Rehm.*—Br.
* herbarum (*Pers.*) *Fr.*—B, Br, D, W.
virgultorum (*Vahl.*) *Fr.*—Br, D, North side of Clew Bay (Hawley).
* *var.* fructigenum (*Bull.*) *Karst.*—Br, K, W.
scutula (*Pers.*) *Karst.*—W.
* phyllophilum (*Desm.*) *Karst.*—D, K.
Coryne sarcoides (*Jacq.*) *Tul.*—Br, D, K, W.
* urnalis (*Nyl.*) *Sacc.*—B, K, P.
§*Corynella glabrovirens *Boud.*—K.
§†Urceolella incarnatina (*Quél.*) *Boud.*—P.
Mollisia cinerea (*Batsch*) *Karst.*—B, Br, D, K, L, P.
melaleuca (*Fr.*) *Sacc.*—K, P.
lignicola *Phill.*—A (A. D. Cotton)
*Belonidium pruinosum (*Jerd.*) *Rehm.*—L (Hawley).
*Pseudopeziza petiolaris (*A. & S.*) *Mass.*—A (Hawley).
Orbilia leucostigma *Fr.*—Br, K.
xanthostigma *Fr.*—D, K, P.
vinosa (*A. & S.*) *Karst.*—Br.
inflatula *Karst.*—L (Hawley).
Patellaria atrata (*Hedw.*) *Fr.*—A (Hawley).
Cenangium abietis (*Pers.*) *Rehm.*—A (Hawley).
Bulgaria polymorpha (*Oeder*) *Wettst.*—Br.
§*Geoglossum microsporum *Cke. & Peck.*—Br.
Leotia lubrica (*Pers.*) *Fr.*—B, Br, K, W.
*Helvella helvelloides (*Fr.*) *Mass.*—B (Hawley).
Lophodermium pinastri (*Schrad.*) *Chev.*—A (Hawley), P.
§†Gloniopsis Mülleri (*Duby*) *Sacc.*—A (Hawley)
*Dichaena quercina (*Pers.*) *Fr.*—K, L, P.
Hysterium angustatum (*A. & S.*) *Fr.*—B (Hawley), Br, K, W.
Hysterographium fraxini (*Pers.*) *de Not.*—B, D, P.
Aspergillus herbariorum (*Wiggers*) *Fisch.*—Br, K, P.
Penicillium candidum (*Link*) *Sacc.*—B (A. L. Smith).
crustaceum (*Linn.*) *Fisch.*—K.
Erysiphe graminis (*DC.*) *Fr.*—K.
Hypomyces aurantius *Tul.*—P.
Nectria cinnabarina *Fr.*—P.
coccinea (*Pers.*) *Fr.*—D.
Aquifolii (*Fr.*) *Berk.*—P.
* episphaeria (*Tode*) *Fr.*—D.
*Gibberella cyanogena (*Desm.*) *Sacc.*—Roonah Quay (Hawley).
Hypocrea rufa (*Pers.*) *Fr.*—P.
Claviceps purpurea *Tul.*—B (Hawley).
* nigricans *Tul.*—L (R. Ll. Praeger).

*Rhopographus Pteridis (*Sow.*) *Wint.*—B, Br, K.
Phyllachora graminis (*Pers.*) *Fckl.*—D.
Lasiosphaeria canescens *Ces. & de Not.*—D, K.
ovina *Ces. & de Not.*—Br, K, W.
Chaetosphaeria tristis (*Tode*) *Schröt.*—L (Hawley).
*Bombardia fasciculata (*Batsch*) *Fr.*—K.
Rosellinia aquila (*Fr.*) *de Not.*—P.
mammiformis (*Pers.*) *Wint.*—L (Hawley).
§*Mycosphaerella ascophylli *Cotton.*—A (A. D. Cotton).
*Stigmatea Ranunculi *Fr.*—K.
* Rumicis (*Desm.*) *Schröt.* W.
Tichothecium pygmaeum *Korb.*—W.
rimosicolum (*Leight.*) *Arnold.*—B. (Hawley).
Leptosphaeria Doliolum (*Pers.*) *Ces. & de Not.*—P.
acuta (*Moug. & Nestl.*) *Karst.*—W.
Pleospora herbarum (*Pers.*) *Rabh.*—Br.
*Gnomonia cerastis (*Riess.*) *Ces. & de Not.*—A (Hawley).
§† Anthostoma saprophilum *E. & E.*—L (Hawley).
Valsa lata (*Pers.*) *Nke.*—Br. K, L, (Hawley).
*Diaporthe Tulasnei *Nke.*—B (Hawley)
* Wibbei *Nke.*—A (Hawley).
§† exasperans *Nke.*—B (Hawley).
* crustosa *Sacc. & Roum.*—K, on *Ilex.*
* salicella (*Fr.*) *Sacc.*—A (Hawley).
Diatrype stigma (*Hoffm.*) *Fr.*—A, Br, K.
disciformis (*Hoffm.*) *Fr.*—Br, K, L (Hawley).
*Diatrypella quercina (*Pers.*) *Nke.*—Br, K.
* verrucaeformis (*Ehrb.*) *Nke.*—W.
* favacea *Fr. Nke.*—B, L (Hawley).
*Hypoxylon semiimmersum *Nke.*—P.
multiforme *Fr.*—B, K.
fuscum (*Pers.*) *Fr.*—P.
Ustulina vulgaris *Tul*—B, Br, D, K, P.
Xylaria Hypoxylon (*Linn.*) *Grev.*—A, B, Br, D, K.

HEMIBASIDIOMYCETAE.

*Ustilago Hydropiperis (*Schum.*) *Schröt.*—B, Br, D, K, P.
Scabiosae (*Sow.*) *Wint.*—K.
violacea (*Pers.*) *Fckl.*—Br.

PROTOBASIDIOMYCETAE.

Melampsora Helioscopiae (*Pers.*) *Cast.*—D, on *Euphorbia Peplus.*
Hypericorum (*DC.*) *Schröt.*—Br, on *Hypericum Androsaemum.*
Lini (*Pers.*) *Desm.*—W.
* Larici-populina *Kleb.*—P, on *Populus canadensis.*
Melampsoridium betulinum (*Pers.*) *Kleb.*—B, D, K.
Coleosporium Euphrasiae (*Schum.*) *Wint.*—A (Hawley).
* Petasitis *de Bary.*—K.
Senecionis (*Pers.*) *Fr.*—L (Hawley).
Sonchi (*Pers.*) *Lév.*—L (Adams).
* Tussilaginis (*Pers.*) *Kleb.*—W.
Uromyces Trifolii (*Hedw.*) *Lév.*—L (Adams).
* Rumicis (*Schum.*) *Wint.*—B (Hawley).
*Puccinia Porri (*Sow.*) *Wint.*—L (Hawley).
Violae (*Schum.*) *DC.*—K, L.
Menthae *Pers.*—Br, K, W.
Primulae (*DC.*) *Duby.*—B, K.

*Puccinia Graminis *Pers.*—K.
Pringsheimiana *Kleb.*—B (A. D. Cotton).
suaveolens (*Pers.*) *Rostr.*—B.
* Hypochaeridis *Oud.*—L (Adams).
Hieracii (*Schum.*) *Mart.*—(Hawley), on *Hieracium Pilosella, Carduus nutans*, and *Leontodon.*
* Centaureae *Mart.*—W.
Taraxaci *Plow.*—L (Hawley).
Pruni *Pers.*—B.
Umbilici *Guep.*—A, Br.
Bunii (*DC.*) *Wint.*—B, K, P.
Phragmidium violaceum (*Schultz*) *Wint.*—B, Br, D, K, P, W.
*Sebacina incrustans (*Pers.*) *Tul.*—K.
Exidia albida (*Fr.*) *Bref.*—B, Br, D, K, P.
*Tremella frondosa *Fr.*—P.
mesenterica (*Retz.*) *Fr.*—B, Br, D, K.

AUTOBASIDIOMYCETAE.

Dacryomyces deliquescens (*Bull.*) *Duby.*—Cl, K, P.
stillatus *Nees.*—B, K.
*Ditiola nuda *B. & Br.*—A (Hawley).
Calocera cornea (*Batsch*) *Fr.*—D, K.
* stricta *Fr.*—Br, D.
*Hypochnus Solani *Prill & Del.*—Mulranny (A. D. Cotton).
*Corticium porosum *B. & Curt.*—K.
lacteum *Fr.*—Br, K, P.
arachnoideum *Berk.*—B, K.
laeve (*Pers.*) *Fr.*—A, K, P.
calceum (*Pers.*) *Fr.*—D.
comedens (*Nees*) *Fr.*—D, K.
Sambuci (*Pers.*) *Fr.*—K, P.
Coniophora puteana (*Schum.*) *Mass.*—K.
* arida (*Fr.*) *Cke.*—D.
Stereum hirsutum (*Willd.*) *Fr.*—D.
*Stereum ochroleucum *Fr.*—Dr, K.
purpureum (*Pers.*) *Fr.*—Cl, D, Dr, P.
* spadiceum (*Pers.*) *Fr.*—Br, D.
sanguinolentum (*A. & S.*) *Fr.*—B.
rugosum (*Pers.*) *Fr.*—A, B, Br, K, L.
Thelephora laciniata (*Pers.*) *Fr.*—K.
Cyphella capula (*Holm.*) *Fr.*—K.
* muscigena (*Pers.*) *Fr.*—Br.
Peniophora quercina (*Pers.*) *Cke.*—A, B.
cinerea (*Pers.*) *Cke.*—D.
velutina (*DC.*) *Cke.*—A, K.
Hymenochaete rubiginosa *Lév.*—K.
Typhula erythropus (*Pers.*) *Fr.*—B, K, P.
* Grevillei *Fr.*—A.
*Clavaria muscoides (*Linn.*) *Fr.*—B, D, P.
cinerea (*Bull.*) *Fr.*—B, P.
cristata (*Pers.*) *Fr.*—A, Br, D, Dr, K, P.
rugosa (*Bull.*) *Fr.*—B, D, P.
* Kunzei *Fr.*—B, Br.
fusiformis (*Sow.*) *Fr.*—B.
* dissipabilis *Britz.*—A, B, P.
vermicularis (*Scop.*) *Fr.*—B, Br, P.
* fumosa (*Pers.*) *Fr.*—B (Hawley).
contorta (*Holmsk.*) *Fr.*—A, L (Hawley).
* fistulosa (*Sow.*) *Fr.*—A, B.
juncea (*A. & S.*) *Fr.*—L (Hawley).
acuta (*Sow.*) *Fr.*—B (Hawley).
Pistillaria puberula *Berk.*—B, Br.
* pusilla (*Pers.*) *Fr.*—P, on leaf of *Ilex.*
*Phlebia merismoides *Fr.*—D, K.
* vaga *Fr.*—B, Br.
Grandinia granulosa (*Pers.*) *Fr.*—B, Cl, K, L, P, W.

*Grandinia mucida *Fr.*—Br, D, K, P.
Radulum orbiculare *Fr.*—B (Hawley).
quercinum (*Pers.*) *Fr.*—B, D.
Hydnum repandum (*Linn.*) *Fr*—B, Br, D, Dr, K.
rufescens (*Pers.*) *Fr.*—Br, K.
ochraceum (*Gmel.*) *Fr.*—K, L, P.
alutaceum *Fr.*—A, D.
udum *Fr.*—P.
niveum (*Pers.*) *Fr.*—K.
* sordidum (*Weinm.*) *Fr.*—B (Hawley).
farinaceum (*Pers.*) *Fr.*—K.
*Caldesiella ferruginosa (*Fr.*) *Sacc.*—L, P.
Irpex fusco-violaceus (*Schr.*) *Fr.*—K, P.
obliquus (*Schr.*) *Fr.*—A, B, Br, Cl, D, K, P.
*Merulius tremellosus (*Schr.*) *Fr.*—D, K.
Poria mollusca (*Pers.*) *Fr.*—A, B, P.
medulla-panis (*Pers.*) *Fr.*—B, Br.
* mucida *Fr*—B, K.
vaporaria (*Pers.*) *Fr.*—K, L, W.
sanguinolenta *Fr.*—A, B, K, L.
* blepharistoma *B. & Br.*—K.
* terrestris (*DC.*) *Fr.*—A, B, K, P.
Fomes applanatus (*Wallr.*) *Fr.*—D, P, W.
fomentarius (*Linn.*) *Fr.*—P.
* connatus *Fr.*—B (Hawley).
annosus *Fr.*—A, B, K, L, P.
Polyporus squamosus (*Huds.*) *Fr.*—B, Br, D, K, P.
varius (*Pers.*) *Fr.*—Br.
sulphureus (*Bull.*) *Fr.*—D, K.
fragilis *Fr.*—K.
* caesius (*Schrad.*) *Fr.*—Br, K, P.
chioneus *Fr.* (*sensu Bresadolae*).—P (Hawley).
adustus (*Willd.*) *Fr.*—Cl, D, Dr, P.
Polyporus betulinus (*Bull.*) *Fr.*—B, Br, D, K, P.
Polystictus versicolor (*Linn.*) *Fr.*—B, Br, Cl, D, K, P.
* hirsutus (*Schrad.*) *Fr.*—K.
velutinus (*Pers.*) *Fr.*—D, K, L.
abietinus (*Dicks.*) *Fr.*—D, K.
Daedalea quercina (*Linn.*) *Fr.*—K, P.
Lenzites betulina (*Linn.*) *Fr.*—K.
Fistulina hepatica (*Huds.*) *Fr.*—Br, D, K.
Boletus luteus *Fr.*—A, B.
elegans (*Schum.*) *Fr.*—B, Br, D, K.
granulatus (*Linn.*) *Fr.*—P.
bovinus (*Linn.*) *Fr.*—A, B, Br, K, W.
badius (*Linn.*) *Fr.*—Br, K.
piperatus (*Bull.*) *Fr.*—D.
* variegatus (*Swartz.*) *Fr.*—Near Kilboyne Wood.
chrysenteron (*Bull.*) *Fr.*—B, D.
subtomentosus (*Linn.*) *Fr.*—Br, D.
edulis (*Bull.*) *Fr.*—B, Br, D.
luridus (*Schaeff.*) *Fr.*—D, P.
* purpureus *Fr.*—D.
scaber (*Bull.*) *Fr.*—B, Br, K, L, P.
* *var.* niveus *Fr.*—B, Br.
Amanita phalloides *Fr.*—K.
mappa *Fr.*—Br, K.
muscaria (*Linn.*) *Fr.*—B, Br, L.
rubescens (*Pers.*) *Fr.*—B, Br, K.
spissa *Fr.*—K.
Amanitopsis vaginata (*Bull.*) *Roze.*—K, P, W.
* fulva (*Schaeff.*) *W. G. Sm.*—K.
Lepiota gracilenta (*Krombh.*) *Fr.*—Clew Bay, near Belclare.
acutesquamosa (*Weinm.*) *Fr.*—B (Hawley).

Lepiota cristata (*A. & S.*) *Fr.*—D.
* carcharias (*Pers.*) *Fr.*—Dr, K.
granulosa (*Batsch.*) *Fr.*—B & L (Hawley).
amianthina (*Scop.*) *Fr.*—Br, D, K.
Armillaria mellea (*Vahl.*) *Fr.*—A, B, Br, C, Cl, D, K, L, P.
mucida (*Schrad.*) *Fr.*—D, L, P.
Tricholema resplendens *Fr.* — L (Hawley).
flavobrunneum *Fr.*—A, Br, D, K.
ustale *Fr.*—B (Hawley).
rutilans (*Schaeff.*) *Fr.*—A, B, Br, D, K.
imbricatum *Fr.*—P.
* macrorhizum (*Lasch.*) *Fr.* — B (Hawley).
saponaceum *Fr.*—Br, Cl.
cuneifolium *Fr.*—B (Hawley).
virgatum *Fr.*—Br.
sulphureum (*Bull.*) *Fr.* — L (Hawley).
* cerinum (*Pers.*) *Fr.*—A (Hawley).
album (*Schaeff.*) *Fr.*—B, Br.
personatum *Fr.*—On a thatched roof of cottage near Cloonagh Lodge.
panaeolum *Fr.*—B & L (Hawley).
melaleucum (*Pers.*) *Fr.*—P.
Clitocybe nebularis (*Batsch*) *Fr.*—Br, P.
* clavipes (*Pers.*) *Fr.*—K.
infundibuliformis (*Schaeff.*) *Fr.*—Br, P.
geotropa (*Bull.*) *Fr.*—D, Dr, P.
* metachroa *Fr.*—P.
* ditopoda *Fr.*—Br, Kilboyne Wood.
fragrans (*Sow.*) *Fr.*—B, Cl, K, P.
Laccaria laccata (*Scop.*) *Berk.*—A, B, Cl, K, P.
* *var.* amethystina (*Vaill.*) *B. & Br.*—A, Br, D, K.
* *var.* tortilis (*Bolt.*) *Fr.*—K.

Collybia radicata (*Relh.*) *Fr.*—K.
platyphylla *Fr.*—Br.
fusipes (*Bull.*) *Fr.*—K.
maculata (*A. & S.*) *Fr.*—Br.
* prolixa (*Fl. Dan.*) *Fr.*—K.
butyracea (*Bull.*) *Fr.*—Dr, K, P.
velutipes (*Curt.*) *Fr.*—Cl.
confluens (*Pers.*) *Fr.*—L (Hawley).
conigena (*Pers.*) *Fr.*—A, K, P.
* cirrhata (*Schum.*) *Fr.*—K.
tuberosa (*Bull.*) *Fr.*—K.
tenacella (*Pers.*) *Fr.*—A, P.
dryophila (*Bull.*) *Fr.*—Br, K, P.
* aquosa (*Bull.*) *Fr.*—B, K.
inolens *Fr.*—Br.

Mycena elegans (*Pers.*) *Fr.* — A (Hawley).
* rubromarginata *Fr.*—D.
* rosella *Fr.*—C.
* rubella *Quél.*—P.
pura (*Pers.*) *Fr.*—A, B, Br, D, Dr, K, P.
* luteo-alba (*Bolt.*) *Fr.*—K, P.
* flavoalba *Fr.*—Br, C, P.
lactea (*Pers.*) *Fr.*—P.
* gypsea *Fr.*—W (Hawley).
rugosa *Fr.*—B, Cl, D, Dr, K, L, P.
* sudora *Fr.*—P.
galericulata (*Scop.*) *Fr.*—A, B, Br, Cl, D, Dr, K, P.
polygramma (*Bull.*) *Fr.*—B, Br, D, K, L, P.
* parabolica (*A. & S.*) *Fr.*—Dr.
* atrocyanea (*Batsch*) *Fr.*—B.
alcalina *Fr.*—D, P.
ammoniaca *Fr.*—A, B, Br, C, L, P.
* metata *Fr.*—B, K.
* tenuis *Fr.*—Br, K, P.
filopes (*Bull.*) *Fr.*—A, B, Br, D, K, P.

Mycena amicta *Fr.*—K.
* virens (*Bull.*) *Quél.*—P.
vitilis *Fr.*—B (Hawley).
tenella *Fr.*—Br, D, K, P.
haematopoda (*Pers.*) *Fr.*—D.
sanguinolenta (*A. & S.*) *Fr.*—K, P.
galopoda (*Pers.*) *Berk.*—A, B, Br, D, K, P.
leucogala *Cke.*—B, Br, C, P.
epipterygia (*Scop.*) *Fr.*—Br, K.
rorida *Fr.*—B, Cl, P.
* clavicularis *Fr.*—D.
tenerrima *Berk.*—B, Br, D, K, P.
* discopoda *Lév.*—B, Br.
pterigena *Fr.*—B, D.
corticola (*Schum.*) *Fr.*—B, Br, K, P.
hiemalis (*Osb.*) *Fr.*—B, D, Dr, K.
* setosa (*Sow.*) *Fr.*—Br, P.
capillaris (*Schum.*) *Fr.*—B & W (Hawley).
*Omphalia striaepilea *Fr.*—K.
umbellifera (*Linn.*) *Fr.*—A, B, Br, C, D.
stellata *Fr.*—P.
* camptophylla *Berk.*—L (Hawley).
grisea *Fr.*—K.
fibula (*Bull.*) *Fr.*—B, K.
* gracillima (*Weinm.*) *Fr.*—P.
integrella (*Pers.*) *Fr.*—B, D, K.
Pleurotus ostreatus (*Jacq.*) *Fr.*—K.
acerosus *Fr.*—Br, D.
applicatus (*Batsch*) *Fr.*—P.
* chioneus (*Pers.*) *Fr.*—D, K.
Volvaria speciosa *Fr.*—L (Hawley).
parvula (*Weinm.*) *Fr.*—L (Hawley).
Pluteus cervinus (*Schaeff.*) *Fr.*—A, Br, L.
*Entoloma prunuloides *Fr.*—B, K, P
* porphyrophaeum *Fr.*—D, K.
*Entoloma placenta (*Batsch*) *Fr.*—K.
* Bloxami *Berk.*—B, P.
ameides *B. & Br.*—K.
jubatum *Fr.*—B, D, K, P.
* griseocyaneum *Fr.*—K, P.
rhodopolium *Fr.*—Br.
sericeum (*Bull.*) *Fr.*—A, B, D, K.
nidorosum *Fr.*—B, Br, K, L.
* speculum *Fr.*—K.
Clitopilus prunulus (*Scop.*) *Fr.*—D, K.
* undatus *Fr.*—B & L (Hawley).
Leptonia lampropoda *Fr.*—B, D, K, P.
* serrulata (*Pers.*) *Fr.*—Br, D.
* formosa *Fr.*—D, K.
* chloropolia *Fr.*—K, L.
sericella (*Fr.*) *Quél.*—B, Br, D, K, P.
Nolanea pascua (*Pers.*) *Fr.*—A, C, D, K, F.
pisciodora *Ces.*—P.
rufocarnea *Berk.*—B (Hawley).
* exilis *Fr.*—B (Hawley).
Eccilia griseorubella (*Lasch.*) *Fr.*—Br.
Claudopus variabilis (*Pers.*) *W. G. Sm.*—Br, D, K, P.
*Pholiota terrigena *Fr.*—W.
* ombrophila *Fr.*—B.
* togularis (*Bull.*) *Fr.*—P.
squarrosa (*Müll.*) *Fr.*—B, K, P.
mutabilis (*Schaeff.*) *Fr.*—Br, K.
marginata (*Batsch*) *Fr.*—B, Br, Cl, D, K, P.
*Inocybe petiginosa (*Fr.*) *Quél.*—Br, K.
pyriodora (*Pers.*) *Fr.*—W.
* obscura (*Pers.*) *Fr.*—B (Hawley).
rimosa (*Bull.*) *Fr.*—B, Br, K.
eutheles *B. & Br.*—D.
destricta *Fr.*—B (Hawley).
asterospora *Quél.*—W.

Inocybe geophylla (*Sow.*) *Fr.*—B, Br, D, K, L, P.
* *var.* violacea *Pat.*—Br, D, K, P.
* Whitei *B. & Br.*—W.
Hebeloma fastibile *Fr.*—B, Br, D, P.
crustuliniforme (*Bull.*) *Fr.*—Br, D.
*Flammula Tricholoma (*A. & S.*) *Karst.*—Br.
sapinea *Fr.*—K.
* scamba *Fr.*—A. P.
* helomorpha *Fr.*—L (Hawley).
Naucoria melinoides (*Bull.*) *Fr.*—Br. K.
scolecina *Fr.*—W.
semiorbicularis (*Bull.*) *Fr.*—B (Hawley).
* tabacina (*DC.*) *Fr.*—B.
badipes *Fr.*—P.
* Myosotis *Fr.*—K.
* temulenta *Fr.*—B, D.
escharoides *Fr.*—A, Br, D, K.
Galera tenera (*Schaeff.*) *Fr.*—Br, D, K, P.
* spartea *Fr.*—B, Br, K.
rubiginosa (*Pers.*) *Fr.*—Br, K.
hypnorum (*Schrank*) *Fr.*—B, Br, C, D, K, P.
* *var.* sphagnorum (*Pers.*) *Fr.*—Br, K.
Tubaria furfuracea (*Pers.*) *W.G.Sm.*—A, B, Br, C, D, K, P.
paludosa *Fr.*—C, K.
* crobula *Fr.*—B, Br.
* inquilina *Fr.*—B, Br.
*Crepidotus calolepis *Fr.*—B, Cl, K, P.
mollis (*Schaeff.*) *Fr.*—D.
Psalliota arvensis (*Schaeff.*) *Fr.*—A, C, P.
campestris (*Linn.*) *Fr.*—B, L, P.
haemorrhoidaria *Kalchbr.*—Br, P.
Stropharia aeruginosa (*Curt.*) *Fr.*—A, B, Br, Cl, K, P.
* squamosa *Fr.*—Br, D.
* merdaria *Fr.*—C, at 2000 feet.
stercoraria *Fr.*—B, Br, K, P.
semiglobata (*Batsch*) *Fr.*—A, B, Br, C, D, Dr, K, P.
Hypholoma sublateritium (*Schaeff.*) *Fr.*—B, Br, D, K, P.
* capnoides *Fr.*—A, Br, K.
epixanthum (*Paul.*) *Fr.*—A, B, D, K, P.
fasciculare (*Huds.*) *Fr.*—A, B, Br, Cl, D, Dr, K, P.
velutinum (*Pers.*) *Fr.*—Br, P.
* lanaripes *Cke.*—P.
* Candolleanum *Fr.*—B (Hawley).
appendiculatum (*Bull.*) *Fr.*—K, P.
hydrophilum (*Bull.*) *Fr.*—Br, K, P.
Psilocybe ericaea (*Pers.*) *Fr.*—A, B, P.
* uda (*Pers.*) *Fr.*—A (Hawley).
semilanceata *Fr.*—A, B, Br, C, D, K, P.
* canobrunnea *Fr.*—W.
foenisecii (*Pers.*) *Fr.*—D, K, L.
Clivensis *B. & Br.*—P.
Psathyra corrugis (*Pers.*) *Fr.*—B, Br, C, D, K, P.
var. vinosa *Cda.*—K.
spadiceogrisea (*Schaeff.*) *Berk.*—L (Hawley).
* bifrons *Berk.*—Br, P.
* *var.* semitincta *Phill.*—D.
* fatua *Fr.*—B & L (Hawley).
* fibrillosa (*Pers.*) *Fr.*—A, B, Br, K, P.
* gossypina (*Bull.*) *Fr.*—Br, P.
Anellaria separata (*Linn.*) *Karst.*—B, P.

Anelaria fimiputris (*Bull.*) *Karst.*—K, P.
*Panaeolus sphinctrinus *Fr.*—Br, K, P.
campanulatus (*Linn.*) *Fr.*—A, B, Br, D, K, P.
papilionaceus (*Bull.*) *Fr.*—D, L, K.
Psathyrella gracilis (*Pers.*) *Fr.*—A, B, Br, C, Cl, D, Dr, K, P.
atomata *Fr.*—B, Br, D, K, P.
disseminata (*Pers.*) *Fr.*—D, L, P.
Coprinus comatus (*Fl. Dan.*) *Fr.*—P.
atramentarius (*Bull.*) *Fr.*—B, D, K, P.
* cinereus *Fr.*—Br.
niveus *Fr.*—A, B, Br, D, K, P.
micaceus (*Bull.*) *Fr.*—A, B, Br, D, K, P.
* radians (*Desm.*) *Fr.*—B.
lagopus *Fr.*—L, P.
† Friesii *Quél.*—B (Hawley).
radiatus (*Bolt.*) *Fr.*—Br, C, D, L.
ephemerus (*Bull.*) *Fr.*—K.
plicatilis (*Curt.*) *Fr.*—B, Br, D, K, L, P.
Cortinarius (Phlegmacium) varius (*Schaeff.*) *Fr.*—B.
largus (*Buxb.*) *Fr.*—Br.
infractus (*Pers.*) *Fr.*—K.
glaucopus (*Schaeff.*) *Fr.*—Br.
purpurascens (*Batsch*) *Fr.*—Br.
* emollitus *Fr.*—K.
* decoloratus (*Pers.*) *Fr.*—A.
(Myxacium) collinitus (*Pers.*) *Fr.*—B, Br.
elatior *Fr.*—A, B, Br, Cl, D, Dr, K, P.
* pluvius *Fr.*—K.
(Inoloma) alboviolaceus (*Pers.*) *Fr.*—B, Br.
Cortinarius (Inoloma) callisteus *Fr.*—Br.
* bolaris (*Pers.*) *Fr.*—B, Br.
* penicillatus *Fr.*—Br.
* (Dermocybe) ochroleucus (*Schaeff.*) *Fr.*—Br.
tabularis (*Bull.*) *Fr.*—B, K.
* camurus *Fr.*—Br.
caninus *Fr.*—A, Br.
* myrtillinus (*Bolt.*) *Fr.*—Br.
anomalus *Fr.*—B, K.
* lepidopus *Cke.*—B, K.
miltinus *Fr.*—A.
cinnamomeus (*Linn.*) *Fr.*—A, D, K.
uliginosus *Berk.*—Near Leenane.
* cotoneus *Fr.*—Br.
(Telamonia) torvus *Fr.*—B, Br, D, K, L.
* impennis *Fr.*—Br, K.
hinnuleus (*Sow.*) *Fr.*—B, Br, D, K.
* helvelloides *Fr.*—Br.
* bovinus *Fr.*—B (Hawley).
* brunneus (*Pers.*) *Fr.*—Br, D.
* biformis *Fr.*—B (Hawley).
* psammocephalus (*Bull.*) *Fr.*—K, P.
iliopodius (*Bull.*) *Fr.*—B, L.
hemitrichus (*Pers.*) *Fr.*—Br.
* rigidus (*Scop.*) *Fr.*—Br, K.
paleaceus (*Weinm.*) *Fr.*—A, B, Br, D, K.
(Hydrocybe) castaneus *Fr.*—B, Br, K.
* pateriformis *Fr.*—K.
* dolabratus *Fr.*—Br.
leucopus (*Pers.*) *Fr.*—A, B, Br, K.
* rigens (*Pers.*) *Fr.*—B (Hawley).
* scandens *Fr.*—P.
* erythrinus *Fr.*—B, Br.

*Cortinarius (Hydrocybe) decipiens (*Pers.*) *Fr.*—A, Br, D, K.
* obtusus *Fr.*—Br, P.
acutus (*Pers.*) *Fr.*—B, Br, L.
* fasciatus *Fr.*—B (Hawley).
Gomphidius viscidus (*Linn.*) *Fr.*—P.
* roseus (*Fr.*) *Quél.*—K.
Paxillus involutus *Fr.*—A, Br, K, L, P.
* leptopus *Fr.*—K, P.
§††Hygrophorus (Limacium) squamulosus *Rea.*—D.
(Camarophyllus) pratensis (*Pers.*) *Fr.*—K, L, P.
virgineus (*Wulf.*) *Fr.*—B, Br, D, K, L,P.
* *var.* roseipes *Massee.*—B, P.
niveus (*Scop.*) *Fr.*—B, Br, Cl, D, K, L, P.
* fornicatus *Fr.*—K, P.
* distans *Berk.*—B (Hawley).
ovinus (*Bull.*) *Fr.*—B, K.
(Hygrocybe) laetus (*Pers.*) *Fr.*—A, B, Br, D, K, L.
ceraceus (*Wulf.*) *Fr.*—B, Br.
coccineus (*Schaeff.*) *Fr.*—Br, C, D, K.
miniatus *Fr.*—B, Br, D, K, P.
* Reai *Maire.*—K, P.
* turundus *Fr.*—D.
* *var.* mollis *B. & Br.*—D, P.
puniceus *Fr.*—B, D, L.
obrusseus *Fr.*—B, D, L.
conicus (*Scop.*) *Fr.*—D, P.
calyptraeformis *Berk.*—B, D, P, L.
chlorophanus *Fr.*—B, Br, D, K, L, P.
psittacinus (*Schaeff.*) *Fr.*—B, Br, D, K, P.
unguinosus *Fr.*—D, P.
nitratus (*Pers.*) *Fr.*—K.

Lactarius torminosus (*Schaeff.*) *Fr.*—B, Br, L.
turpis (*Weinm.*) *Fr.*—A, B, Br, K, P.
* pubescens *Fr.*—A, B, Br, Cl, W.
insulsus *Fr.*—Br.
blennius *Fr.*—B, Br, D, K, L, P.
hysginus *Fr.*—Br.
circellatus (*Batt.*) *Fr.*—D.
* uvidus *Fr.*—Br.
pyrogalus (*Bull.*) *Fr.*—B, L.
chrysorrheus *Fr.*—B, Br, D, K, P.
piperatus (*Scop.*) *Fr.*—B, Br, L, P, W.
vellereus *Fr.*—B, Br, D, K, P.
deliciosus (*Linn.*) *Fr.*—A, Br, K, P.
pallidus (*Pers.*) *Fr.*—D, K, P.
quietus *Fr.*—A, B, Br, K, P.
* aurantiacus (*Fl. Dan.*) *Fr.*—Br.
theiogalus (*Bull.*) *Fr.*—A (Hawley).
* vietus *Fr.*—B, Br.
rufus (*Scop.*) *Fr.*—A, K.
* helvus *Fr.*—L (Hawley).
glyciosmus *Fr.*—B, Br, D, K, P.
serifluus (*DC.*) *Fr.*—B, Br, D, K, P.
mitissimus *Fr.*—B, Br, Cl, D, K, P.
subdulcis (*Bull.*) *Fr.*—A, B, Br, D, K, P.
camphoratus (*Bull.*) *Fr.*—K, P.
* cimicarius (*Batsch*) *Phill.*—A, Br, K.
* obnubilis (*Lasch*) *Fr.*—B (Hawley).
Russula nigricans (*Bull.*) *Fr.*—B, Br, D, K, L, P.
adusta (*Pers.*) *Fr.*—A, K.
delica *Fr.*—B (Hawley).
* olivascens *Fr.*—K.

Russula sardonia (*Fr.*) *Bres.*—D, K.
depallens (*Pers.*) *Fr.*—A, Br, K, P.
* caerulea (*Pers.*) *Fr.*—A, D, K, P.
drimeia *Cke.*—A, B, Br, K, L, P.
* cutifracta *Cke.*—B.
lepida *Fr.*—B, Br, K, L.
rubra (*DC.*) *Fr.*—B, D, Kilboyne House.
* atropurpurea (*Krombh.*) *Fr.*—Br.
vesca *Fr.*—Br, D, K.
xerampelina (*Schaeff.*) *Fr.*—Br, K, P.
cyanoxantha (*Schaeff.*) *Fr.*—B, Br, D, K, L, P.
galochroa *Fr.*—Br.
consobrina *Fr.*—K.
* *var.* sororia (*Larbr.*) *Fr.*—K.
foetens (*Pers.*) *Fr.*—D, K.
fellea *Fr.*—B, Br, D, K, L, P.
emetica *Fr.*—B, D, K, L, P.
* fallax (*Schaeff.*) *Fr.*—Br.
ochroleuca (*Pers.*) *Fr.*—A, B, Br, D, K, P.
fragilis (*Pers.*) *Fr.*—A, B, Br, D, Dr, K, P.
* *var.* nivea *Cke.*—Br, K.
* *var.* violacea *Cke.*—A, B, Br, D, K, P.
integra (*Linn.*) *Fr.*—B (Hawley).
* roseipes (*Secr.*) *Bres.*—K.
* nitida (*Pers.*) *Fr.*—Br. K.
puellaris *Fr.*—A, Br, K, P.
* ochracea (*Pers.*) *Fr.*—W (Hawley).
lutea (*Huds.*) *Fr.*—B, Br, Murrisk Abbey (Hawley).
Cantharellus cibarius *Fr.*—B, Br, D, K.
aurantiacus (*Wulf.*) *Fr.*—B, D, K, L, P.
tubaeformis (*Bull.*) *Fr.*—Br.
Cantharellus muscigenus (*Bull.*) *Fr.*—Br.
Nyctalis asterophora *Fr.*—K, L.
parasitica (*Bull.*) *Fr.*—A, B, Br, Cl. D, K, P.
Marasmius oreades (*Bolt.*) *Fr.*—B.
erythropus (*Pers.*) *Fr.*—Br. D, K, P.
ramealis (*Bull.*) *Fr.*—B, Br, K, L, P.
* candidus (*Bolt.*) *Fr.*—B.
Androsaceus rotula (*Fr.*) *Pat.*—B, Br, D, K.
graminum (*Lib.*) *Pat.*—K, P.
* epiphylloides *Rea.*—D, K.
*Rhizopogon luteolus *Fr.*—A (Hawley).
*Lycoperdon perlatum *Pers.*—Br.
* depressum *Bon.*—B, K, P.
caelatum *Bull.*—D.
pyriforme (*Schaeff.*) *Pers.*—B, Br, K, P.
spadiceum *Pers.* (*teste* Lloyd)—A (Hawley).
* umbrinum *Pers.*—Br.
Bovista plumbea *Pers.*—D, K, P.
nigrescens *Pers.*—B, K.
Cyathus striatus *Hoffm.*—Br, K.
Scleroderma vulgare *Hornem.*—Br, P.
verrucosum (*Bull.*) *Pers.*—Br.
Sphaerobolus stellatus *Tode.*—Br.

FUNGI IMPERFECTI.

*Phyllosticta Ajugae *Sacc. & Speg.*—B (Hawley).
* primulicola *Desm.*—B (Hawley).
*Phoma nebulosa (*Pers.*) *Mont.*—B.
*Cytospora Salicis (*Cda.*) *Rabh.*—A (Hawley).
*Ascochyta Pisi *Lib.*—L (Adams).
*Septoria scabiosicola *Desm.*—A, B, L, W.

*Septoria Violae *Rabh.*—B, K.
Cylindrium flavo-virens *Bon.*—Br, K, P.
Trichoderma viride (*Pers.*) *Fr.*—Br, K.
*Gliocladium lignicolum *Grove.* — L (Hawley).
*Rhinotrichum Thwaitesii *B. & Br.*—P.
*Botrytis cinerea (*Pers.*) *Fr.*—Br.
Sepedonium chysospermum (*Nees.*) *Grev.*—Br, D, K, L.
*Ramularia Ajugae (*Niessl.*) *Sacc.*—B (Hawley).
Torula herbarum (*Link*) *Cda.*—Br.
Zygodemus fuscus *Cda.*—Br, D, K, P.
Bispora monilioides *Cda.*—B, K.
*Fusicladium depressum (*B. & Br.*) *Sacc.*—W.
*Clasterosporium hirudo *Sacc., var.* anglicum *Grove*—L (Hawley).
*Helminthosporium rhopaloides *Fres.*—A (Hawley), on Potato.
* Smithii *B. & Br.*—L (Hawley).
Sporochisma mirabile *B. & Br.*—Br, P, L.
Stilbella tomentosa (*Schräd.*) *Lind.*—D, K.
Isaria farinosa (*Dicks.*) *Fr.*—K.
* arachnophila (*Ditm.*) *Sacc.*—Br.
Stysanus stemonites (*Pers.*) *Cda.*—Br, K.
Aegerita candida (*Pers.*) *Grev.*—Br. L.

7. Notes on the List.

Corynella glabro-virens Boud.

I have adopted the genus Corynella of Boudier because this species seems to belong rather to the Calloriaceae than to the Bulgariaceae. This minute species is known by its bright emerald green disc, which is deeper in colour at the margin, and its terseptate spores. It was accompanied by *Stilbum-like* conidia of the same colour.

Urceolella incarnatina (Quél.) Boud.

We have assigned this species to Boudier's genus Urceolella because it seemed impossible to transfer it satisfactorily to any of the genera included in our British mycological works. This very minute species is new to the British Isles, and is of a delicate flesh-colour when moist, covered on the outside with a very short, fine pubescence.

Geoglossum microsporum Cke. & Peck.

Ascophores black, dry, not at all viscid. Spores pale brownish when fresh, straight or slightly curved, obtuse, cylindrical, $25 - 40 \times 4 - 6\ \mu$, becoming ultimately seven- to nine-septate. Paraphyses curved, brownish, $2\ \mu$ thick at the apex. The spore-measurements given in Massee's "British Fungus Flora," iv, 484, seem to be based to a great extent on American specimens.

Gloniopsis Mülleri (Duby) Sacc.

Achill Island (Hawley). The spores in this specimen were rather smaller than in those from the Ile de Levant at Kew. They were five-septate and constricted, and showed no signs of becoming brown. There is a drawing by Phillips at Kew of apparently the same species collected at Shrewsbury, but with shorter perithecia.

Mycosphaerella ascophylli Cotton.

Achill Island (A. D. Cotton): see Transactions British Mycological Society, iii, 95.

Anthostoma saprophilum E. & E.

Louisburgh (Hawley). This addition to the Britannic fungus-flora is also new to Europe.

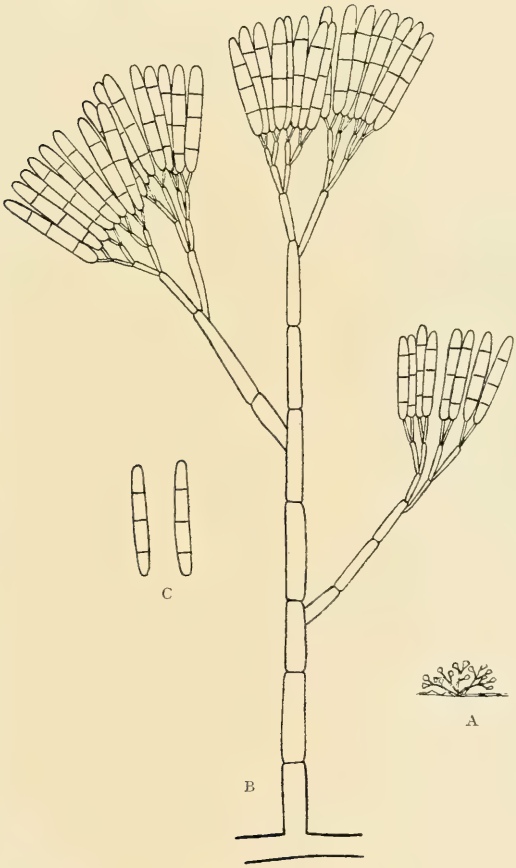
Diaporthe exasperans Nke.

Belclare (Hawley). We are not aware that this has been recorded for Britain. It occurred also in Clare Island along with *Melanconis stilbostoma* (Fr.), Tul., from which it is separated by its smaller spores and other characters.

Hygrophorus (Limacium) squamulosus Rea.

Pileus 5–7 cm. latus, convexo-expansus, subumbonatus, glutinosus, sub glutine *floccoso-squamulosus*, margine incurvo *tomentoso supra basim lamellarum*, luteo-olivaceus centro fusco. Caro albida ad inferam partem stipitis lutescens. Stipes 6–8 cm. longus, 1–2·5 cm. crassus, aequalis vel deorsim incrassatus, solidus, glutinosus, concolor, apice albo-farinosus. Lamellae 5–10 mm. latae, sinuato-adnatae, albae, subconfertae, acie irregulariter undulatae. Odor et sapor gratus. Sporae albae, globosae, $3{\cdot}5 - 4 \times 3{\cdot}5\ \mu$.

At first sight somewhat resembling some forms of *Hygrophorus olivaceo-albus* Fr., but at once distinguished by the floccose squamules and tomentose margin of the pileus, in which latter respect it resembles *Tricholoma album* (Schaeff.) Fr.



Candelospora ilicicola Hawley, *n. gen. et sp.*

A = group of conidiophores highly magnified. B = single conidiophore, × 400.
C = two conidia, × 400.

14

LICHENES.

By ANNIE LORRAIN SMITH, F.L.S.

Read June 26. Published August 21, 1911.

The territory selected by the Clare Island Survey Committee for their study of its flora and fauna extends from Achill southwards to Killary Harbour, with the islands lying off the coast, and, on the landward side, includes Louisburgh, Westport, and Castlebar. It is a region of rock and moorland, the uncultivated and barren tracts affording just the undisturbed conditions necessary for the growth of lichens.

The rocks of the district belong to the older series—Silurian and others—and are described elsewhere; there are, in addition, areas of limestone at Westport and again at Castlebar with a lichen-flora very distinct from that of the siliceous rocks. Calcareous species were also found sparingly over the whole district on walls where mortar had been used in building. Clare Island itself, the largest of the islands and typical of the others, is formed likewise of the older rocks, and presents a rugged, storm-beaten coast on the northern and western sides, facing the Atlantic with high, precipitous cliffs, but sloping down towards the eastern or landward side to a boulder-strewn shore.

Over the island the rocks are covered by grass, moor, and bog; but often they are denuded of soil, and lie exposed to sun and wind—ideal situations for lichens. Towards the north-west side of the island, the ground rises to over 1500 feet above sea-level, but the upper reaches of the hill are boggy, and do not afford foothold for purely alpine forms. There is a small patch of woodland in the most sheltered part of the island on the north-eastern side. It consists of stunted trees and brushwood about 10 feet in height; and a fair number of "tree" forms were found on the trunks and branches, mostly Graphideae, *Opegrapha atra* and *Graphina anguina* being the two commonest species.

In the Achill and Mulranny district rock-specimens abound—some of them of a more or less alpine character on the higher reaches of the hills. Croaghpatrick, near Louisburgh, which attains a height of 2510 feet, was also searched. The prevailing rock is quartzite, and was found to be

inhospitable for lichens; but *Rhizocarpon geographicum* and two species of Gyrophora peculiar to high altitudes were found on the rocks there.

At Louisburgh, Belclare, and Westport there are considerable woodland areas with fine old trees; and they yielded a rich crop of corticolous lichens. There were scattered trees also at Achill and Castlebar, on which several species were found.

Though there have been a number of noted field lichenologists in Ireland, very few specimens have been collected in our district. Carrington, Carroll, Sir Thomas Gage, Miss Hutchins, Admiral Jones, Salwey, and T. Taylor collected mainly in the south and south-west, in Cork and Kerry. We find also records from Wicklow by Moore and Taylor; from Donegal by Moore; and from northern Ireland by Thompson, Moore, and Miss Hutchins. Carroll and Moore made occasional expeditions into Galway, and duly recorded their finds; but the chief collector in the western districts was Charles Larbalestier. He found several new lichens which were determined by Nylander and published in various volumes of "Flora" from forty to fifty years ago. Larbalestier long survived his fellow-collectors; he died a few months ago (April, 1911) in his native Jersey. Most of his work was done in Connemara, at Kylemore, Twelve Bens, Killary Bay, &c.; but he also travelled up to Mayo and made a few records from Lord Sligo's demesne at Westport.

With these exceptions, the western districts, and more especially Mayo, have been practically unsearched for lichens until the botanists of the Clare Island Survey turned their attention to them. The first collection of any importance in the district was made in the early summer of 1909 by Miss M. C. Knowles, who then worked chiefly at the larger forms of Parmelia, Physcia, Cladonia, Peltigera, &c. The specimens were sent to me at South Kensington to be examined, and a number were found to be new, not only to the district, but to the Irish flora. The committee owe a great debt of gratitude to Miss Knowles, whose exceptional ability as observer and collector has so greatly aided the lichenological survey. In the following spring Mr. W. West, a skilled field-worker, took advantage of his stay on the island to collect a series of rock and ground specimens. They were sent by him to South Kensington, and have been incorporated in the lists. Mr. W. A. Wattam, Huddersfield, went in June, 1910, to Achill and the Curraun peninsula, where he spent a busy fortnight. He devoted most of his attention to the higher grounds of Curraun, Glendarary, and Slievemore, where he made a rich collection of rock specimens, including such mountain forms as *Rhizocarpon geographicum*, *Ephebe pubescens*, *Gyrophora torrefacta*, and *G. cylindrica*. At the summit of Croaghaun Mountain he found *Cladonia bellidiflora*, an upland species, in great

profusion: one patch 14 inches in length forming "a crimson band of exquisite beauty, owing to the vast amount of fructifying podetia."

Early in October, 1910, accompanied by Miss Knowles, Mr. Praeger, and other botanists, I visited Achill Sound, Clare Island, Louisburgh, Belclare, Westport, and Castlebar. We explored generally the whole district, and made large collections, which were, as before, determined at South Kensington; and I have again to thank Miss Knowles for her assistance in the arduous task of examining the specimens with the microscope. We had many duplicates sent in by the different workers and from the different localities, but finally we were able to reckon about 280 species with forty sub-species, varieties, or forms. Of these, according to Mr. Adams's "Distribution of Lichens in Ireland,"[1] only about thirty had been previously recorded in the sub-province marked by him C2 (the County of Mayo) in which our district is included. A large number had been already collected in Galway, but between thirty and forty on our lists are new to Ireland. There are nine in Mr. Adams's list recorded from Mayo that we did not find. These are:—*Bacidia effusa* (*intermedia*) Arn., *B. luteola* (*rubella*) Mudd., *Buellia advenula* A.L.Sm., *Collema flaccidum* Ach., *Gyrophora erosa* Ach. (?), *Lecanora pyracea* Nyl., *Lecidea arridens* Nyl. (?), *Porina lectissima* A. Zahlbr., and *Roccella fuciformis*, DC.

As has been already stated, a region of rock, moorland, and sea-coast such as that selected by the Clare Island Committee for their survey is peculiarly favourable for the development of an abundant lichen flora. These lowly plants are mostly of slow, continuous growth, the same plants and even the same fruits persisting year after year; so they flourish best on some substratum that is not subject to change or disturbance. The number of species on our list gives but little idea of the vast lichen growths that are to be found on the western shores. The exposed rocks were everywhere covered with sheets of leafy Parmeliae or densely coated with mingling crustaceous forms which competed for every inch of space, while the peaty soil yielded fine growths of Cladonia and Stereocaulon, and spreading over the grass were various species of Peltigera, notably *P. canina* and *P. rufescens*, with its crested form *praetextata*.

The rocks bordering the sea and the great cliffs of the north-west shore of Clare Island are black with an unbroken growth of *Verrucaria maura*. *Lichina pygmaea*, a small, dark, shrubby lichen, is also abundant on some of the rocks washed by high tides; and within reach of the spray *Ramalina scopulorum* and *R. cuspidata* found room for their grey tufts of strap-shaped

[1] Proc. R. I. Acad., xxvii., Sect. B., No. 10. 1909.

branches. The boulders near the shore were gay with the yellow *Physcia parietina* or *Lecanora lobulata*. Further away the rocks were covered with great white patches of *Lecanora parella*, with its large, crowded apothecia; and *Lecanora atra*, with a grey, irregular crust and outstanding black fruits, was very noticeable and very abundant. Further inland still, these two dominant species were partly replaced by *Lecidea rivulosa*, with its thick crust of varying shades of purplish brown. Mr. Wattam also reports from Achill that "this is undoubtedly the most common of all rock-lichens. It occurred on every mountain-range and wayside boulder, both at high and low altitudes, and makes perfect maps of varied brown hues intersected with black hypothallus." Some of the patches observed by him measured 9 feet by 3 feet. Other Lecideae, such as *L. contigua* and *L. confluens*, with stout, black fruits, occurred not seldom; and mingling with these more massive forms were species of Rhizocarpon and Buellia in varying mosaics of green, grey, or brown; and everywhere, though inconspicuous, the thin crust and small iron-red fruits of *Lecanora ferruginea*. Species with bright brown thallus were not frequent, but we secured specimens of *Lecanora Dicksonii* and *Rhizocarpon Oederi*, both of a yellowish red hue, and on the stones of a stream the equally bright *Lecanora lacustris*.

On many of the boulders the crustaceous forms were shouldered aside by the leafy Parmeliae, the most common of all *Parmelia saxatilis*, with its lovely grey thallus seamed and scored by innumerable zigzag white lines, and often rough with small projecting points called "isidia"—outgrowths from the thallus, which break away and form the beginnings of new growths. Almost imperceptibly *P. saxatilis* passes over to the allied species *P. omphalodes*, a darker plant, with a smooth shining thallus. Another Parmelia found in large sheets is *P. perlata*, the curled edges of its thallus bordered with white pearly soredia. *P. caperata*, though less abundant, helped to cover the boulders with its yellowish green wrinkled thallus. On the same rocks, bristling tufts of Ramalina pushed up between the Parmelia lobes. Other boulders were taken possession of by the thick warted crusts of grey Pertusariae, many of them sterile forms impossible to determine accurately.

In the limestone districts of Westport and Castlebar the stone walls were adorned with the brilliant yellow *Lecanora murorum* and *L. callopisma*, and spotted all along with the milk-white thallus of *L. calcarea*, or the dark brown patches of *Verrucaria nigrescens*. The outcropping rocks were dotted with pin-holes, each one the seat of *Verrucaria calciseda*, while here and there the white surface was blackened with the crust of *Pannularia nigra*.

Among tree-lichens, the largest number belonged to various Graphideae

and Lecanorae. *Pyrenula nitida* was very common and very noticeable; and minute forms of other Pyrenocarpei covered the trunks and branches. In a wood at Louisburgh a fallen tree-trunk was almost wholly occupied by *Collema nigrescens*, and some fine gatherings of *Coccocarpia plumbea*, with its thick leathery thallus, were secured at the same place.

Not a few rare species were discovered in the mass of material examined. Among these may be noted *Arthonia subvarians*, a parasitic species from Castlebar, recorded previously in England; *Arthopyrenia leptotera*, found on rocks by the sea at Achill, previously recorded from Jersey; *A. microspila*, also new to Ireland, generally associated with Graphis (*sp.*), as is the specimen collected at Castlebar. A well-marked species, *Bacidia arceutina*, was found at Achill on the branch of a tree, and a variety on peaty ground also at Achill has been determined as var. *hypnea*, though that plant has hitherto been recorded as growing over mosses and hepatics on boulders. *B. atrogrisea* was collected at Castlebar and at Achill, the latter specimen sent by Mr. Wattam. Two collections of *B. umbrina* were also made on rocks at Achill; it is distinguished by the long, narrow, coiled or vermiform spores.

Bilimbia albidocarnea, with the subspecies *chlorotropoides*, was discovered by Charles Larbalestier in Galway. The subspecies was now again found at Castlebar. Typical specimens of *B. lignaria* were growing on the ground at Achill, and again at Clare Island; a saxicolous form of the species was gathered at Achill and Belclare, and should probably have varietal rank. A similar specimen was named *Lecidea saxigena* by Uloth; in both forms the blue-green tips of the paraphyses are a marked and characteristic feature. *Collemopsis Schaereri* was found on the limestone at Castlebar, a thin black crust crowded with apothecia, and on the same habitat *Gyalecta cupularis* and *G. exanthematica*, the latter well-marked by its fissured apothecia. *Lecanora gelida* occurred in abundance on a stone wall at Belclare, easily known, even when sterile, by the brown spreading cephalodia on the thallus.

Microthelia dissepta, a very rare lichen, dotted with its black fruits the thallus of *Rhizocarpon confervoides*; it is another of the lichens discovered by Larbalestier in Galway. A soil lichen, first sent by W. West from Clare Island, *Pannularia microphylla*, grew in fine abundance, and was subsequently found also at Achill; it forms a brown, compact crust of minute, closely packed brown lobes, among which are seated the dark apothecia.

A form of *Pertusaria Wulfenii* was collected on a wall at Belclare; the spores were so much larger ($95–100\mu \times 30–45\mu$) than the size given by Crombie that it seemed at first to be a new variety; but Continental authors give a much larger measurement for the spores of the species, and ours came well within the limits.

Many of the specimens were unfortunately sterile, and could not be determined; the fruits were there, but the spores were scattered.

An alpine species, *Pertusaria gyrocheila,* was submitted to me lately by Mr. W. West, who had found it growing in great abundance on Slievemore, Achill. The fruits are rather large, of a labyrinthine or gyrose form, and are borne on raised, scattered pustules. It was originally collected by Carroll on Ben Lawers, and described by Nylander in "Flora," 1865. Mr. West has also collected it on the mountains of Harris on the West of Scotland. These were its only previous records.

Some specimens of Usnea were collected both from trees and from rocks. They were poorly developed and somewhat difficult to determine.

Several species of Verrucaria and allied genera were found only once. They are easily overlooked by the most careful collectors; and are probably fairly common and abundant.

The distribution of lichens is ecological even more than geographical. They are intimately associated with their substratum, each growing generally on its own special rock, tree, or soil. Some few grow indiscriminately where they can find conditions favourable to their development. As a rule they avoid too shady situations, and they are to be found in most profusion on the sunny side of tree or wall. The green algae, often deeply seated in the thallus, require the light rays at their highest intensity, these being often obscured by the pigments—protective or otherwise—of the cortical cells. Some species never leave the shore; others are almost entirely confined to mountain-tops. Each species has its chosen locality as well as its favourite habitat. They clothe the rocks with a soft and variegated colouring, or lend a darker shade to the frowning cliffs by the sea. Everywhere they add their share to nature's infinite variety.

In compiling the lists of lichens we have followed the classification of the two parts of the Monograph of British Lichens published by the Trustees of the British Museum. They are known and used by British lichenologists, although Part I. is now somewhat out of date. The species new to Ireland, as far as could be ascertained, have been marked with an asterisk. Use has been made of Mr. Adams's lists in questions of distribution. We do not claim to have exhausted the lichen flora of the district, but only to have given a representative list of these plants, many of them very difficult of detection. My warmest thanks are due to all who have given generously of their time and skill.

List of Species.

Species new to Ireland are marked with an asterisk; tree or bark specimens are marked *B*; rock and wall specimens *R*; ground and soil specimens *G*.

EPHEBACEI.

Ephebe pubescens Nyl.—*R*. Louisburgh. Achill.

COLLEMACEI.

Lichina pygmaea Ag.—*R*. Achill. Clare Island.
  confinis Ag.—*R*. Achill. Clare Island. Louisburgh.
Collema cheileum Ach.—*R*. Achill. Belclare.
  crispum Ach.—*R*. Clare Island.
    var. **ceranoides** Nyl.—*R*. Clare Island.
  cristatum Hoffm.—*R*. Castlebar. Louisburgh.
  furvum Ach.—*R*. Clare Island.
  granuliferum Nyl.—*R*. Clare Island. Westport.
  multipartitum Sm.—*R*. Castlebar.
  nigrescens Ach.—*B*. Belclare. Clare Island. Louisburgh. Westport.
  pulposum Ach.—*R*. Castlebar. Louisburgh.
Leptogium scotinum Fr.—*R*. Clare Island.
  tremelloides Gray.—*G*. Clare Island. Belclare.
Collemopsis Schaereri Nyl.—*R*. Castlebar.

LICHENACEI.

Sphaerophorus compressus Ach.—*G*. Achill. Louisburgh.
  coralloides Pers.—*G*. Achill. Clare Island. Croaghpatrick.
Baeomyces aeruginosus DC.—*G*. Louisburgh.
  rufus DC.—*G*. Achill.
Stereocaulon coralloides Fr.—*G*. Achill. Louisburgh.
  denudatum var. **pulvinatum** Floerke.—*G*. Croaghpatrick. Louisburgh.
Pycnothelia papillaria Duf.—*G*. Achill. Clare Island.
Cladonia alciornis Floerke.—*G*. Clare Island.
  bellidiflora Floerke.—*G*. Achill. Croaghpatrick.
  cervicornis Schaer.—*G*. Achill. Croaghpatrick.
  coccifera Schaer.—*G*. Achill. Louisburgh,
  deformis Hoffm.—*G*. Louisburgh.
  degenerans Floerke.—*G*. Clare Island. Croaghpatrick. Louisburgh.
  digitata Hoffm.—*G*. Louisburgh.
  fimbriata Fr.—*G*. Achill. Clare Island. Louisburgh.
    sub-sp. **fibula**, var. **subcornuta** Nyl.—*G*. Achill, Louisburgh.

Cladonia floerkeana Fr.—*G.* Louisburgh.
furcata Hoffm.—*G.* Achill. Clare Island. Louisburgh.
var. **recurva** Floerke.—*G.* Louisburgh.
var. **spinosa** Hook.—*G.* Louisburgh.
gracilis Hoffm.—*G.* Clare Island.
macilenta Hoffm.—*G.* Achill. Clare Island. Louisburgh.
var. **scabrosa** Nyl.—*G.* Louisburgh.
pityrea Floerke.—*G.* Clare Island. Louisburgh.
pungens Floerke.—*G.* Achill. Castlebar. Clare Island. Louisburgh.
pyxidata Fr.—*G.* Castlebar. Clare Island. Louisburgh. The Bills.
var. **chlorophaea** Floerke.—*G.* Clare Island.
squamosa Hoffm.—*G.* Louisburgh.
subsp. **adspersa** Nyl.—*G.* Achill.
sobolifera Del.—*G.* Achill.
verticillata Floerke.—*G.* Achill. Belclare. Croaghpatrick. Louisburgh.
Cladina sylvatica Nyl.—*G.* Achill. Clare Island. Croaghpatrick. Louisburgh.
uncialis Nyl.—*G.* Achill. Clare Island. Croaghpatrick. Louisburgh.
f. **adunca** Cromb.—*G.* Clare Island. Louisburgh.
f. **bolacina** Cromb.—*G.* Achill.
Ramalina calicaris Nyl.—*B.* Clare Island. Louisburgh.
cuspidata Nyl.—*R.* Achill. Louisburgh. The Bills.
subsp. **breviuscula** Nyl.—*R.* Achill.
* **Curnowii** Cromb.—*R.* Clare Island.
evernioides Nyl.—*B.* Westport.
farinacea Ach.—*B.* Achill. Clare Island. Louisburgh. Westport.
fastigiata Ach.—*B.* Westport.
fraxinea Ach.—*B.* Westport.
var. **ampliata** Ach.—*B.* Westport.
pollinaria Ach.—*B.* Westport.
scopulorum Ach.—*R.* Achill. Clare Island. Louisburgh.
var. **incrassata** Nyl.—*L.* Clare Island.
subfarinacea Nyl.—*R.* Clare Island.
Usnea ceratina Ach.—*B, R.* Clare Island.
dasypoga Nyl.—*B, R.* Louisburgh.
florida Ach.—*B, R.* Achill. Clare Island.
hirta Hoffm.—*B, R.* Achill. Louisburgh.
Platysma glaucum Nyl.—*R.* Clare Island.
Parmelia Borreri Turn.—*B.* Achill. Westport.
caperata Ach.—*B, R.* Achill. Clare Island. Louisburgh.
conspersa Ach.—*R.* Achill. Louisburgh.
f. **isidiata**.—*R.* Achill.

Parmelia exasperata Nyl.—*B.* Clare Island. Louisburgh.
fuliginosa Nyl.—*R.* Achill. Clare Island. Louisburgh.
laevigata Ach.—*B.* Achill. Louisburgh.
omphalodes Ach.—*R.* Achill. Clare Island. Croaghpatrick.
perlata Ach.—*B, R.* Achill. Belclare. Castlebar. Clare Island. Louisburgh.
var. **ciliata** Nyl.—*B, R.* Achill. Belclare. Clare Island. Louisburgh.
physodes Ach.—*B.* Clare Island.
prolixa Nyl.—*R.* Clare Island. Louisburgh.
saxatilis L.—*B, R.* Achill. Belclare. Castlebar. Clare Island. Croaghpatrick. Louisburgh. Westport.
f. **furfuracea** Schaer.—*R.* Achill. Clare Island.
sulcata Tayl.—*B.* Achill. Clare Island. Louisburgh.
tiliacea Ach.—*B.* Belclare.
Stictina fuliginosa Nyl.—*R.* Belclare. Clare Island.
limbata Nyl.—*B.* Louisburgh.
Lobaria pulmonaria Hoffm.—*G.* Clare Island.
Ricasolia amplissima Leight.—*B, R.* Louisburgh.
laetevirens Leight.—*B, R.* Clare Island.
Peltigera canina Hoffm.—*G.* Achill. Clare Island. Louisburgh.
horizontalis Hoffm.—*G.* Clare Island. Louisburgh.
polydactyla Hoffm.—*G.* Belclare. Clare Island.
* **spuria** Leight.—*G.* Belclare. Clare Island. Louisburgh.
rufescens Hoffm.—*G.* Belclare. Clare Island.
f. **praetextata** Floerke.—*G.* Belclare. Louisburgh.
Physcia aipolia Nyl.—*B.* Belclare. Louisburgh.
aquila Nyl.—*R.* Clare Island. The Bills.
lychnea Nyl.—*B.* Clare Island.
parietina De Not.—*B, R.* Achill. Clare Island. Louisburgh. The Bills.
var. **virescens** Nyl.—*B.* Clare Island.
pulverulenta Nyl.—*B.* Louisburgh. Westport.
stellaris subsp. **tenella** Nyl.—*B.* Achill. Clare Island. Louisburgh.
var. **leptalea** Nyl.—*B.* Achill. Louisburgh.
Gyrophora cylindrica Ach.—*R.* Achill. Croaghpatrick.
torrefacta Ach.—*R.* Achill. Croaghpatrick.
Pannaria rubiginosa Del.—*B.* Belclare. Clare Island. Louisburgh.
Pannularia microphylla Nyl.—*G.* Achill. Clare Island.
nigra Nyl.—*R.* Castlebar. Westport.
var. **psotina** Cromb.—*R.* Castlebar.
Coccocarpia plumbea Nyl.—*B.* Achill. Belclare. Louisburgh.
Lecanora albella Ach.—*B.* Achill. Belclare. Clare Island. Louisburgh. Westport.

Lecanora allophana Nyl.—*B.* Westport.
angulosa Ach.—*B.* Clare Island. Westport.
atra Ach.—*R.* Achill, Clare Island. Louisburgh.
caesiorufa Nyl.—*R.* Achill. Clare Island.
calcarea Somm.—*R.* Castlebar. Clare Island.
callopisma Ach.—*R.* Castlebar, Clare Island. Louisburgh.
chlarotera Nyl.—*B.* Louisburgh. Westport.
citrina Ach.—*R.* Belclare. Castlebar. Clare Island. Louisburgh.
coilocarpa Nyl.—*R.* Clare Island.
Dicksonii Nyl.—*R.* Croaghpatrick.
erysibe Nyl.—*R.* Clare Island.
exigua Nyl.—*R.* Clare Island.
* **expallens** var. **lutescens** Nyl.—*B.* Achill.
ferruginea Huds.—*R.* Belclare. Louisburgh.
var. **festiva** Nyl.—*R.* Achill. Belclare. Clare Island. Louisburgh.
galactina Ach.—*R.* Achill. Castlebar. Clare Island.
subsp. **dispersa**.—*R.* Clare Island.
gangaleoides Nyl.—*R.* Clare Island. Louisburgh. The Bills.
gelida Ach.—*R.* Belclare.
(**Psoroma**) **hypnorum** Ach.—*B.* Clare Island.
intumescens Koerb.—*B.* Belclare. Louisburgh.
irrubata subsp. **calva** Nyl.—*R.* Achill. Belclare. Castlebar. Clare Island. Westport.
lacustris Th. Fr.—*R.* Clare Island.
lobulata Somm.—*R.* Achill. Clare Island.
murorum Ach.—*R.* Castlebar. Clare Island. Louisburgh.
parella Ach.—*R, B.* Achill. Belclare. Castlebar. Clare Island. Louisburgh. Westport.
polytropa Schaer.—*R.* Achill. Clare Island. Louisburgh.
subsp. **intricata** Nyl.—*R.* Louisburgh.
pruinosa Nyl.—*R.* Clare Island.
rugosa Nyl.—*B.* Achill. Belclare. Louisburgh.
var. **chlarona** Nyl.—*B.* Achill. Belclare. Clare Island. Louisburgh. Westport.
smaragdula Nyl.—*R.* Achill. Clare Island.
sophodes Ach.—*B.* Louisburgh.
var. **laevigata** Nyl.—*R.* Clare Island.
subfusca var. **campestris** Nyl.—*R.* Achill. Belclare. Clare Island. Louisburgh.
* **symmictera** Nyl.—*B.* Louisburgh.
tartarea Ach.—*R.* Achill. Croaghpatrick. Louisburgh.
vitellina Ach.—*R.* Louisburgh.

Lecanora vitellinula Nyl.—*R.* Castlebar.
Pertusaria communis DC.—*B*, *R.* Belclare. Clare Island. Louisburgh. Westport.
ceuthocarpa Sm.—*R.* Louisburgh.
concreta Nyl.—*R.* Achill. Clare Island. Croaghpatrick. Louisburgh.
f. **Westringii**.—*R.* Clare Island.
dealbata f. **corallina** Cromb.—*R.* Belclare Croaghpatrick.
globulifera Nyl.—*B.* Louisburgh. Westport.
lactea Nyl.—*R.* Achill.
leioplaca Schaer.—*B.* Achill. Belclare. Louisburgh. Westport.
f. **hexaspora** Nyl.—*B.* Westport.
* **gyrocheila** Nyl.—*R.* Achill.
pustulata Nyl.—*B.* Louisburgh.
Wulfenii var. **rupicola** Nyl.—*R.* Achill. Belclare. Clare Island. Croaghpatrick.
Gyalecta cupularis Schaer.—*R.* Castlebar. Clare Island.
exanthematica Sm.—*R.* Castlebar.
Lecidea albocoerulescens Ach.—*R.* Achill. Belclare. Clare Island.
* **auriculata** Th. Fr.—*R.* Achill.
* var. **diducens** Th. Fr.—*R.* Achill. Louisburgh.
cinerascens A. L. Sm.—*R.* Achill. Clare Island.
coarctata Nyl.—*R.* Achill.
var. **elacista** Cromb.—*R.* Westport.
confluens Ach.—*R.* Clare Island. Croaghpatrick.
var. **oxydata** Leight.—*R.* Croaghpatrick.
contigua Fr.—*R.* Achill. Belclare. Clare Island. Croaghpatrick. Louisburgh.
var. **calcarea** Leight.—*R.* Clare Island.
var. **limitata** Leight.—*R.* Clare Island.
var. **flavicunda** Nyl.—*R.* Croaghpatrick. Louisburgh.
var. **platycarpa**.—*R.* Achill. Louisburgh.
crustulata Koerb.—*R.* Clare Island.
goniophila Schaer.—*R.* Clare Island.
granulosa Schaer.—*R.* Achill.
* **latypea** Ach.—*R.* Clare Island.
lithophila Ach.—*R.* Clare Island.
* **Metzleri** Th. Fr.—*R.* Castlebar.
mutabilis Fée.—*B.* Castlebar.
parasema Fr.—*B.* Achill. Belclare. Castlebar. Clare Island. Louisburgh. Westport.
var. **elaeochroma** Sch.—*B.* Westport.
protrusa Fr.—*R.* Achill.

Lecidea rivulosa Ach.—*R.* Achill. Clare Island. Croaghpatrick.
sorediza Nyl.—*R.* Clare Island.
Taylori Mudd.—*R.* Clare Island.
Biatorina biformigera A. L. Sm.—*R.* Clare Island.
chalybeia Mudd.—*R.* Clare Island.
lenticularis Koerb.—*R.* Castlebar. Clare Island. Louisburgh.
lutea Arn.—*B.* Belclare.
premnea A. L. Sm.—*B.* Belclare.
Bilimbia aromatica Jatta.—*R.* Achill. Castlebar. Clare Island.
albidocarnea subsp. **chlorotropoides** A. L. Sm.—*R.* Castlebar.
lignaria Massal.—*G.* Achill. Clare Island.
var. **saxigena**.—*R.* Achill. Belclare.
melaena Arn.—*G.* Louisburgh.
mesoidea A. L. Sm.—*R.* Clare Island.
Naegelii Anzi.—*B.* Clare Island.
sabulosa Massal.—*G.* Achill.
Bacidia arceutina Branth and Rostr.—*B.* Achill.
var. **hypnea** A. L. Sm.—*G.* Achill.
atrogrisea Arn.—*B.* On Hazel, Castlebar. Achill.
egenula Th. Fr.—*R.* On walls, Clare Island.
umbrina Branth and Rostr.—*R.* Achill.
Buellia aethalea Th. Fr.—*R.* Achill.
atroalba Th. Fr.—*R.* Clare Island.
canescens De Not.—*R.* Clare Island. Louisburgh. The Bills.
colludens Tuckerm.—*R.* Achill. Clare Island. Croaghpatrick.
confervoides Koerb.—*R.* Westport.
coniopta Nyl.—*R.* Clare Island.
myriocarpa Mudd. (on. rock).—*B.* Clare Island.
Parmeliarum Oliv.—On Parmelia, Clare Island.
saxatilis Koerb.—*R.* Clare Island.
spuria Koerb.—*R.* Clare Island. Louisburgh.
stellulata Mudd.—*R.* Clare Island. Louisburgh.
verruculosa Mudd.—*R.* Clare Island.
Rhizocarpon alboatrum Th. Fr.—*R.* Achill. Louisburgh.
calcareum Th. Fr.—*R.* Castlebar. Westport.
confervoides DC.—*R.* Achill. Belclare. Clare Island. Croaghpatrick. Louisburgh.
geographicum DC.—*R.* Achill. Clare Island. Louisburgh.
Œderi Floerke.—*R.* Belclare. Clare Island.
petraeum Massal.—*R.* Achill. Clare Island. Louisburgh.
var. **excentricum** A. L. Sm.—*R.* Belclare. Clare Island. Louisburgh.

Arthonia gregaria Koerb.—*B.* Belclare. Louisburgh.
var. **kermesina** A. L. Sm.—*B.* Belclare.
radiata Ach.—*B.* Castlebar. Clare Island.
var. **Swartziana** Sydow.—*B*, Louisburgh. Westport.
* **subvarians** Nyl.—*R.* Castlebar.
***Opegrapha areniseda** Nyl.—*R.* Belclare.
atra Pers.—*B.* Achill. Belclare. Castlebar. Clare Island. Louisburgh Westport.
betulina Sm.—*B.* Louisburgh. Westport.
* **calcarea** Turn.—*R.* Achill. Clare Island. Louisburgh.
confluens Stiz.—*R.* Achill. Clare Island.
saxicola Ach. var. **Decandollei** Stiz.—*R.* Achill.
varia Fr.—*B.* Louisburgh. Westport.
vulgata Ach.—*B.* Belclare. Louisburgh. Westport.
Graphis elegans Ach.—*B.* Clare Island. Louisburgh.
scripta Ach.—*B.* Belclare. Louisburgh.
var. **serpentina** Nyl. *B.* Castlebar. Louisburgh.
Phaeographis inusta Muell.-Arg.—*B.* Belclare. Louisburgh. Westport.
Graphina anguina Muell.-Arg.—*B.* Belclare. Clare Island. Louisburgh. Westport.
var. **pulverulenta** A. L. Sm.—*B.* Achill.
Enterographa crassa Fée.—*B.* Westport.
Dermatocarpon aquaticum A. Zahlbruckner.—*R.* Achill.
hepaticum Th. Fr.—*G.* Belclare. Louisburgh.
lachneum A. L. Sm.—*G.* Westport.
miniatum Th. Fr.—*R.* Clare Island.
Normandina pulchella Cromb.—*B*, *G.* Clare Island. Louisburgh.
Verrucaria aethiobola Wahlenb.—*R.* Clare Island.
calciseda DC.—*R.* Castlebar. Westport.
coerulea DC.—*R.* Castlebar.
fuscella Ach.—*R.* Castlebar. Westport.
laevata Ach.—*R.* Clare Island.
margacea Wahlenb.—*R.* Clare Island.
maura Wahlenb.—*R.* Achill. Clare Island. Louisburgh.
* var. **memnonia** Koerb.—*R.* Clare Island.
* **mauroides** Schaer.—*R.* Clare Island.
* **microspora** Nyl.—*R.* Clare Island.
mucosa Wahlenb.—*R.* Clare Island.
muralis Ach.—*R.* Achill. Castlebar. Clare Island.
nigrescens Pers.—*R.* Castlebar. Clare Island. Westport.
prominula var. **viridans** Nyl.—*R.* Clare Island.
submersa Schaer.—*R.* Clare Island.
viridula Ach.—*R.* Clare Island.

Thelidium pyrenophorum Koerb.—*R.* Achill.
Polyblastia deminuta Arn.—*R.* Castlebar.
* **intercedens** Lönnr.—*R.* Clare Island.
Staurothele rupifraga Arn.—*R.* Castlebar.
Acrocordia biformis Oliv.—*B.* Belclare. Louisburgh. Westport.
gemmata Koerb.—*B.* Westport.
* **Arthopyrenia epidermidis** Mudd.—*B.* Belclare. Louisburgh. Westport.
cinereopruinosa Koerb.—*B.* Clare Island.
fallax Arn.—*B.* Belclare. Castlebar.
* **leptotera** A. L. Sm.—*R.* Achill.
* **litoralis** A. L. Sm.—*R.* Clare Island.
* **microspila** Koerb.—*B.* On Hazel. Castlebar.
* **punctiformis** Arn.—*B.* Achill. Castlebar.
* **submicans** A. L. Sm.—*B.* Louisburgh.
* **Microthelia micula** Flot.—*B.* Belclare.
* **dissepta** A. L. Sm.—*B.* On *Rhizocarpon confervoides*, DC. Achill.
Porina carpinea A. Zahlbr.—*B.* Achill. Clare Island. Louisburgh.
chlorotica Wainio.—*R.* Achill. Castlebar. Clare Island. Louisburgh.
olivacea A. L. Sm.—*B.* Achill.
Pyrenula nitida Weig.—*B.* Belclare Louisburgh. Westport.
Melanotheca gelatinosa Nyl.—*B.* Clare Island. Louisburgh.

Bibliography.

In view of the publication by Mr. Adams in a recent volume of these "Proceedings" of a full bibliography of Irish Lichens, as an addendum to his paper on "The Distribution of Lichens in Ireland" (vol. xxxvii, Sect. B, No. 10, 1909), a list of the papers dealing with the Lichens of this district appears superfluous. No important paper has appeared since the date of Mr. Adams's list.

Index of Genera.

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MARINE ALGAE.

By A. D. COTTON.

Plates I.–XI.

Read June 24 and November 11. Published November 27, 1912.

CONTENTS.

PREFACE.

The natural history Survey of Clare Island and the adjoining mainland provided an opportunity of investigating one of the most interesting algological regions in the British Isles. Since the first decade of the last century, when Miss Hutchins collected in Bantry Bay, and more especially since the days when Harvey published his famous "Phycologia Britannica," the west of Ireland has always possessed a great attraction for the marine botanist. But although various collections and many gatherings of new and rare species have been dealt with, no systematic investigation of that area has been undertaken, nor has any list or general account of the algal flora been published. The selection of Clare Island as a centre for a detailed survey was therefore particularly satisfactory from an algological standpoint. Results for the systematist and student of plant-distribution were certain, and the

variety of ground in the neighbourhood provided ample scope for the modern study of plant-communities. The position of the island—off the coast of Co. Mayo, and in the Gulf Stream drift—ensured the presence of that southern element which gives the Irish flora its peculiar interest.

The following report shows that the hopes raised have been amply fulfilled. The flora proved quite as rich as was expected; and practically all the species for which the west of Ireland is noted occur within the survey-area. Valuable systematic results have been obtained; and the variety of algal associations present rendered the study of the marine vegetation one of the most comprehensive that has yet been carried out. Important phytogeographic data also, necessitating the modifying of previous views, were secured.

INTRODUCTION.

1.—Definition of the Area.

Owing to the comprehensive nature of a natural history survey, the limits of the area investigated varied in different cases, since in some it was advisable to include a much larger area than in others. With regard to the marine algae, it was thought best to limit the investigation to Clare Island and the neighbourhood of Clew Bay. By concentrating attention on a small district a more accurate knowledge of the true nature of the vegetation can be obtained, and the variety of ground presented in the area mentioned proved quite as much as was possible to work with a moderate degree of thoroughness.

The Survey-area for the algae, therefore, consisted of Clare Island, the shores and waters of Clew Bay, and an extension to the north to include Bellacragher Bay and Achill Sound.

At the same time it appeared advisable not to overlook the interesting records from Roundstone, a locality only twenty-five miles south of Clew Bay. This district was carefully worked some seventy years ago by W. McCalla, and he collected several species which were not found in the Clare Island district. A brief visit was paid to Roundstone; and all records from that locality are included in the report.

2.—Previous Work in the Area.

According to the scheme of geographical areas devised by Adams (see Adams, '11, in Bibliography) the province of Connaught is divided into three sub-divisions. Co. Mayo (which includes the survey-area proper) forms sub-division C 2, and, according to an annotated copy of Adams' Synopsis (Adams,

'08), kindly sent me by the author, possesses thirty records of algae. Co. Galway, on the other hand, which forms sub-division C 1, has a much longer list, owing to the collections made at Roundstone Bay. For the third sub-division, C 3 (i.e., counties Sligo and Leitrim), there are practically no records.

With regard to sub-division C 2, Wm. Thompson, the zoologist, collected a few plants in Clew Bay about 1840; and Harvey quotes one record—*Asperococcus bullosus*—in "Phycologia Britannica." In a report of a natural history excursion to Achill at Easter, 1898, H. Hanna deals with the marine algae (Hanna, '98). He records twenty species; and this constitutes the only account of the sea-weeds of the area. Adams, in his list, adds nine names to the flora of the sub-division, culled from various sources. A single species has been recorded from Clare Island, namely *Codium tomentosum* (*vide* H. H. Dixon, Ann. Bot., xi, p. 590).

The Roundstone records date from 1808. *Fucus Mackaii* was described from that locality by Dawson Turner ("Historia Fucorum," Pl. 52); and it still remains one of the few stations for the plant in Ireland. In addition to the discovery of this species, Mackay noted the presence of *Rhodochorton floridulum*, which Harvey mentions in the chapter on algae in Mackay's "Flora Hibernica." McCalla's records follow. He thoroughly explored the shore, and supplied Harvey, as the pages of "Phycologia Britannica" testify, with much valuable material both from Roundstone Bay and Birturbuy Bay. McCalla was also one of the pioneers of dredging amongst algologists, and by this method he obtained many interesting species. He commenced to issue a set of "Algae Hibernicae," but, owing to his untimely death in 1849, only two volumes were published. Harvey visited Roundstone at least once, and in later times, Johnson ('93) and H. Hanna. Foslie also, the well-known specialist on calcareous algae, came over from Norway on purpose to investigate the Lithothamnia which had been described from Roundstone by McCalla and Harvey. An account of his trip was published in the "Irish Naturalist" ('99, p. 175). Foslie was keenly interested in the Lithothamnia of the British Isles, and it was proposed to send him for identification all the Clew Bay material. His premature death in 1910 came as a great shock. Three days were spent by me at Roundstone in September, 1911, and, with the exception of *Codium amphibium*, all the species for which that locality is famous were seen in their natural habitat. The total number of species listed by J. Adams for the sub-division C 1 is 162.

Outside the province of Connaught, Valencia Harbour (in the extreme south-west) has been specially investigated by biologists, and Weiss, who dealt with the algae ['00], gives a list of eighty-six species collected by him during August and September, 1896, with notes on the same.

3. Field-Work and Assistance.

My visits to the Survey-area extended over three years. In each year two visits, varying from a fortnight to three weeks, were paid to the island and mainland, whilst during the last year, an additional winter visit was accomplished. Owing to the uncertainty of communication, no attempt was made during this last trip to cross to the island, but since the conditions of the exposed mainland are similar to those of Clare Island, a fair idea of the winter aspect of the vegetation of the whole area was obtained. In addition, Mr. J. Adams, of the Royal College of Science, Dublin, visited the district in August, 1909, investigating the island and dredging in Clew Bay.

The dates of the visits were as follows:—

1909. April 8–20; July 12–27. [August 20–27, J. Adams.]
1910. June 16–July 1; September 30–October 13.
1911. February 13–21; April 28–May 13; August 17–September 4.

About one-half the time of each trip was spent on the island, and the remainder either on the mainland or in dredging. Spring-tides were usually selected for the former locality, when exposed or semi-exposed shores were examined at low-water. As is well known, spring-tides are more useful in sheltered regions than in exposed, and a greater number of rare and sub-littoral species are doubtless uncovered during springs in Clew Bay than on Clare Island. But since these can readily be obtained by dredging, there was no object in reserving low-tides for mainland work.

Dredging was carried out in February, May, July, and August. For the more open waters I had the advantage of the ss. "Helga," of the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland. The outer part of Clew Bay was explored, and a number of hauls were taken further out, i.e., to the south and west of Clare Island, and near The Bills, in depths ranging from 10 to 20 fathoms. A large amount of material was collected, and considerable light obtained as to the nature of the benthos, but for detailed study much longer time than was at my disposal was necessary. J. Adams also dredged from the "Helga" in 1909, and two interesting algae were found only on that occasion.

For the inner part of Clew Bay a small sailing-boat was used; and good work was accomplished by means of a hand-dredge in 1–5 fathoms. The "coral-banks" were investigated, and in quiet weather very much may be learned as to the nature of the flora. The February dredgings were useful in obtaining fruiting specimens of encrusting algae. In May the mass of vegetation is so great that it is impossible to do more than sample various localities. As the hauls of July, 1909, had provided several rare and interesting

plants, a few days were set apart in August, 1911, to search for noteworthy absentees. Rough weather, however, set in, and dredging from a small boat was out of the question.

With regard to the nature of the field-work, the visits of the first year were mainly devoted to the listing of species from all parts of the area, and to working out critical forms. The same study was continued in 1910, and the analysis of algal communities was also taken in hand. The third year was principally devoted to the search for species which were to be expected but had not been found, and to the completion of the work on algal communities. On each visit, moreover, a large amount of material was collected for the Royal Botanic Gardens, Kew, as some extra leave had been granted for that purpose.

The time devoted to ecology necessarily robbed the systematic list of a certain number of names. Searching for rare or microscopic species invariably yields results in the way of new or little-known plants, but the records of minute species, such as Cyanophyceae, are not yet of much value for comparative purposes. Moreover, the amount of time and labour spent in working out microscopic forms is often very great, and out of proportion to the results obtained. Unfortunately there was no specialist for the Cyanophyceae (which are abundant in brackish parts of Clew Bay) who could be appealed to for aid.

The list, therefore, can hardly be considered as exhaustive. With regard to the littoral flora, the island-list must be fairly complete; and on the mainland the additions during the last trip were chiefly microscopic forms. But in the sub-littoral region there are probably many species yet to be discovered, as the vegetation is very local and less easy of exploration. The fact that such conspicuous weeds as Dictyopteris, Acrothrix, *Dasya corymbosa*, and several others were only seen once, confirms this view.

Assistance.—Dr. P. Kuckuck joined the collecting party during June, 1910, and advantage was taken of his critical knowledge of the Phoeophyceae to work out Ectocarpi, Chordarieae, &c., and to make comparisons between the flora of the North Sea and Baltic, and that of Clare Island.

In April, 1911, Dr. F. Börgesen paid a visit to the Survey-area. Naturally the vegetation of Clare Island had been continually compared with the detailed account given by him for that of the Faeröes, and several striking contrasts had been noted. It was, therefore, of the greatest value to be able to examine the algal associations with Dr. Börgesen, and to discuss the problems that had arisen. His help also with regard to the Iceland flora was particularly useful.

In order to make the floristic section of the work as accurate as possible,

which for comparative purposes is of the very greatest importance, I have availed myself freely of the help of specialists. Dr. Kuckuck kindly worked out the Ralfsiae, and checked a number of other members of the Phoeophyceae. The weight of his authority in doubtful cases was most valuable. I am also much indebted to Dr. M. Lemoine. Since the death of Foslie, the identification of encrusting Lithothamnia was uncertain work, owing to the confusion in the literature, and the scarcity of reliable material in British herbaria. Madame Lemoine willingly undertook to examine the Irish material, and, by her method of anatomical investigation, to work out and compare critical species with authentic specimens. Though no important additions to the list have resulted, it is highly satisfactory to have trustworthy identifications. An interesting point with regard to geographical distribution has, moreover, been cleared up by her. Dr. K. Rosenvinge kindly determined the Chantransiae, whilst Prof. N. Wille, Prof. C. Sauvageau, and Dr. H. H. Peterson examined the species of Ulothrix, Spacelaria, and Ceramium respectively. Prof. G. S. West's opinion on the brackish and freshwater species, and Mr. J. Adams' aid in connexion with the distribution of Irish plants were most helpful. Mr. E. M. Holmes has taken the keenest interest in the Clare Island flora, and throughout the work of identification has always most liberally bestowed the benefit of his valuable and unique experience. To all these botanists I offer my sincerest thanks. Special acknowledgments are due to Mr. R. Lloyd Praeger, the organizer and secretary of the Survey, to whom I am deeply indebted for advice on matters botanical and geological, as well as for encouragement and assistance in a number of ways.

I.—THE EXTERNAL CONDITIONS OF THE AREA.

1.—Climatic Conditions.

1. *Atmospheric Temperature and Moisture.*—The insular climate of Ireland, and the influence of the Gulf Stream drift, combine to render the Clare Island district particularly mild and damp. In winter rough stormy weather prevails, together with a large amount of rain, but frost is rare. In summer the weather is changeable, rain and gales from the south-west are frequent, and the average temperature relatively low. Though occasional warm days occur, spells of hot dry weather are most unusual; and this renders the intertidal region more favourable for vegetation than that of the south coast of England. A glance at the isotherms of Europe shows that the mean January temperature of 43° F. (= 6·11° C.) corresponds with that of the south of France and the north of the Adriatic; whilst the July isotherm of 58° F.

(= 14·44° C.) runs up the coast of Norway, across the north of Sweden to northern Russia and Siberia. Clare Island is situated on the same latitude as Heligoland and Kiel, but, as will be seen later, the flora is of a very much more southern type.

The atmospheric moisture is of importance in connexion with the littoral vegetation. But the problem of desiccation during low water is a very complicated one, the latitude, together with the amount of wind and sunshine, having to be taken into consideration. The following figures ("Irish Coast Pilot," ed. 6, 1911) give the mean humidity for the Blacksod Point Observatory for the last thirty-five years. It will be noted that the highest figures are those of the winter months, whereas in the Faeröes the reverse is the case, for which the absence in Ireland of summer fogs is probably responsible:—

Jan.	Febr.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
88	87	86	86	81	81	84	83	84	81	86	85

NOTE.—Observations made at 8 a.m. 100 = Saturation point.

2. *Temperature and Salinity of the Sea.*—Important as are atmospheric conditions, the temperature of the water is even more intimately connected with the algal vegetation. The direct influence of the former is confined to the intertidal region, and is thus intermittent; but the effect of the latter is much more general, being felt both by the littoral and sub-littoral flora. A complete series of observations on sea-temperatures at different depths is not available for Clare Island; but the Meteorological Office has favoured me with details of the mean monthly surface-temperatures for Blacksod Bay and Cleggan during the year 1911; and Mr. G. P. Farran has kindly supplied me with two sets of temperatures and salinities for various depths in Clew Bay and off Clare Island. From these it is evident that the surface temperature does not differ much from that of 10–20 fathoms, so that the monthly table given below affords a good general guide. The Blacksod and Cleggan observatories are about twenty miles north and south respectively of Clare Island. It will be noted that many of the Blacksod figures are slightly higher than those of Cleggan, for which local topography doubtless accounts:—

MEAN SURFACE TEMPERATURE, BLACKSOD AND CLEGGAN, 1911. (C°).

	Jan.	Febr.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Blacksod,	7·2	6·7	6·7	8·3	11·7	13·3	16·1	16·1	13·3	10·6	7·2	6·7
Cleggan,	7·2	6·7	6·7	8·3	11·1	12·2	13·3	15·0	13·9	10·6	7·2	5·6

CLARE ISLAND, MAY, 1909.

Station Number.	Date.	Surface.		1–10 fathoms.		11–20 fathoms.		21–30 fathoms.	
		Temp. °C.	Sal. °/₀	Temp. °C.	Sal. °/₀	Temp. °C.	Sal. °/₀	Temp. °C.	Sal. °/₀
Clare Island W. 67,	21. 5. '09	11·15	34·61	—	—	10·69 (20 fath.)	34·64	—	—
,, W. 69,	22. 5. '09	11·35	34·60	—	—	—	—	10·78 (24 fath.)	34·64
,, W. 70,	,,	11·30	34·61	—	—	10·50 (18 fath.)	34·67	—	—
,, W. 72,	,,	11·3	34·69	11·23 (9 fath.)	34·72	—	—	—	—
,, W. 75,	24. 5. '09	11·0	34·74	—	—	10·71 (12 fath.)	34·72	10·55 (25 fath.)	34·72
,, W. 81,	25. 5. '09	11·05	34·70	—	—	—	—	10·87 (25 fath.)	34·65
,, W. 82,	,,	11·15	34·79	—	—	—	—	—	—

CLARE ISLAND, AUGUST, 1911.

Clare Island W. 197,	18. 8. '11	17·40	34·43	—	—	15·19 (18 fath.)	34·72	—	—
,, —	,,	16·96	34·54	16·12 (8½ fath.)	34·56	—	—	—	—
,, —	20. 8. '11	17·77	34·42	—	—	—	—	—	—
,, —	,,	17·94	34·42	—	—	—	—	—	—
,, —	,,	18·05	34·31	—	—	—	—	—	—
,, —	,,	18·25	34·29	—	—	—	—	—	—
,,	,,	17·92	34·29	—	—	—	—	—	—
,,	21. 8. '11	16·92	34·51	—	—	—	—	—	—
,, W. 205,	,,	16·68	34·67	—	—	—	—	13·68 (22 fath.)	—
,, W. 206,	,,	16·67	34·79	—	—	—	—	14·00 (24 fath.)	34·88
The Bills W. 207,	,,	16·88	—	—	—	—	—	13·48 (25 fath.)	—
,, W. 208,	,,	16·91	34·78	—	—	—	—	14·01 (26 fath.)	34·97
Clare Island W. 210,	,,	16·93	34·63	—	—	14·46 (20 fath.)	—	—	—
Clew Bay W. 216,	,,	17·74	34·42	—	—	—	—	—	—
Clare Island W. 222,	22. 8. '11	16·34	34·78	—	—	14·94 (17 fath.)	34·79	13·96 (24 fath.)	34·88
Clew Bay W. 228,	23. 8. '11	17·25	34·67	—	—	—	—	—	—
,, W. 230,	,,	16·96	34·47	—	—	—	—	—	—

(3) *Tides and Currents.*—The presence of a good ebb and flow on Clare Island gives a wide intertidal region for shore-collecting. At Westport Quay the rise and fall during spring-tides is about 15 feet, and in April and September 16 feet 6 inches, whilst with neap-tides there is a rise of 12–13 feet. On Clare Island the range is, if anything, greater. Low water at spring-tides is in the middle of the day. In certain spots (i.e. between the islands in Clew Bay and at Darby's Point, Achill Sound) there is a strong current, and the vegetation is of a different character from that found in other parts. Ballacragher Bay, owing to its narrow opening, has but a small tide—not more than 5–6 feet—except during springs.

2. Physical Nature of the Coast and Conditions of Exposure.

Our district presents great diversities in the physical nature of the shore; and in describing the same it will be both convenient and natural to divide it into two areas, viz. (1) Clare Island, and (2) the mainland. Speaking generally, the island presents an exposed rocky coast, whilst the mainland consists of sheltered ground. In view of the possibility of future work in the neighbourhood, a detailed account of the coast-line is given.

(1) *Clare Island.*—With the exception of the bay near the harbour and a few sandy patches elsewhere, the whole shore is rocky and cliff-bound. Taking the different parts of the island in order, we find that on the south side the rocks are composed of Silurian slate, which forms flat slopes where the beds lie more or less horizontally, but which is very sharp and rugged where the strata are upturned. Rock-pools, narrow gulleys, and deep channels are frequent, and these were found to be useful, as this part of the shore is as a whole somewhat rough and exposed for general collecting.

The eastern end of the south shore, and from the corner of the bay to Kinnacorra, is composed of Carboniferous sandstone, a formation found to afford excellent collecting-ground. Various degrees of slope and exposure are presented; and towards Kinnacorra there is a fine series of flat rocks and a number of shallow pools. The Carboniferous sandstone is continued to Portlea, a semi-sheltered bay on the north-east side of the island. A boulder-beach surmounts the upper part of this bay; and the rocks below are flat, with a vegetation somewhat different from that found elsewhere. Further north, towards the lighthouse, the slate is again in evidence; and here caves and vertical surfaces, receiving little direct sunlight, are found, and several shade-loving species appear in the open. Though bounded by cliffs, the shore at this point is easily accessible. The fine stretch of cliff on the north-west side of the island is for the most part precipitous, and the narrow strip of shore below is very exposed and difficult of exploration.

In certain spots it is possible to descend to sea-level, which is found to be strewn with large, irregular blocks and boulders. Little seaweed vegetation, however, occurs. On the cliff, colonies of sea-birds provide the conditions which favour a vigorous growth of *Prasiola stipitata.*

With regard to exposure, Beetle Head (or Kinatevdilla) and the shore below the north-west cliff are open to the ocean, and feel the full force of the Atlantic rollers. The south side is open to the sea from the south-west, and is also very exposed; but it is not subjected to quite such boisterous conditions as is the north-west side. Owing to the prevalence of south-westerly gales, the exposure on this shore must, however, be very severe. A bend at the eastern end towards the castle affords some protection, as evidenced by the change in the character of the Fucus growth. The sandy bay near the harbour, which faces east, provides the only sheltered shore on the island, and a few sand-loving species are found at the northern corner. Beyond the bay, the stretch of rocks leading to Kinnacorra is subjected to moderate wave-action, and on the whole the conditions are semi-exposed. At Alnahaskilla (beyond Kinnacorra) greater exposure is met with, owing to the sea coming in from the north; and for the same reason all points along the north-east side are subjected to rough water, though a certain amount of shelter is found in the intervening bays and inlets. In a general way the north-east shore is decidedly more protected than the south, but less so than Kinnacorra.

(2) *The Mainland.*—When investigating the mainland, it was the usual practice to begin at Roonah Point, at the south-west corner of the Clew Bay, work round to Mulranny on the northern side, and then proceed to Achill Sound and Bellacragher Bay. In describing the ground it will be convenient to follow the same order.

Roonah Quay faces west, and the rocky shore of Silurian slates at the point is subjected to the same exposed conditions as Clare Island. To the south there is a long stretch of boulder-beach, but the presence of rocks in shallow water provides shelter, and there is a certain amount of fairly good collecting-ground. At the point itself, small bays and caves with partial shelter occur. Turning the corner into Clew Bay the exposure rapidly decreases, and between this point and Bartraw there is a series of beaches composed of rocks, boulders, or sand. The surf-loving Nemalion is found as far in as Old Head, where steep rocks and rough water occur for the last time; shallow water then sets in, and there is much sand. When the islands of the bay are reached, the tide recedes for a long distance, and a certain amount of mud begins to appear, but in several spots a luxuriant littoral vegetation exists.

Many of the islands provide flat beaches of sand and stone with good collecting-ground at low water. At Annagh Island there is a salt-marsh. The Bunowen river at Louisburgh, the stream at Belclare, and the rivers at Westport and Newport give brackish and fresh-water conditions. In the innermost part of the bay there are wide stretches of mud, and the ground is very poor; with the exception of hasty inspections near Westport and one day at Newport, it was but little explored. The northern side consists largely of sand. At Mulranny there are strips of salt-marsh, also fresh-water and brackish streams. The peninsula of Curraun Achill follows, with a rocky shore of Old Red Sandstone and exposed conditions.

The floor of Clew Bay is everywhere soft, consisting of sand with stones. In spring and early summer there is a rich and luxuriant sub-littoral vegetation, which in shallower parts may be easily studied from a boat, or hauled up by a hand-dredge. Banks of Lithothamnium occur, and there are numerous Zostera beds. Between the outer islands, channels with a swift current, where the bottom is usually stony, are frequent.

Achill Sound, easily reached by train from Mulranny, provides perfect shelter, and yet fully saline conditions. At low water, the Sound becomes dry, exposing a large stretch of sand. The water enters from both the north and south, and at the end of the ebb-tide the parting of the streams will be observed to take place at a point about a quarter of a mile south of Achill Bridge. The vegetation is for the most part poor, especially in the summer; but channels provide good ground, and the stones set out by the peasants yield a fine crop of Fucus. Further south (towards Achillbeg) there are swift currents and deeper water, and here a marked increase in the luxuriance of the vegetation is noticeable. On the north side of the bridge there is much mud; but the peat banks flooded by the tide offer some interesting types of plant-associations. Bellacragher Bay, a lough-like inlet surrounded by high hills, differs from Achill Sound in possessing deep water, and being less tidal. It is connected with the sea (Blacksod Bay) by a narrow opening at the north-west corner. Several streams descend from the hills; and owing to the water only partly escaping on the ebb, the whole bay must be often more or less brackish. Some samples taken at the end of the dry summer of 1911 showed, however, almost normal salinity. The littoral region is narrow, and composed of stones or rock. The bottom appears to be rocky, since a vigorous belt of Laminaria is disclosed at low water.

II. THE ALGAL VEGETATION.

(1) Historical Résumé of Previous Work.

As the present paper forms the first detailed account of the algal associations in any area in the British Isles, a general introductory sketch of the subject may be useful.

Kjellmann's papers on the algal regions and formations of the Murman Sea ('77) and the Skager Rack ('78), form the starting point of the modern method of studying algal communities. Kjellmann divided the vegetation into three "regions," and these he further divided into a number of "formations," which were characterized by a distinctive vegetative facies, due to the predominance of one or more algae.

The main outlines of Kjellmann's classification have been accepted by subsequent writers, though of late years changes in terminology and great elaboration have been noticeable. One of the earliest attempts to apply Kjellmann's methods of study to other countries is contained in a paper by Rattray ('85). The paper, which is a biological and ecological account of the algae of the Firth of Forth, is seldom referred to, though it was apparently the first and, until quite recently, the only one of the kind dealing with an area in the British Isles.

In other countries, however, this branch of ecology has received more attention. The Norwegian algal vegetation has been studied by Hansteen ('92), Gran ('93), Boye ('94–'95), and Kylin ('10), and an account of the Faeröese algae was published by Simmons ('99). The Greenland marine algae have been thoroughly studied by Rosenvinge, who, after giving two systematic accounts, furnished a paper dealing with the algological communities ('99). The marine algae of the Baltic have been investigated by Svedelius ('01), who, in his "Osterjöns Hafsalgflora," devotes a chapter to the algal regions and formations found under the peculiar conditions presented in that area. The question of defining the algal regions in the non-tidal Baltic had also been dealt with by Reinke ('89). The algae of the Faeröes have been described a second time in the "Botany of the Faeröes"; and Börgesen's treatise "The Algae Vegetation" ('05), which followed his systematic account, is the most important contribution to this branch of algological literature. Kylin, in his algal flora of the west coast of Sweden ('07), deals with associations and other ecological problems at some length. Joubin ('09) described the marine communities at Roscoff, and published an elaborately coloured vegetation-map. The map will be most useful to students working in the locality; but floristic and ecological data are at present somewhat scanty for

comparative purposes. For the Adriatic, we have Tecket's general account of the algal vegetation of Trieste ('06). The Iceland marine algae are the latest to receive attention from the ecological standpoint, Jónsson's work ('10) forming a useful addition to his systematic papers which appeared previously. Outside Europe, Svedelius' paper on the periodicity of algae in Ceylon coral-reefs ('06), Skottsberg's work in the Antarctic ('06), and Börgesen's accounts of the algal vegetation of the Danish West Indies ('00, '01, '11) are apparently the only papers of the kind which have appeared; but reference should be made to Weber van Bosse ('04), and Schiller ('09), which border on the subject.

Turning to the British Isles, with the exception of Rattray's paper referred to above, no account of the algal communities found on our coasts has appeared, though, as will be seen later, a certain amount of autecology has been done. The numerous and important additions to the British algal flora recorded by Mr. E. M. Holmes and by the late Mr. E. A. L. Batters, have kept our knowledge of the flora well up to date as far as its purely systematic aspect is concerned. Ecological factors, too, were not disregarded, the "habitat" of a species having been always given a prominent place by British writers; so much so, that in a few cases the specific distinction of similar plants has been strongly advocated on the ground of a difference in habitat. Casual reference to the "Fucus-belt," "Coral-banks," and "Laminaria-zone," shows that the more obvious associations were not overlooked.

Rattray ('85) treats at some length of the size of individuals when gathered from different localities and from different levels; he also deals with various problems connected with the distribution and development of the spores. With regard to algal communities, he recognizes the "regions" of Kjellmann, and describes a number of "areas" ("formations" of Kjellmann) characterized by the presence of certain dominant species. His "areas," whether littoral or sub-littoral, are classified almost entirely with reference to vertical distribution, and there is no attempt to connect them with other conditions such as exposure and desiccation. This results at times in a curious association of names in a given zone, and renders the account somewhat obscure to anyone not familiar with the exact topography of the locality. The paper is, however, full of facts, and will be of great interest and value to the next investigator of the algal vegetation of the Firth of Forth.

In a memoir on *Chondrus crispus* by Darbishire ('02), the general ecology of the plant is dealt with, and incidentally reference is made to the principal zones of vegetation that occur on the shores of the Isle of Man. Two

interesting ecological papers by Miss S. M. Baker have lately appeared ('09, '10), in which experiments, with a view to determine the causes which bring about zonation, are described; but the general question of algal associations is not touched upon. The ecology of *Ulva Lactuca* has been discussed by me at some length in a report to the Royal Commission on Sewage Disposal ('11 *b*). The subject of plant-communities was not in view, but the presence of a distinct mud-formation and an Ulva-association, though not stated in words, was clearly demonstrated. N. H. Johnson has furnished two notes dealing respectively with the mapping and nomenclature of marine vegetation ('11, '12).

An account of the algal associations of a definite area in the British Isles was thus urgently needed, and in the Clare Island investigations this study was given a prominent place. It will be noted that in several of the works referred to, the systematic account was published first, and the ecological treatise appeared later. This order of investigation is essential. The flora must be thoroughly mastered, before the groupings of the species can be accurately studied.

(2) The Areas and the Units of Vegetation.

A. *The Regions.*

Kjellmann's term "region" has been generally adopted by algologists; but the limits of the three vertical divisions included under this term are variously accepted. In the present account they are taken as under:—The *littoral* region extends from the level of the highest marine vegetation to that of low-water mark at neap-tide. The *sub-littoral* begins from the lower limit of the last-named, and extends down to the limit of seaweed vegetation (i.e. about 25 fathoms). The *elittoral* region follows, and being devoid of algal vegetation, is of no importance in the present paper.

The reasons for so defining these regions are as follows:—With regard to the upper limit of the littoral region, this, according to Kjellmann, commenced at the highest tide-level; but, as several writers have pointed out, the algae on exposed coasts often extend far above the spring-tide limit. A separate region—the supra-littoral—has been suggested by Lorenz. Börgesen, however ('05), showed that no hard-and-fast line can be drawn between the vegetation of the supra-littoral and littoral, and for this reason he did not recognize the area as a definite region. In Clare Island the supra-littoral vegetation, though often found, is of less general occurrence than, for instance, in the Faeröes. It is largely due to the presence of spray (a factor

which is regulated by the exposure and lie of the rocks), but shade and terrestrial moisture are also important. The associations, moreover, found in this area are the same as those in the upper part of the littoral region, and often merely extensions of them. I therefore agree with Börgesen in not regarding it as a separate region.

With regard to the lower limit of the littoral area, on exposed coasts the low-water mark at neap-tide is certainly the natural line of demarkation. At the same time, on a calm day during spring-tides, the Laminaria and Alaria growth may be exposed, and become dry for a short time; but this is obviously exceptional. On sheltered shores the boundary-line is not so clearly marked; and it is difficult to define the beginning of the sub-littoral vegetation. In Clew Bay it is particularly perplexing; and the flatter the shore, the less marked is the boundary. As time did not allow of special work on this point, the lower limit of the littoral region has been made uniform with that on exposed coasts—namely, the ebb-mark at neap-tide.

B.—*The Formations and Associations.*

A good deal of confusion exists with regard to the terms 'Formation' and 'Association.' Kjellman first introduced the word 'Formation' into algological literature in his paper on the algological communities of the Skager Rack ('78). He describes an algal formation as a small portion of the whole algal vegetation which is distinguished by a characteristic "Vegetations-Gepräge," adding that in a general way these portions of the vegetation obtain their characteristic stamp through one or more algae that predominate. Most other writers have followed Kjellmann's nomenclature. It is, however, more in accordance with the terminology now generally employed to use the term 'association' for these communities, and to reserve the term 'formation' for communities which occur together in a definite type of habitat. The substitution of the former term for the latter was first put forward by Börgesen ('05), and the name 'formation' was at the same time employed by him for "associations when united together under the same or nearly the same ecological conditions." Examples of Börgesen's formations are the Chlorophyceae, the Fucaceae, and the Laminaria communities of exposed coasts. Kylin ('07) does not follow this nomenclature, but adheres to the term 'formation' with the meaning attached to it by Kjellmann. Jónsson ('10), on the other hand, follows Börgesen.

Börgesen's use of the term 'association' is certainly more correct; but the

larger communities for which he employs the name 'formation' appear to represent groups of associations rather than formations. The term 'formation' if used to correspond with 'salt-marsh formation,' or 'sand-dune formation' of phanerogamic botanists, would be more properly applied to the vegetation covering such areas as exposed rocky coasts, or sheltered muddy shores. These might indeed be called 'subformations' by some botanists, in which case the whole marine flora would form one formation—the 'salt-water formation.' This, however, is hardly justifiable, and there appears to be no reason why the term 'formation' should not be applied to the principal types of the marine vegetation, as well as to the sand-dunes or peat-moors that occur above them.

In the present state of our knowledge it is difficult to define these marine formations; but notwithstanding this I have ventured to use the term for the vegetation covering the principal types of ground that occur on our shores. The formations proposed are three in number:—

1. The rocky-shore formation.
2. The sand and sandy-mud formation.
3. The salt-marsh formation.

All three are represented in the Clare Island area, and in addition two other types are distinguishable, which are dealt with under the heading of—

4. The vegetation of river-mouths.
5. The vegetation of brackish bays.

Each of these five types of vegetation consists of a number of associations, and the latter may frequently show natural groupings. But the associations found vary considerably in different localities, being influenced perhaps most largely by the factor of wave-exposure.

It should be clearly understood that the classification suggested above makes no pretension to be final. It is possible that the rocky-shore formation will have to be divided into other formations; but, judging from general field-work in many parts of the British Isles, this does not appear very probable. The flora certainly varies with the nature of the rock, but the changes consist in the modification or re-arrangement of the associations, rather than in any profound alteration in the plant-formation. The general plant-covering of all rocky shores (including chalk) appears to be of the same type; and for this reason it is here regarded as a simple formation, though further work will doubtless show many differences in detail.

The distinction between associations and societies is more puzzling Many of the small communities that have been described by various writers appear to represent societies (as understood by Tansley and Moss) rather than associations; caution, however, is needed, as definite zonation is discernible in one locality, whilst in others the growth is patchy and discontinuous. For this reason I have adopted a conservative attitude in the present report, and have used the term 'association' instead of replacing it by that of 'society.' In the case of communities described for the first time, when the status was doubtful, a non-committal expression has been used. The whole question of transient societies requires careful working out. Many algae appear periodically, and of these some are short-lived, being conspicuous only for a few weeks, whilst others require six or eight months to complete their life-cycle. It is clear, therefore, that before the status of these communities can be settled, a more complete knowledge of the seasonable range of many species is needed, as well as a more detailed analysis of the vegetation.

3.—The Vegetation of the Area.

i—*The Rocky-shore Formation.*

The rocky-shore formation embraces every form of hard ground, from the exposed rugged slates of Clare Island, to the flat low-lying sandstones of Clew Bay. Great variety in slope and exposure is met with, and also in the surface and hardness of the rock. Speaking generally, the formation is characteristic of open shores. In exposed localities it is the only one to be found. On sheltered shores it is not infrequently poorly developed, or replaced by the sand-and-rock or sandy-mud series. A characteristic feature is the strong basal disk by which the plants are attached, this being true both of exposed and sheltered coasts. Some of the smaller species have, however, other methods of attachment, as explained later. The vegetation of boulder-beaches is included in the formation, and also that of more or less buried rocks and stones, though, in the latter case, the vegetation clearly approaches that of sand-and-rock (pp. 65–67). The pebble-attached association of quiet bays, being characteristic of a soft bottom and not of rock, is placed *pro tem.* under the sand-formation.

The associations differ markedly according to the amount of exposure, and two series are to be recognized—namely, exposed and sheltered. The littoral and sub-littoral vegetation must also be distinguished; but, except for these, no further sub-division has been attempted. The hardness of the rock, and

the degree of slope influence the vegetation, as does also the nature of the rock-surface; but, as stated on p. 16, this produces merely a change in the associations, rather than a fundamental difference in the plant-covering. Boulders may be singled out for notice, since their vegetation is peculiar and well marked. The associations on a boulder-beach are much broken up, and secondary series on the vertical faces of the rock are of general occurrence (see Plate II). The tops of the boulders are usually bare, owing probably to immediate escape of the water, and to extreme desiccation, which prohibit respectively the retention and development of spores. Points such as these continually present themselves when studying the communities, and several are noted in the report; but it is too early to offer generalizations.

A word may be said as to methods of attachment. In addition to the stout disk typical of the formation, three are distinguishable. In the case of simple filamentous species such as Bangia, Urospora, and Ulothrix, each thread is fixed to the rock by the basal cell, with or without the assistance of corticating filaments. Hence the association, which consists of many thousands of minute plants, does not require a rough surface, but occurs also on smooth rocks where other species obtain no footing. It is in reality attached along its whole base. The second type is that of *Ceramium acanthonotum*, which possesses rhizoids. Such plants cannot grow on smooth rocks, but occur on mussels and barnacles, amongst which they thrust a dense system of rhizoidal filaments. Where Mytilus and Balanus form extensive sheets, these algae are often plentiful. The third type—a soft, spongy disk—is supplied by *Callithamnion arbuscula*. This is intermediate between the two former and the stout cellular disk. The spongy disk is composed of filaments more or less free at the margins, but forming a dense tissue in the centre. Algae possessing this type require a rough surface, and are commonly found on barnacles.

Many transitions exist between the various forms of holdfasts, and the subject, which is of great importance in connexion with the rock-surface, requires detailed study. Epiphytes are adfixed in a number of ways; see Tobler ('06), Menz ('10), and Delf ('12). In spite of the above exceptions, the majority of the algae forming associations on a rocky shore are attached by a stout disk (Fucus, Porphyra, Rhodymenia).

The following table presents the associations and other communities composing the rocky-shore formation in the Clare Island area:—

A. *Exposed coast series.*	B. *Sheltered coast series.*
(a) *Littoral Region.*	(a) *Littoral Region.*
Hildenbrandtia-Verrucaria.	Hildenbrandtia-Verrucaria.
Prasiola.	Fucaceae.
Enteromorpha intestinalis.	Lichina.
Fucaceae.	Porphyra.
Lichina.	Laurencia-Gigartina.
Porphyra.	Corallina-Lithothamnium.
Bangia-Urospora-Ulothrix.	Corallina-Cladostephus.
Rhodymenia.	Rhodochorton floridulum.
Laurencia-Gigartina.	Sand-pool vegetation.
Callithamnion arbuscula.	Cave vegetation.
Nemalion.	
Himanthalia.	
Corallina-Lithothamnium.	
Pool vegetation.	
Cave vegetation.	
(b) *Sub-littoral region.*	(b) *Sub-littoral region.*
Laminaria.	Laminaria.
Encrusting algae.	Encrusting algae.
	Fruticulose Lithothamnium.

A. *Exposed Coast Series.*

(a) *Littoral Region.*

Hildenbrandtia-Verrucaria Association.

The description of this algal and lichen community is somewhat brief, owing to the difficulty of distinguishing the species *in situ*, and the labour involved both in collecting and naming material. *Hildenbrandtia prototypus* and the marine species of Verrucaria are usually taken together as forming one association, and some writers include other plants such as *Rivularia atra* and *Calothrix scopulorum*. It is, however, a question whether it would not be advisable to include in the association all the littoral encrusting species that are soft and not calcareous (see note on sheltered form of association, p. 51).

Hildenbrandtia and Verrucaria resemble each other precisely in growth-form; and they are often found growing together covering an area of several

square yards. Both possess exceedingly thin encrusting thalli, which are so closely adpressed to the rock, that the latter appear as if coated with paint. In addition to those mentioned above, probably several other species of lichens are present. Of the three plants referred to, *V. maura* forms a band a short distance above the Pelvetia zone, whilst the other two appear below Pelvetia, and descend nearly to the level of low-water. Hildenbrandtia is more susceptible to drying up than *V. mucosa*, and in the Pelvetia and *F. spiralis* zones it occurs under the shade of algae, in damp chinks, or in pools. On ordinary open shores its growth does not occur above this level; but on very exposed coasts when there is spray, it ascends far above high-water line, being found in dark fissures in the rock, or in small pools that occur on the rugged cliffs, the water of which is often brackish. On the lower part of the shore Hildenbrandtia is not confined to pools and chinks, but is found on bare rocks, and remains quite dry for several hours. In the lowest levels, it is usually replaced by a broad band of *Ralfsia clavata*, in which patches of *Petrocelis cruenta* are frequent, especially if the rocks are smooth.

Verrucaria mucosa grows mostly on half-tide rocks that are fully exposed to light and air; in shady positions or where a covering of algae prevents excessive desiccation, the growth extends to the *F. spiralis* zone; but it rarely, if ever, takes advantage of pools to ascend to a higher level. In this respect it differs from Hildenbrandtia. The plant prefers smooth rocks or boulders, and is seen at its best on the beach north of Portlea, where it covers the upper sides of the boulders from about half-tide level to below the low-water limit of neap-tides. Its growth here is almost pure, and the individual patches are very large, some noted measuring a yard across. The vertical range on the shore varied somewhat in the different localities; but this may possibly have been due to the presence of more than one species. On only one or two occasions was a Verrucaria-growth noted in a rock-pool. Probably few lichens are so difficult to determine or so little understood as the marine Verrucariae; and it is a source of great satisfaction to learn that Miss M. C. Knowles is working at the problem, and doing so from an ecological as well as from a systematic standpoint. The encrusting algae also are in need of critical study.

The present community is well developed in all parts of the survey-area. It is abundant on smooth slabs and boulders, and is also found on the rough slate and sandstone. It extends to sheltered localities, where, if rocks and boulders are absent, it often occurs on stones and pebbles. A very similar vegetation exists in Sweden, Iceland, and the Faeröes, according to the accounts of Kylin, Jónsson, and Börgesen.

Prasiola stipitata Association.

This association as it occurs in the Survey area is characteristic of bird-cliffs; but during the winter months it is found to a small extent outside these areas. It is well developed on Caher Island, The Bills, and below the bird colonies near the Signal Tower on Clare Island. The growth is most abundant on the shady side of the cliffs, where it ascends to a considerable height above high-water level, and forms the uppermost association of the marine algae. With *P. stipitata* occurs, in the upper part, a certain amount of *P. crispa* var. *marina*. The localities referred to are very exposed, and, in rough weather, the cliffs are constantly soaked with spray, though during calm periods the vegetation must remain dry for some days. The fact that, in June, the small part of the south side of The Bills that was examined showed no trace of Prasiola, suggests that in summer the growth is confined to the more shady situations—a view which is supported by points noted in the following paragraph.

During the winter and spring months, Prasiola is found apart from birds. Wide patches were noted at Roonah and Old Head during the February visit, and in April, 1911, in many spots on Clare Island. The growth is practically pure, but is sometimes mixed with a certain amount of Calothrix and Lyngbya; it occurs on both smooth and rough rocks. In these localities, as on the bird cliffs, Prasiola forms the uppermost algal vegetation, frequently reaching the *Lichina confinis* band, but more often forming patches between that zone and Pelvetia. In several spots on the south shore of Clare Island it was present only on rocks sloping landwards, where it was consequently somewhat shaded; but in others it was found on sun-dried rocks and well above the uppermost Pelvetia. These rocks were fully exposed to the surf; and the plants, except during the calmest weather, would be splashed with spray. By July all this vegetation had disappeared; and it was not noted during June of the previous year.

The question of the connexion of *Prasiola stipitata* with bird-colonies is an interesting one. The preference shown by the fresh-water species, *P. crispa*, for localities soaked with ammoniacal liquid is well known; and its marine relative evidently shares the same avidity for nitrogenous compounds. During a trip to Belfast in connexion with the growth of Ulva in sewage-polluted water, *P. stipitata* was, on the shores of Belfast Lough during April, noted only around small drainage outfalls. In Larne Lough also a vigorous crop was always to be found in similar situations. At Ballycastle, Co. Antrim, however, as in Clare Island and Clew Bay, numerous patches of Prasiola occurred (chiefly in shady spots) where there was no special supply of nitrogenous food.

The vegetation described above, taken together with the Enteromorpha growth, corresponds to Börgesen's "Chlorophyceae Formation." In Clare Island, the Enteromorpha vegetation is entirely distinct from Prasiola, and it occurs only where certain definite conditions are present. In the Faeröes, on the other hand, species of these two algal genera are of general occurrence, and form together a well-marked green belt around the islands. The same is the case in Iceland.

Enteromorpha intestinalis Association.

As remarked above, the Enteromorpha association of exposed coasts is included by Börgesen in his Chlorophyceae formation. In Clare Island, however, the Enteromorpha growth differs so markedly from Börgesen's community that it is necessary to regard it as a distinct association. In the Faeröes the formation is described as stretching like a green belt along the coast, and composed of four associations which occur in the following sequence:—*Prasiola crispa*, *Rhizoclonium riparium*, *E. intestinalis*, and *P. stipitata*. In Clare Island the Enteromorpha association is quite distinct from that of Prasiola, and is found, not as a continuous band, but only where fresh water exudes from the cliffs. This type of green vegetation, though not previously described, is frequently met with in the British Isles. It is not largely developed in the Clare Island district, but is found in its typical form, and is therefore included in the present account.

On crossing from Achill Sound to the island, the association in question strikes the eye as a bright green band near high-water mark, between Kinnacorra and the harbour, and wherever a band of this nature is seen it is a sure sign of the presence of fresh water. Where only a small amount exudes, or the shore falls rapidly, the band is narrow, and a fucaceous or other community follows it at once; but with more water and a gradual slope the association takes the form of wide-spreading bands which run transversely over the rocks with a copious development below of Cyanophyceae and Diatoms. A small amount of *Rhizoclonium riparium* is, on flat rocks, sometimes intermixed with Enteromorpha; but more often the growth is practically pure, var. *cornucopiae* being usually plentiful. On vertical rocks and below small waterfalls Rhizoclonium is more abundant and may be dominant. The forms of Enteromorpha present are mostly short forms of *E. intestinalis* var. *genuina* and var. *cornucopiae*, with the addition occasionally of var. *micrococca*.

With regard to the bathymetric range of the association, its upper limit varies directly with the position and manner in which the fresh water oozes from the rocks. In some places the growth is completely submerged at high tide, but in other spots the upper part is not even reached by the spray of an

ordinary spring-tide (e.g., below the lace school on Clare Island). With an alga such as *Enteromorpha intestinalis*, which is not dependent on salt water, this is only to be expected. By the end of summer much of the growth may be killed through drought, and the lower part of the association then appears as a pure white band of dead tissue.

In rock-pools above high-water mark an Enteromorpha vegetation is found on exposed coasts which may be regarded as merely a pool extension of the community just described. The pools in question usually have a large admixture of rain-water, and during the less sunny parts of the year, they contain a vigorous growth of Enteromorpha, and occasionally Hildenbrandtia and *Cladophora sericea.*

Fucaceae Association. (Exposed Coasts.)

The conspicuous growth of the Fucaceae that is found on all rocky shores of the British Isles is well represented in the Survey area. The large size of the plants concerned, and the readiness with which the species can be recognized, render the Fucaceae association one of the most useful and instructive for ecological study. With few other genera can the effect of wave-action on an exposed coast be studied with so much ease, and with few other associations can the differences in composition and in plant-form be so readily traced. On sheltered coasts the study is more difficult. Though familiar in a general way to all British algologists, no definite account of the Fucaceae associations of our islands has been published, and the study of the vegetation as it exists in Co. Mayo was not without value in bringing to light several interesting features.

The composition of the association as it occurs in the British Isles is as follows, the species occurring in the order given from above downwards:—

Pelvetia canaliculata.
Fucus spiralis.
Ascophyllum nodosum (moderate shelter necessary).
Fucus vesiculosus.
F. serratus.
F. ceranoides (admixture of fresh water necessary).

An additional species, *F. inflatus,* was recorded by Börgesen for the Shetland Isles, and Mr. E. M. Holmes has lately received a specimen of this boreal species from Lewis, so possibly it is a regular constituent of the association in the north of Scotland. Besides the ordinary forms and varieties, some very remarkable modifications occasionally occur. (See p. 80.)

Fully exposed Coasts.—Turning to the Fucaceae association of Clare Island,

we find that in fully exposed localities it is composed of three species only, namely—Pelvetia, *F. spiralis*, and *F. vesiculosus*, var. *evesiculosus*, a precise combination which has not previously been described, unless it be that referred to by Boye ('94–5). Pelvetia forms a narrow zone about 1½–2 feet deep. *F. spiralis* follows with a band only slightly deeper, and composed of fronds seldom more than 6 or 8 inches in length; whilst the lowermost zone of *F. vesiculosus*, var. *evesiculosus*, has a greater bathymetric range, and therefore covers a wider horizontal surface. The fronds are very narrow and the growth short, though, except in the most boisterous spots, it is longer than *F. spiralis*. This type of vegetation is found more or less along the whole south shore of Clare Island, where there is full exposure; and it forms a band covering the entire upper part of the littoral region. The shore is for the most part steep; hence the bands are narrow. With a flatter shore and less exposure, the association spreads out horizontally, and other differences are noticeable as mentioned later.

Of the three species, Pelvetia is perhaps the most susceptible to severe exposure, and *F. spiralis* the least so. In a general way Pelvetia forms a band just above the ordinary high-water level, but it is splashed daily, except in spells of exceptionally calm weather. In very open spots, or where waves break and there is much spray, it ascends much higher. Everywhere it forms a band that is very conspicuous in summer and autumn by its orange-yellow receptacles. Owing to their bathymetric position, the two species of Fuci, unlike Pelvetia, feel the full force of the waves, but it is only in places with the severest exposure that the association is wanting. The attachment to the rock is exceedingly secure, and, though often torn by the waves, none but old and worn-out specimens become detached. Several spots were noted where *F. spiralis* only occurred, and it appeared that the exposure was too great for *F. vesiculosus*. When fruit is absent it is difficult to distinguish the two species; but in fertile specimens the short, rounded, hermaphrodite fruits of *F. spiralis*, and the narrow, pointed, unisexual receptacles of *F. vesiculosus* separate them at once. On exposed coasts the former plant fruits from spring to late autumn, the latter in winter, spring, and early summer.

Moderately exposed Coasts.—On passing to less exposed rocks or to bays where there is a measure of shelter, a difference in form and in composition is at once apparent. Pelvetia remains the same, but takes a somewhat lower level. *F. spiralis* becomes longer and the fronds wider, but still retains its typical *spiralis* form. *F. vesiculosus* is also larger, and often possesses a few bladders, the size of the frond and the number of bladders increasing with the amount of shelter. A fourth species, *F. serratus*, now enters the association. This begins in the lower part of the *F. vesiculosus* zone (slightly above

Himanthalia), and forms a broad band extending down to the Laminaria level. It appears to enjoy moderate wave-action, but requires flat rocks, and disappears at once where the rocks are steep or the exposure too great. This form of fucaceous growth occurs typically on the slopes near Kinnacorra, near the Castle, and at several spots on the south shore.

With greater shelter further differences are evident. Pelvetia and *F. serratus* remain as before, but *F. spiralis* broadens out into var. *platycarpus* and *F. vesiculosus* develops more vesicles, the length of both species increasing and assuming the heavy bulky growth characteristic of sheltered coasts. The horizontal distribution also of all the species tends to increase, owing to the shore being usually flatter. Such growth occurs in several bays on the island, and is common in more open parts of Clew Bay. *Ascophyllum nodosum* requires considerable shelter; and in Clare Island it is present in one spot only, namely Ooghbeg on the south shore. The shore here is rather flat, and the force of the waves is broken by the presence of blocks and boulders. At Portlea (parts of which might appear to be equally sheltered) Ascophyllum is absent, but the presence of a vigorous Himanthalia vegetation indicates greater exposure than might be supposed. For further notes on this species see p. 55.

Epiphytes.—The typical epiphytes of the exposed Fucus association are as follows, and in the most exposed spots these are practically all that occur:—

Ulothrix pseudoflacca (in spring).
Enteromorpha compressa.
Ectocarpus luteolus.
Elachista fucicola.
Porphyra umbilicalis.

Where the conditions are less boisterous (e.g. at Kinnacorra) a number of other species occur in addition, for example—

Ectocarpus tomentosus.
E. fasciculatus.
Porphyra leucosticta (in spring).
Rhodymenia palmata.
Polysiphonia fastigiata (on F. spiralis).
Ceramium rubrum.
C. Boergesenii.

Subvegetation.—This, though always better developed in the lower than in the upper levels, is largely dependent on the denseness of the Fucus growth, i.e. on the amount of room and light available. When conditions are favourable, the first four of the following communities are usually represented, and the last three are occasionally present in addition:—

Hildenbrandtia-Verrucaria Association.
Porphyra umbilicalis ,,
Laurencia pinnatifida ,,
Corallina spp. Society
Lichina pygmaea Association.
Rhodymenia palmata ,,
Lithothamnium Lenormandi Society.

In the low littoral region, if the *F. serratus* vegetation is not dense, a very large number of species occur, the shelter and shade being highly suitable for :—

Dictyota dichotoma.	Polysiphonia fruticulosa.
Chylocladia ovalis.	P. thuyoides.
C. articulata.	Plumaria elegans.
Delesseria alata.	Lithothamnion polymorphum.
Nitophyllum laceratum.	Sporelings, many spp.

Comparison with other Countries.—In a general way the Fucaceae association described above represents that of the whole of the British Isles. It agrees well with that observed on the south and east of England, and though the Fucaceae of the British Isles have never been specially investigated from the present point of view, it is not likely that any startling departures from the Clare Island type will be met with. The greatest variation may be expected on the north of Scotland. The vegetation described for the Norwegian coast is similar, agreeing floristically, but differing in minor points. With more thorough investigation some of the latter will probably disappear. In west Sweden, Pelvetia is absent, and Kylin makes no reference to *F. spiralis* on exposed coasts. He notes the presence of the form *F. Areschougii* on moderately open shores, and it would be remarkable if the short exposed form, so addicted to boisterous localities elsewhere, were absent. A belt of an evesiculate variety of *F. vesiculosus* is well developed, but from specimens sent by Dr. Kylin, it is clear that his form (*compressus racemosus*, Kjellman) is different from that which occurs on Clare Island. The Faeröese Fucus vegetation differs in several respects from the Irish. In the first place, *F. serratus* is absent, *F. inflatus* taking its place; *F. spiralis* is not found with extreme shelter, and *F. vesiculosus* disappears entirely with exposure; lastly, Pelvetia is absent from exposed coasts. The last two points were specially investigated by Dr. Börgesen during his visit to Clare Island; and he agreed that both species flourish in Ireland with very much more exposure than in the Faeröes. The Fucus vegetation of Iceland is similar to that of the last-named, in that it possesses a vigorous growth of *F. inflatus*, though *F. serratus* is present in addition. From the brief account given by Joubin ('09), the Fucaceae vegetation at Roscoff appears to agree in the main with that of the British Isles.

The Lichina communities.

Though a lichen and not an alga, *Lichina pygmaea* is always found between the tide-marks, and forms so essential a part of the marine vegetation that it

deserves mention in the present report. The second species, *L. confinis*, is scarcely littoral, being confined to rocks just above high-water line, but its growth may be suitably described together with that of *L. pygmaea*. The zones formed by these two species at times approach one another, but they never overlap. Both occur on sheltered as well as on exposed coasts, though for *L. pygmaea* rocks or boulders are essential. With the exception of Joubin ('09), algologists have not dealt with this vegetation, though Nylander, as long ago as 1861, drew attention to the belts of Lichina on the sea-shore.

(a). *L. pygmaea*, the larger and more conspicuous species, forms circular patches which vary from a few inches to a foot in diameter. It usually commences immediately below Pelvetia, and extends downwards through the *F. spiralis* belt to *F. vesiculosus*, or to within a few feet of low-water. In certain localities it extends well up into the Pelvetia band; but it never occurs above it. The maximum development usually takes place in the upper part of the zone, where the plant often forms a very conspicuous black band on the vertical faces of rocks or boulders capped with *F. spiralis*. It undoubtedly favours sloping or vertical surfaces; but it also occurs on those that are horizontal. Though frequent on smooth boulders, it prefers rough or eroded rocks, and is abundant on barnacles. Unlike *L. confinis*, the present species can only stand a certain amount of drying. In the lower part of the association it occurs fully open to the sun; but in the uppermost levels it is usually found in chinks and pockets which retain moisture, or on rocks with a shady aspect. In calm weather, during neap-tides, the Pelvetia zone may be left entirely dry for several consecutive days; and any growth of *L. pygmaea* that reaches this level is occasionally subjected to like conditions.

On the exposed and semi-exposed shores of Clare Island and the mainland *L. pygmaea* is abundant, but where the exposure is excessive it does not appear to flourish. On the large blocks and boulders to the north of Portlea it is one of the few macroscopic plants which form a definite association; and in such localities, where Fuci are absent, the lichens form a useful means of determining tidal levels. A very luxuriant vegetation of Verrucaria spp. covers the boulders of this beach almost from top to bottom (p. 20).

During the summer (July-Sept.), a fine growth of *Rivularia bullata* is frequently found epiphytically on *L. pygmaea*. In 1911 it was unusually abundant, being noted in August in all the exposed parts of the mainland and Clare Island. *R. bullata* is not confined to the Lichina patches, but also occurs on bare rock. It sets in about half-tide level, and continues to low-water mark.

(b). The second species, *L. confinis*, has fronds barely 3 mm. long, and the individual patches are 2–4 cm. in diameter; being black in colour it is very

inconspicuous on the dark slaty rocks of Clare Island. It usually occurs a short distance above Pelvetia, and extends up the cliffs on the south shore to a height of 12–15 feet. In this position it is frequently drenched with spray, though in summer it may be dry, except for rain, for weeks together. With less exposure its vertical range is restricted. On the gentle slopes at Kinnacorra it is only 3–4 feet above Pelvetia; whilst on the flat shores of Clew Bay and Achill Sound it hardly exceeds the neap-tide level, and is regularly covered during the highest tides. This occasional flooding by spring-tides in sheltered localities obviously takes the place of the soaking by spray on open coasts. In Clew Bay and other places where rocks and boulders are absent, the plant often occurs on flat stones, and may even be traced as an irregular band running along the shore. In Roundstone Bay the three plants, *L. confinis, P. canaliculata,* and *L. pygmaea* were noted on large slabs, forming luxuriant and well-marked zones, each species following the other as a band, 1–2 feet deep.

The Lichina vegetation at Roscoff described by Joubin ('09) is evidently very similar to that found in Ireland. Both species are present, and the plants show a preference for exposed situations.

Porphyra umbilicalis Association.

Porphyra is one of those algae which occur as a definite association on both exposed and sheltered shores. The form assumed by the plant is very distinct in the two situations; and it is curious that it has not been seen as an association in localities offering intermediate conditions, although its occurrence in small quantity is common enough. Another feature which gives interest to the exposed Porphyra community is the diversity of its bathymetric range in different countries, and even in different spots in the same locality. For instance, in Clare Island the upper limit of the Porphyra belt is almost always below the Pelvetia zone, whereas in the Faeröes the greater part is normally above that belt, and on exposed shores it may occur as much as 40–50 feet above high-water line. Doubtless surf and spray are largely responsible for its presence in such positions, just as they are seen to be directly responsible for minor variations on Clare Island. But this alone does not account for all the differences that have been noted, and further study is needed.

On most parts of Clare Island a certain amount of Porphyra vegetation is present; in some it is extensive and forms broad or narrow bands; in others it is limited, and occurs only as small patches between other communities. It prefers rocks of a moderate or rather steep slope, but is also

found on flat rocks, and rarely on the perpendicular faces. The rock-surface may be rugged or smooth, and a very favourite substratum is that of mussels. In all cases the rocks are exposed; and often the most vigorous patches are those where the waves strike with great force. The normal position of Porphyra is in the upper part of the littoral region, where it occurs as a band a short distance below Pelvetia. In some cases the band is quite narrow, as is shown in Plate I, where it occurs between Pelvetia and *F. vesiculosus*, taking the place of *Fucus spiralis*; in others it is mixed with *F. spiralis*, and runs down through the wider belt of *F. vesiculosus* that follows. Porphyra also occurs where the Fucaceae are absent, and is here commonly mingled with Bangia or *Ceramium acanthonotum*. At Kinnacorra it is found on smooth sloping rocks devoid of vegetation, and forms a fairly wide band from a short distance below high-water mark down to about half-tide, at which level Bangia takes its place. In this position, being quite unprotected from the sun, it becomes very dry and disappears during summer.

A very distinct aspect is acquired by the association during winter, owing to the presence of an abundant growth of var. *linearis*. This plant, though often regarded as a distinct species, represents sporelings of *P. umbilicalis*, which at that season are elongated and tapering. The growth appears first in October, and develops rapidly during the winter, frequently covering boulders and smooth rocks over extensive areas. It is usually quite distinct from the normal Porphyra association, and forms a band above it. In March the effect of drying winds and increased sunlight is felt, and much of the growth dies. By April var. *linearis* has disappeared, except in lower and shaded places.

With regard to the supra-littoral growth, the contrast between Clare Island and the Faeröes is most marked. In a few spots Porphyra was noted as extending into the Pelvetia band on Clare Island; and at Alnahaskilla it was found at the highest tide-level on the north side of steep bare rocks, a sample of the kind of growth that takes place on a much larger scale on the Faeröes. Below the big cliff on the north side of the island, where the shore is steep and the rocks fully open to the Atlantic, Porphyra was one of the few algae that were noted in the littoral zone. But even here, with shade and continual spray, there was no supra-littoral growth comparable to that described by Börgesen. Its growth probably exceeded the limit of high-water level (which, owing to the constant swell, is not easy to determine), but not to any remarkable extent. In the Faeröes, on the other hand, even in sheltered localities, the *lowest* limit is at high-water mark, and in exposed situations it is not found till far above that level.

Kjellmann and other Scandinavian algologists have regarded the Porphyra

community as a winter vegetation; and Börgesen states that, though in the Faeröes it is developed all the year round, it is in more southern countries characteristic of winter. On Clare Island this is hardly the case. The Porphyra association is in fine condition in July and August, and abundant even on the south shore (*vide* Plate I). It is, however, more widely spread in winter, owing partly to the presence of a band of var. *linearis*; but the association in the Clare Island neighbourhood certainly occurs throughout the year. Börgesen also remarks that he did not observe the Porphyra vegetation at North Berwick (Scotland) in July, 1909, but Dr. A. A. Lawson informs me that at St. Andrews (about seventeen miles further north) it was plentiful in July and August, 1910; though in the hot dry summer of 1911 it was much less conspicuous. In the south of England it is a winter and spring vegetation, though in July, 1911, the Porphyra belt was still discernible on exposed rocks at Portland Bill. The exposed Porphyra association is also recorded from Iceland (where it closely resembles that of the Faeröes), west Sweden (Kjellmann, '78, Kylin, '07), and Norway (Kylin, '10).

To sum up, the Porphyra vegetation of the exposed coasts of Clare Island forms a belt in the littoral zone, at a very much lower level than it does on the Faeröes, and does not, even in shady and very exposed localities, grow far above the high-water line. In contrast to the south of England, Sweden, and Denmark, but in agreement with that described for Norway and the Faeröes, it exists through the entire year. The form of the plant on exposed coasts is entirely different from that found in sheltered localities.

Bangia-Urospora-Ulothrix Association.

The most striking feature of this community is its sporadic appearance. During the first two years of the Survey scarcely a thread of Bangia or Urospora was found; but during the spring of 1911 a remarkably fine and widespread development of the typical Bangia-Urospora-Ulothrix association occurred on Clare Island and on the exposed parts of the mainland. This vegetation was probably at its best during the time of the April visit; by August it had entirely vanished. In the Faeröes it appears to be more or less permanent; but, as shown below, its sporadic appearance is known in other countries, and it may even be absent for several years in succession over a wide stretch of coast-line (*vide* Börgesen, '05, p. 720). For this reason the appearance of well-marked belts of Bangia and Urospora during the last year of the Survey was particularly gratifying.

The community in question occurs on exposed and moderately exposed rocks, especially where the surface is smooth and where other algae do not obtain a footing. In bathymetric range the association as a whole corresponds

to that of Porphyra, extending from below the Pelvetia zone to within a few feet of low water. Its composition is as follows :—

Bangia fuscopurpurea,	co-dominant.
Ulothrix pseudoflacca,	
Urospora mirabilis,	
Ulothrix consociata,	
Enteromorpha minima.	

As a rule all the species, except *E. minima*, which is local, occur together, though each forms a separate patch or narrow strip within the association. Occasionally, however, the species occur separately; and a pure growth of Bangia or Urospora may cover a wide area. In a few cases the growth may be thoroughly mixed.

An effort was made, when the full series was present, to determine the vertical sequence of the species; but this was unsuccessful in so far as obtaining a constancy in succession was concerned. The necessity of microscopic examination made the determination in the field difficult, and the work required more time than was available. As a general rule, however, where the association is typically developed, Bangia appears to have a wider vertical distribution than the other species, as it is often both the first to appear and last to leave on passing from top to bottom of the area. But occasionally a Ulothrix growth is found at a very high level in sheltered localities where Bangia is absent.

The occurrence of the Bangia-Urospora association on smooth rocks and boulders where other vegetation is absent is explained by the exceedingly fine unbranched filaments of the plants, reducing to a minimum the strain on the basal attachment. At the same time each filament is separately fixed to the rock, so that the association may be said to be attached along its whole base.

The most usual extraneous species is *Porphyra umbilicalis*, small specimens of which frequently occur in the upper levels; and it is into the Porphyra association that the present community most frequently merges. Bangia, which is less restricted than Ulothrix or Urospora, also occurs on barnacles, where it enters into competition with *Ceramium acanthonotum*.

The total absence of Bangia in some years has been referred to by Börgesen for Norway ('05, p. 720), and Rosenvinge for Denmark ('09). The latter, who has studied the Bangiales of Denmark in detail, writes as follows concerning *B. fuscopurpurea*:—

"The most dangerous condition for the Bangia vegetation is a fairly long period of easterly winds so light that this vegetation is not reached by the

waves, especially when the weather at the time is bright and dry. Its occurrence is therefore very different, not only at various seasons, but in different years. In winter it is very abundant; but the critical period of the spring will every year kill a greater part of it; and on the duration and intensity of this period depends to what degree that will take place. In summer, for example, it occurs at Frederikshavn in some years only in small quantity, while in others it forms extensive growths—as in the beginning of August, 1902" (l.c., p. 58).

With regard to Clare Island, drying winds during a critical period of the life-history no doubt largely influence the growth of the plants. The association may occur annually as winter vegetation, and it may possibly have been present in the early spring of 1910; but if this was the case, it had completely disappeared by June, and was certainly absent in April, 1909.

Comparison with other Countries.—An association corresponding to that described has been noted in many countries. It is present in Norway, Sweden, Greenland, Iceland, and the Faeröes, having been dealt with by Kylin, Rosenvinge, Jónsson, and Börgesen respectively; and, as already shown, it occurs in Denmark. The belt in these countries, as would be expected, is found at a higher level than in Clare Island. It reaches, or extends above, the high-water line in each case; and in the exposed part of the Faeröes it occurs as much as 30 feet above this level. In Greenland the association differs floristically, and is termed by Rosenvinge the *Monostroma groenlandicum* association, after the dominant species. In the Baltic (Gotland) Svedelius has described a similar vegetation, consisting entirely of *Urospora penicilliformis.*

Rhodymenia Association.

An association of Rhodymenia similar to that described by Börgesen, and noted by him as being widely spread on the Faeröes, occurs in our district, though only to a limited extent. Börgesen stated that he had found no reference to such an association, but that he expected it to be common in the North Atlantic. In the Clare Island area it is but feebly developed; but at Dog's Bay, near Roundstone, a very extensive growth was observed, showing that the association exists on some parts of the west of Ireland, as indeed was already known. On the island, patches of Rhodymenia occur in several spots between Portlea and the lighthouse, and on the mainland at Roonah and at Old Head.

Judging by the localities in which the plant was found, Rhodymenia prefers a northern aspect, which would account for the complete absence of its growth, as an association, on the south shore of Clare Island. At Old

Head it is found on flat, sloping, or vertical, semi-exposed rocks, which face north or north-east. At Portlea it affects similar situations, but shows a decided preference for vertical rocks (these being at the sametime the more shaded). The plants are attached by a strong basal disk, and are usually found on mussels, but they occur also on limpets and bare rock. The vertical area covered by the alga is rather extensive, reaching at times from the bottom of the *F. spiralis* zone down to about low-water mark, but more often forming a band below the upper Porphyra. It is frequently interrupted by patches of other vegetation. At Old Head, *Fucus vesiculosus*, var. *evesiculosus* is the chief intruder; but portions of the Porphyra and *Callithamnion arbuscula* associations above, and the Nemalion vegetation below, are also interspersed amongst it. A modified form of the association occurs on boulder-beaches, the plant hanging in profusion from the lower part of boulders surmounted by Himanthalia (Plate II).

The form of the alga when growing as an association on exposed coasts is very distinct. Short and tufted, not more than 3 to 4 inches long, it consists of narrow or rounded fronds, with a number of small lateral proliferations. Though narrow, it is very distinct from var. *sarniense*, which is thinner and paler in colour, and resembles *Gracilaria multipartita* in form. With increased shelter the plant becomes larger, till at length the pool-form, with fronds a foot or more in length, is reached. The islanders distinguish the larger and small forms as Dillisk and Crannogh respectively, and always associate the latter with the presence of "small shells"—i.e., mussels (see Economic Section).

Börgesen remarks that the Rhodymenia association prefers places where fresh water oozes from the rocks. This is not the case on Clare Island. As a pool or streamlet plant, Rhodymenia enjoys an admixture of fresh water; but when growing as above described, it was always found in a purely marine habitat.

Laurencia-Gigartina Association.

Near the low-water line on exposed coasts there often exists a dense carpet composed of the two red algae,—*Laurencia pinnatifida* and *Gigartina mamillosa*. Gigartina occupies the lower part and goes down into the sub-littoral region, whilst Laurencia extends more or less in an upward direction. The band formed by the latter is often conspicuous, so much so that it was at first regarded as a distinct association. Further examination at spring-tides showed that it was frequently connected with a zone of Gigartina, and that in the more exposed places the latter species was dominant. It gradually became evident that their relative abundance was largely a matter of exposure and slope, and that these two species of similar habit could be

naturally regarded as forming a single belt. In a general way Laurencia prefers a certain amount of shelter, and thrives on sloping or flat rocks, whereas Gigartina enjoys the roughest water and steep surfaces. On comparing this plant-community with those of other countries, it was found that the joint belts formed by the two species in Clare Island corresponded to Börgesen's Gigartina association in the Faeröes—a conclusion which was confirmed by him during his visit. It was thought best, therefore, to connect the Irish type of vegetation with the Faeröese, and the name Laurencia-Gigartina association has been given. In the Faeröes Laurencia is very rare, being found only in pools.

The Gigartina band may be dealt with first. On exposed coasts it is barely uncovered during neap-tides, but with spring-tides a distinct belt reaching down to the Alaria and *L. digitata* zone is revealed. It is frequently accompanied by a certain amount of the narrow form of *Chondrus crispus*. Well seen on vertical rocks, where it forms a band 2 feet deep, it also occurs on flat and sloping surfaces, here usually as an undergrowth to Himanthalia. On the open coasts it is often accompanied by the following algae, all of which are known to enjoy the turbulent conditions of low-water mark:—

Scytosiphon lomentarius.	Plocamium coccineum.
Rhizoclonium implexum.	Polysiphonia thuyoides.
Chylocladia ovalis.	P. Brodiaei.
Lomentaria clavellosa.	Corallina squamata.

The Gigartina belt occurs also on the more sheltered ground at Portlea. It first appears well up in the Laurencia band; but as the lower levels of the littoral region are reached, it increases greatly in quantity, till finally it occurs as a pure growth covering comparatively large areas. At Kinnacorra, on the other hand, where there are varying degrees of exposure, the Gigartina vegetation is practically absent.

Passing now to Laurencia, we find this is more conspicuous on account of its truly littoral habit. It begins shortly below the half-tide level, and runs down into the Himanthalia association. It is common on moderately exposed shores, and appears to prefer clean, gently sloping rocks where sand is absent. Under these conditions Laurencia may exist as a pure growth 2 or 3 yards wide, but where the shore is flat it extends over a much wider area, being then mixed with other species. When sand is present it gradually gives place to *Rhodochorton floridulum*.

In its lower levels the Laurencia belt forms an undergrowth to Himanthalia, and on sheltered shores occurs in a similar manner beneath *F. serratus*. It is found at times under *F. vesiculosus*, and thus runs upwards considerably

higher than on bare rocks. If the shade be not too dense, its growth is quite as luxuriant as when fully exposed to light and air.

Another species, *L. hybrida*, is a characteristic element in the upper part of the association. This plant is more restricted in its range, and appears to be more sensitive to desiccation. On a flat shore it reaches its maximum development somewhere about the middle of the *L. pinnatifida* band, where it is at times co-dominant. In the lowest parts it is practically absent; and in the upper it is found only in the damper positions. On very exposed shores *L. hybrida* is scarce (see p. 136).

L. pinnatifida reaches its maximum development about April or May; and at this season sloping rocks are carpeted with a growth 4 to 6 inches high. After May many of the larger fronds disappear, and the association as a whole becomes inconspicuous. There remain, however, numerous small shoots, which are continually augmented during the summer, the plant being apparently perennial: *L. hybrida*, on the other hand, is an annual. Young sporelings 1 to 2 mm. long are discernible in September; they develop during winter, fruit in spring, and disappear in May.

Very marked colour-changes due to illumination are shown by *L. pinnatifida*, and to a less extent by Gigartina. The normal colour of the former is a deep purplish red; but during summer the growth in sunny situations is pale yellow green. This gradually gives place to purplish green in autumn, which becomes redder as the days shorten. The production of antheridia by Laurencia in March and April gives the plants a golden hue, owing mainly to the yellow substance found in the antheridial cavities. As a large number of male plants are often found together, sheets of bright yellow fronds are frequent.

Callithamnion arbuscula Association.

The plant-community formed either by *Callithamnion arbuscula*, or *Ceramium acanthonotum*, or a mixture of both, has been described by several writers under various names. Callithamnion is the more conspicuous plant, and most writers have dealt largely with this species; *Ceramium acanthonotum* is, however, an equally important element. Clare Island is peculiar in possessing in addition a small quantity of the southern *Callithamnion granulatum*.

The association is well developed on many parts of the island and exposed mainland. The relative amount of the two species varied during the different seasons—a fact which probably explains discrepancies in accounts of the same area by different writers. In July, 1910, *Ceramium acanthonotum* was the dominant species on Clare Island, whereas in August, 1911,

Callithamnion arbuscula was more abundant. Apart from these seasonal variations, Ceramium is found chiefly on bare slopes with much or moderate exposure; sometimes it occurs pure, forming a dense carpet several yards square, but more often it is mixed and interrupted. Callithamnion prefers the more boisterous positions, and is especially luxuriant on steep or vertical rocks.

The belt formed by the association is at the same level as the lower part of the Bangia and Porphyra associations, or slightly higher than the Nemalion and Corallina communities. It usually begins just below *F. spiralis*, and extends to within a few feet of low-water mark. Callithamnion often appears a short distance above Ceramium, but for the most part the two species occupy the same level. Where fresh-water streams exist, Ceramium not infrequently ascends the shore, and may reach as high as Pelvetia. *C. arbuscula*, on the other hand, does not thrive in fresh water.

Unlike the Bangia-Urospora association, the present plant-community is most frequent on rough surfaces offering a good foothold. Ceramium, which forms a spreading growth, usually occurs on mussels and Corallina, amongst which it pushes a mass of rhizoids; but it also grows epiphytically on the Callithamnion. The latter, on the contrary, has a scattered habit, each plant possessing a single stem, which is thick and spongy. It is most frequently attached to limpets, mussels, or the rock between them; only rarely is it found on other algae. Although both species occupy a fairly high level, owing to the retention of water by their spongy thalli neither becomes dry when the tide is out.

The associations into which the *Callithamnion arbuscula* vegetation most frequently merges are those of Bangia, Nemalion, Corallina; and in addition to algae derived from these sources the following species frequently occur scattered in it:—

Rhizoclonium tortuosum.	Polysiphonia macrocarpa.
Enteromorpha compressa.	P. Brodiaei.
Scytosiphon lomentarius.	P. thuyoides.
Petrospongium Berkeleyi.	

Comparison with other Localities.—In the British Isles Börgesen has noted the community in Shetland, and I have observed it at Whitby (Yorks). On the south coast of England, where *C. arbuscula* is absent, the association is represented by a belt composed entirely of *C. granulatum* (= *C. spongiosum*, Harv.). This has been noted at Swanage and Portland, and is doubtless common. *Ceramium acanthonotum*, though known on the south coast, does not enter into the Callithamnion association in either of these localities.

It is interesting to note that, though *C. arbuscula* was the essential species in Clare Island, specimens of the southern *C. granulatum* were scattered here and there amongst it. The latter agreed in form with the Dorset specimens, being short, very densely branched, and of a peculiar pale colour—a feature which gives the clue to its presence (see p. 142).

Hansteen, Boye, and Kylin have each dealt with a vegetation on the west coast of Norway that is probably very similar to that here described, though it is Callithamnion that has mostly attracted attention. Kleen also records both algae from Nordland. In the Faeröes, Simons refers to a "*C. acanthonotum* formation," not observing the presence of *C. arbuscula*, whilst Börgesen, exploring the coast more thoroughly, found the latter abundantly in exposed places, and adopted the older term. Both species are found in Iceland, though Jónsson does not allude to them as forming an association.

Some remarks by Harvey with reference to this vegetation may be quoted here. He observes with regard to *C. arbuscula* that "it delights in the most exposed rocks and the roughest water, and very commonly grows on the shells of *Mytilus rugosus*" (Phyc. Brit., pl. 274); and concerning *C. spongiosum*, he writes, "It is curious that it appears to occupy the place of *C. arbuscula* on shores where the latter is not found, these plants never growing together, though both affect similar situations on different shores" (l. c., pl. 125). As shown above, Harvey's statement as to position and habitat of the species holds good for many countries, though the Clare Island work proves that the two species may occasionally occur together.

Nemalion Association.

The present vegetation, described by Kjellmann in 1875, was one of the first algal associations to be recognized. It differs from many others in being a purely summer growth, and might therefore be more suitably regarded as a plant-society. The Nemalion belt occurs in the lower half of the littoral region—that part of the shore which is crowded with a succession of algae, and in which many transient societies are recognisable. Nemalion prefers bare rocks, and usually develops in spots devoid of other vegetation. It would probably find a place as a subdivision of Börgesen's "Corallina formation"; but in the present state of our knowledge it appears advisable to follow previous writers rather than introduce doubtful alterations.

The Nemalion growth is first noticeable early in June, reaches its maximum in August or September, and disappears in October. The association in Clare

Island (as in S. England) is composed of two species—*N. multifidum*, and the stouter unbranched *N. elminthoides* Batters (= *N. lubricum* J. Ag.).[1] The zone formed is 5 to 6 feet deep, and extends from about half-tide level to the ordinary low-water mark. Its luxuriance varies considerably in different localities. In some, a vigorous growth is present in the upper part of the zone, whilst in others the algae are better developed near low-water mark. *N. elminthoides* is usually confined to the upper portion, and lasts later in the season than *N. multifida*. The plants are attached to bare rock, or limpets, and occasionally to mussels. They prefer sloping surfaces, fully exposed to waves and surf.

The Nemalion association is found in the band of *Lithophyllum incrustans*; but it prefers bare rock devoid of other vegetation. Where mussels occur, it is usually replaced by the association of *Ceramium acanthonotum*, or Rhodymenia. Amongst it are scattered individuals of *Scytosiphon lomentarius*, *Enteromorpha compressa*, *Rhizoclonium implexum*, and *Polysiphonia Brodiaei*, the last-named being confined to the lowest levels. On Clare Island the association is of frequent occurrence; and in Clew Bay it occurs on exposed points, such as Old Head. A similar type of growth has been described by Kjellmann ('78), and Kylin ('07), for west Sweden; by Gran ('93) for Norway; it would appear also to be widespread in Denmark (*vide* Rosenvinge, '09). In the south of England the community is frequently met with, having been noted by me on the coasts of Dorset, Devon, and Cornwall.

Himanthalia Association.

This familiar association, which is well developed on Clare Island, is characteristic of moderately exposed shores. It forms a belt in the lowest part of the littoral region; but the extent of its horizontal range varies with the amount of slope and the nature of the coast. On steep and vertical rocks it is absent, or exists as a narrow band, 1 foot deep. On a shore of moderate slope the band is wider, and extends from the Laminaria zone to 2 or 3 feet above low-water mark; whilst on flat shores, especially where there is a dense sub-vegetation, it covers a wide area. With partial shelter, Himanthalia descends some distance into the sub-littoral region, and occurs mixed with *Cystoseira ericoides* and species of Laminaria; but apart from the extension both in an upward and downward direction, its normal position

[1] This plant, clearly figured by Velley, is usually regarded as a distinct species; but as seen in Clare Island and in the South of England, it is difficult to separate from *N. multifidum*.

on a sloping shore is between the *Laurencia pinnatifida* belt and the Laminaria association.

In the form of a narrow band, the Himanthalia vegetation is seen on the south shore of Clare Island in spots where the rocks are steep, and there is full exposure to the waves; as a wider zone, it shows well on rocks which form large sloping slabs, as at Kinnacorra. At Portlea a more extensive growth is met with. The shore here is flat, but there is a moderate amount of rough water and surf. A dense undergrowth of *Laurencia pinnatifida* and other algae covers the lower part of the littoral region, and on this the Himanthalia lies as a thin covering. The belt, however, is not so deep as it appears; for, although during spring-tides it is left dry for three or four hours, during neap-tides the time of exposure and the amount uncovered are small. The undergrowth conserves moisture, and enables the alga to ascend to a higher level than otherwise. Portlea also affords an example of another type of growth, viz., that on blocks and boulders. In this case Himanthalia is attached to the upper parts of the boulders; but the strap-like fructifications hang down over the sides (see Pl. II). Here again the alga may ascend above its normal limit owing to the shade between the boulders.

Börgesen remarks that, according to Boye, Himanthalia avoids localities directly exposed to the surf, which is in contrast to its habit in the Faeröes. In the British Isles it is certainly a surf-loving species; and in Clare Island it occurs along the south shore, and also on such exposed points as Alnahaskilla. At Ooghbeg, the one spot on Clare Island where Ascophyllum exists, Himanthalia is found where the waves break at low-water; but as a rule, if there is sufficient shelter for Ascophyllum, Himanthalia is absent. As noted by Börgesen, the present alga cannot stand desiccation; and though odd plants are seen some half-way up the shore, they do not thrive unless protected from the sun. As a pool-plant it is one of the commonest species, and is then usually infested by *Ectocarpus fasciculatus*, *Ceramium Boergesenii*, and *Herponema velutina*. In the open, *Elachista scutulata* is the usual epiphyte.

Corallina and Lithothamnium Associations.

A belt of *Corallina* spp. is found just above low-water mark in many parts of Clare Island. It is characteristic of very exposed rocks, where it appears to take the place of the *Laurencia pinnatifida* band of less open spots. An extensive growth of encrusting algae is usually met with as an undergrowth, and the two types of vegetation appear to be intimately connected, and may for the present be treated together.

The species concerned are as follows:—

Corallina squamata, dom.	
C. officinalis, co- or sub-dom.	
Lithothamnium Lenormandi,	Undergrowth, in zones.
Lithyphyllum incrustans.	
Lithothamnium polymorphum.	

(*a*) The Corallina growth is very much worn down by the waves, so that it occurs in the form of dense cushions, the specific identity of which is difficult to ascertain. In shallow depressions or with slight shelter, the production of larger and more perfect fronds allows their true nature to be determined, and in each case examined it was evident that the bulk of the growth was composed of *C. squamata*, though *C. officinalis* was at times also present.

The first signs of the Corallina belt are found at about half-tide level, usually just below the top of the Nemalion zone. The plants are found here in chinks and fissures, where there is little risk of drying, and on passing downwards they gradually spread out over the surface of the rocks. They are, especially in the upper parts, frequently attached to mussels; and the growth of these two organisms together form the compact cushions referred to. At the lower part of the zone the fronds are large. This is due partly to their being protected by the Laminaria foliage, and partly to their being below the level at which the waves break. A great improvement in colour is at the same time noticeable. *C. squamata* as well as *C. officinalis* occurs at the top of the Laminaria belt; and the latter certainly, if not indeed both, descends some distance into the sub-littoral region.

With increased shelter, though the plants are larger and less broken by the waves, the band as a whole is not so conspicuous, owing to its being replaced by other algae (usually Laurencia). Shallow pools are an exception. Here a fine growth of *C. officinalis* is often present, and less frequently *C. squamata*. The latter is seen at its best on narrow ledges, or hanging from the sides of shady rocks.

The Corallina association above dealt with differs floristically from all others hitherto described, in being composed largely of the southern species *C. squamata*. This is probably the case in all the warmer parts of the British Isles. There is no question as to the abundance of *C. squamata* in Clare Island; and it is doubtless equally common along the whole of the south and west of Ireland. It also occurs in plenty in the south of England, and has been noted as forming the principal constituent of the Corallina association at the end of Portland Bill.

(*b*) The Lithothamnium vegetation is described here together with that of Corallina, because it is exceptionally well developed when found in company

with a widespread growth of that alga. A thorough study of its occurrence in varying conditions was not made; consequently the following notes must be regarded as but a contribution to the study.

The growth in question occurs in three zones, *Lithothamnium Lenormandi*, the uppermost, *Lithophyllum incrustans*, the second, and the third, *Lithothamnium polymorphum*, appears only when low-water mark is reached. All three plants resent desiccation, and cannot bear being dried up. *L. polymorphum*, and, to a lesser degree, *L. Lenormandi*, prefer shade; but *L. incrustans* thrives in the bright sunshine of shallow rock-pools. The zone of *L. Lenormandi* occurs on damp rocks slightly above half-tide level, at which height moisture is local, being found in fissures, on shady vertical surfaces, or under the foliage of the larger algae. The zone is more extensive than at first sight appears, and is probably widespread in the British Isles. *L. incrustans* follows. This is abundant in all the rock-pools, and is by far the commonest species in the district. Apart from its growth in pools, *L. incrustans* first appears in chinks and hollows in the lower half of the littoral region. As one descends the shore the crusts become larger and more widely spread; and on reaching the Himanthalia level they form large sheets, filling up interstices between limpets, barnacles, and *Ralfsia clavata*. At low-water mark the plant is joined by *L. polymorphum*, the red warty thallus of which is at once distinguishable from the paler *L. incrustans*, though the latter at this level assumes its true mauve-pink colour, in contrast to its almost white appearance higher up. *L. polymorphum* extends into the sub-littoral region; *L. incrustans* probably does the same, but its growth here on exposed shores was not investigated.

The Lithothamnium vegetation described above is specially characteristic of exposed, somewhat bare rocks, where algae such as Laurencia and Himanthalia are poorly developed, but where there is a large growth of the short form of Corallina. In localities where there is less exposure, or where shrubby and foliaceous algae occur in plenty, the Lithothamnium vegetation is poor: some traces of the *L. Lenormandi* and *L. polymorphum* zones may be found, but *L. incrustans* usually disappears altogether.

Vegetation of Rock-pools.

Several different types of pools may be distinguished according to their elevation, and to the geological nature of the shore. A number of other factors must also be taken into consideration—namely, the size, depth, and configuration of the pools, and conditions of temperature, illumination, and drainage. Whilst much of the pool-vegetation is perennial and more or less constant, a large part is transient and varies considerably, not only from month to

month, but from one year to another. A detailed study and analysis of the vegetation was impossible; but a series of observations was made, and a general account is given below.

In the upper pools an encrusting vegetation is always conspicuous. At the highest levels *Hildenbrandtia prototypus* is found, especially on rugged rocks and on exposed cliffs. Slightly below, and generally in flatter areas, *Ralfsia verrucosa* appears, covering the bottom of shallow pools with a thick crust, and often completely ousting Hildenbrandtia. At a lower level (probably that of ordinary high-tide), *Lithophyllum incrustans* begins to develop, first as a very thin crust which does not fruit; then rapidly increasing in vigour on the lower rocks, it passes into the Lithothamnium association (p. 41). Ralfsia and Lithophyllum are, in the upper shallow pools, in competition. The former cakes off with age, allowing Lithophyllum for a time to get the upper hand. Ralfsia, however, tolerates more fresh water, and probably grows more rapidly. Both can withstand intense insolation, and often form large sheets without any protecting vegetation whatever. The water of these pools becomes in summer very warm.

With regard to the upright vegetation, *Enteromorpha intestinalis* is often alone in the highest pools, but is joined by *Cladophora sericea*, *Chaetomorpha aerea*, and *Scytosiphon lomentarius*, where the salt-water is constantly renewed by spray and splashing. Below these a series of fairly characteristic pools, situated about high-water level, is reached, which are well supplied with seaweeds during winter and spring. But in summer the larger algae are scarce, or represented by a few hardy species, usually infested with Diatoms and Cyanophyceae. The dominant species are:—

Cladophora rupestris.	Gigartina mamillosa.
C. sericea.	Laurencia hybrida (except summer).
Scytosiphon lomentarius.	Polysiphonia fruticulosa.
Leathesia difformis.	Dumontia filiformis (except summer).
Gelidium *sp.*	Corallina officinalis.

The additional winter and spring flora need not be listed. The pools are not always replenished in calm weather, and are distinctly brackish; they are about 6 inches deep, and commonly run parallel with the shore.

At a lower level the typical purely marine rock-pools commence, in varied form, and with abundant vegetation. They are much more difficult to classify, and have a constantly changing flora. With a sufficient depth, large algae, such as Halidrys, *Cystoseira fibrosa*, &c., are plentiful, and provide shade; hence almost any of the shade-loving Florideae (except those which require daily exposure to the air) may be met with. If shallow, the flora is more limited,

though sporelings and young plants of a very large number of species occur. In Vancouver, Henkel ('06) has worked on the structure of rock-pools; and Skinner's paper ('03) is one of the only attempts to analyse the flora and the conditions obtaining. His conclusions, equally applicable to the British coasts, are as follows:—In general, the higher the elevation of the pool, and the less exposed to wave-action, the fewer the species found, though the number of individuals may be great. The more gradual the slope, and the rougher and more irregular the sides, the more abundant the plant-life. A perpendicular or receding wall is unfavourable for the location of plants.

An attempt is made below to indicate the characteristic species of ordinary rock-pools not more than 18 inches deep. A complete list is out of the question. In a general way they are at their best in early spring. During the dark days of winter many of the Florideae, which at other seasons thrive in more shady spots, are found in shallow pools (e.g. *Phyllophora rubens, Plocamium coccineum, Laurencia obtusa, Rhodomela subfusca, Halurus equisetifolius*). Hence in winter and spring the Florideae are markedly dominant. In March and April many transient species develop; and in May and June brown algae are abundant, and also species of Cladophora. The Florideae in shallow pools are in summer of poor colour; and a great decrease in the number of species is noticeable. Ulva and Enteromorpha spp. may be dominant in August and September. Excluding large species, such as *Fucus, Laminaria,* &c., and small epiphytes like Myrionema, Elachista, and Chantransia, the most typical species are as indicated in the list on pp. 44, 45.

Cave-Vegetation.

As would be expected from the conditions obtaining in caves, shade-loving littoral plants abound; whilst in addition species from the sub-littoral region also occur. Provided wave-action is not too severe, the cave-flora is often full of interest biologically, long tunnel-like caves, with pools and boulders, being particularly instructive.

Though the Clare Island caves are neither numerous nor extensive, their flora is characteristic and worthy of record. They may be roughly divided into two sets, namely, exposed and sheltered. The flora of caves fully exposed to the sea is usually poor, incrusting species on the walls being at times the only vegetation present; but sheltered caves, especially if stocked with boulders, are rich in species, and possess the shaggy growth of which Plumaria is typical, as well as the mossy and incrusting coverings supplied respectively by *Rhodochorton Rothii* and *Lithothamnium polymorphum.*

Characteristic Vegetation of Rock-pools.

—	Feb., 1911. Roonah Pt.	April, 1911. Clare Island.	July, 1909. Clare Island.	Oct., 1910. Clare Island.
Monostroma Grevillei,	—	× *ab.*	—	—
Enteromorpha clathrata,	—	×	×	× *ab.*
E. compressa,	×	×	× *ab.*	× *ab.*
Ulva Lactuca,	× *y.*	×	× *ab.*	× *ab.*
Rhizoclonium implexum,	—	×	×	—
Cladophora pellucida,	—	×	—	—
C. rupestris,	×	×	×	×
C. sericea,	× *y.*	×	×	×
C. glaucescens,	—	×	—	—
C. albida,	—	×	—	—
C. lanosa,	—	×	—	—
Codium adhaerens,	—	×	×	×
C. tomentosum,	×	× *r.*	×	×
C. mucronatum,	× *y.*	×	×	×
Dictyosiphon foeniculaceus,	—	×	×	—
Litosiphon pusillum,	—	—	×	×
Phloeospora brachiatum,	—	—	×	—
Scytosiphon lomentarius,	×	×	×	×
Ectocarpus confervoides,	—	×	×	×
E. fasciculatus,	—	×	×	×
E. granulosus,	—	×	×	—
Pylaiella litoralis,	×	×	×	×
Ismophloea sphaerophora,	—	×	—	—
Myriotrichia claviformis,	—	—	×	×
Sphacelaria cirrhosa,	×	×	×	×
Cladostephus verticillatus,	×	×	×	×
Chordaria flagelliformis,	—	—	×	×
Mesogloia vermiculata,	—	—	×	—
Castagnea virescens,	—	—	×	—
Leathesia tuberiformis,	—	× *y.*	× *ab.*	×
Dictyota dichotoma,	× *y.*	× *ab.*	× *ab.*	—
Porphyra leucosticta,	—	×	—	—
P. umbilicalis,	×	×	× *r.*	—
Pterocladia capillacea,	—	×	× *r.*	—
Gelidium pulchellum,	—	×	×	×
G. latifolium,	—	×	×	×
Chondrus crispus,	×	×	×	×
Gigartina mamillosus,	×	×	×	×
Phyllophora rubens,	×	×	×	×

—	Feb., 1911. Roonah Pt.	April, 1911. Clare Island.	July, 1909. Clare Island.	Oct., 1910. Clare Island.
Phyllophora membranifolia,	×	×	×	×
Cystoclonium purpurascens,	×	×	×	×
Calliblepharis jubata, .	—	×	×	—
Rhodymenia palmata, .	×	×	×	×
Lomentaria articulata, .	× *ab.*	×	×	×
L. clavellosa, . . .	—	×	—	—
Chylocladia kaliformis, .	—	× *ab.*	—	—
C. ovalis, . . .	× *ab.*	×	×	×
Plocamium coccineum, .	× *ab.*	×	—	×
Nitophyllum punctatum, .	—	× *r.*	—	—
N. laceratum, . . .	× *ab. y.*	× *ab.*	×	—
Delesseria sanguinea, .	—	× *r.*	×	—
D. ruscifolia, . . .	—	× *r.*	×	—
D. hypoglossum, . . .	×	×	×	×
Rhodomela subfusca, .	× *ab.*	—	—	—
Laurencia obtusa, . .	×	—	—	—
L. hybrida, . . .	×	× *ab.*	—	—
L. pinnatifida, . . .	× *ab.*	×	×	×
Polysiphonia urceolata, .	×	× *r.*	—	—
P. nigrescens, . .	×	× *r.*	× *r.*	×
P. Brodiaei, . . .	× *y.*	×	× *r.*	—
P. fruticulosa, . . .	—	×	×	×
Pterosiphonia thuyoides, .	×	×	×	×
Dasya arbuscula, . .	—	—	×	×
Spermothamnion Turneri, .	×	×	×	×
Griffithsia setacea, . .	—	×	—	×
Halurus equisetifolius, .	×	×	—	—
Monospora pedicellata, .	—	× *y.*	×	—
Plumaria elegans, . .	×	×	×	×
Ceramium rubrum, . .	×	×	×	×
C. Boergesenii, . . .	×	×	×	×
C. ciliatum, . . .	× *y.*	×	×	×
Dumontia filiformis, . .	×	×	—	—
Dilsea edulis, . . .	×	×	—	—
Furcellaria fastigiata, .	×	×	×	×
Lithophyllum lichenoides, .	×	×	×	×
Corallina officinalis, . .	×	×	×	×
C. squamata, . . .	×	×	×	×
C. rubens, . . .	×	×	×	×

1. *Exposed Caves.*—Several of these occur between Portlea and the lighthouse, and are accessible at low tide. The walls, almost up to the roof, are covered with encrusting organisms representing algae, lichens, and sponges; and except for local patches, shrubby species are absent. In the following list, the first four are dominant, occurring roughly as bands from above downward in the order mentioned, whilst the three last are scattered irregularly a short distance above high-water mark:—

Hildenbrandtia prototypus.	Lithothamnium laevigatum.
Verrucaria *sp.*	Ralfsia clavata.
Lithothamnium Lenormandi.	Cruoria pellita.
L. polymorphum.	

Large sheets of sponges also occur, and amongst these *Halichondria panicea*, frequently with *Rhizoclonium Kerneri* f. *endozoica*, is abundant.

Small patches of a very short growth of the following fruticulose species are occasionally found, their presence probably indicating local shelter:—

Phyllophora rubens.	Plumaria elegans.
Chylocladia ovalis.	Corallina officinalis.

Where fresh water exudes from the roof or walls, streaks of *Cladophora rupestris*, if the exposure be not too great, mark its presence, and at times *Rhodochorton floridulum* in addition. Pools are generally lacking; if present, their flora resembles that given below for sheltered caves.

2. *Sheltered Caves.*—Several types of these may be distinguished according to the nature of the shore and the manner in which they receive protection. In our area the two following only need be mentioned:—(*a*) Open caves on exposed coasts, protected by rocks at the entrance (Roonah Point); and (*b*) high-level caves with the entrance at, or just above, high-water mark. In the former there is often a variety of ground and vegetation, especially if boulders and pools occur; in the latter the conditions are more uniform.

(*a*) The encrusting vegetation at Roonah Point is the same as that on exposed coasts, but less extensive; the mossy growth of *Rhodochorton Rothii* is abundant on the drier boulders and on the upper parts of the walls; *Sphacelaria britannica* and various Cyanophyceae occur with this species, and *Phyllophora Traillii* is found in patches. An abundant growth of shade-loving Florideae follows at a lower level, covering rocks, boulders, and shallow pools, *Chylocladia articulata*, *Delesseria alata*, *Nitophyllum laceratum*, *Polysiphonia urceolata*, and encrusting species such as *Lithothamnium*

Lenormandi and *L. polymorphum* being the most usual. The pool-flora consists chiefly of the following species:—

Phyllophora rubens.	Polysiphonia urceolata.
P. membranifolia.	Chylocladia articulata.
Rhodymenia palmata.	Griffithsia setacea.
Nitophyllum laceratum.	Pterosiphonia parasitica.
Delesseria sanguinea.	Lithophyllum incrustans.
Plocamium coccineum.	Lithothamnium polymorphum.

(*b*) A small tunnel-like cave on the south side of Portlea was carefully investigated each season. Though short, it was the only really dark cave examined, and its flora proved of considerable interest, three of the rarest algae of the island occurring in it. Near the mouth of the cave the shaggy growth lining the walls consisted of *Cladophora rupestris* (dominant) and Plumaria (sub-dominant), with the following species scattered freely amongst them:—

Ectocarpus Holmesii.	Polysiphonia macrocarpa.
Gelidium pusillum.	Rhodochorton floridulum.
Rhodymenia palmata.	Callithamnion scopulorum.
Polysiphonia urceolata.	Spermothamnion Turneri.

A little further in, Plumaria becomes dominant, and, with the exception of *Cladophora rupestris*, which assumes a thin feebly branched habit, the other algae gradually disappear. On the bottom and at the margins of pools, *Derbesia marina* is found, and on the sloping sides *Codium amphibium* under the drip of fresh water. At the further end, the walls are mostly clothed with a pure growth of Plumaria, though patches of *Lithothamnium Lenormandi* var. *squamulosa* exist, and Derbesia occupies the water-edges. The pool-flora is remarkable; Plumaria, *Ceramium acanthonotum* and *Polysiphonia macrocarpa* are common, whilst further in there is a felt of the minute *Ptilothamnion lucifugum* (sp. nov.).

(b). *Sub-littoral Region.*

The sub-littoral vegetation of exposed coasts is difficult of exploration. In calm weather much may be learnt from a boat at dead low water, but in a general way a small boat and a hand-dredge are of little use. Two associations only are described below, these being the only ones which were definitely investigated. Colonies of the beautiful *Cystoseira ericoides* are plentiful off the shore, in company with such plants as Saccorhiza and Himanthalia, but unfavourable weather baffled attempts at their study.

Laminaria Association.

Clare Island is girdled at low-water mark with a fine belt of Laminaria, which descends on all sides deep down into the sub-littoral region. With the exception of the somewhat doubtful *L. hieroglyphica*, all the English species occur, so that the west of Ireland presents the exposed Laminaria vegetation of the British Isles in its most varied form. Though a submerged association, each species reaches to the top of the sub-littoral region, and is thus visible during the lowest spring-tides. Alaria and *L. digitata* are uppermost, and are often uncovered; Saccorhiza and *L. saccharina* follow, and usually show in calm weather, whilst the erect stipes of *L. Cloustoni* protrude in favoured localities only. Alaria, *L. digitata*, and *L. Cloustoni* form well-marked belts which are always to be found on the type of shore that they respectively require, whereas the growth of Saccorhiza, and *L. saccharina*, though at times plentiful, is scattered and local.

A steep coast with almost perpendicular rocks is the Alaria shore *par excellence*, though *L. digitata* is also usually present. On sloping rocks the same vegetation obtains, the amount of *L. digitata* increasing as the shore becomes less steep, till at length Alaria disappears altogether. *L. digitata* often descends into many fathoms (at least 8); but Alaria appears to form a shallow belt in the uppermost part of the littoral region. *L. Cloustoni* enjoys the Atlantic swell, but prefers a flat bottom, and is absent on steep rocks. Within the shelter of a reef, or in other similarly protected spots, the plants are found nearer the surface of the water, and at the lowest tides the tops of their stipes protrude. In such positions the association may be conveniently examined from a boat (e.g., at Roonah Quay).

A flat or gently sloping bottom with a certain amount of shelter is most suitable for Saccorhiza and *L. saccharina*. In certain spots on the south shore, and especially in channels between the rocks, the former grows in plot-like areas, which may be easily examined from the rocks in quiet weather. It is also plentful in the shallow water off Kinnacorra. Streak-like patches of *L. saccharina* have also been noted in these localities, but the plant is more characteristic of quiet regions.

As stated on p. 15, the Laminaria association, though it may be partially uncovered during spring-tides, marks in reality the upper limit of the sub-littoral region. The amount uncovered varies with the exposure. In the most boisterous spots Alaria ascends high, and consequently, if a spell of quiet weather synchronizes with spring-tides, a considerable amount, 3–5 feet, is left bare. Börgesen mentions a case in the Faeröes, where Alaria flourished at a level above that of high-water line. Nothing like this has been seen in

Ireland, and it probably only occurs where great exposure is coupled with a wet, foggy climate.

The usual epiphytes characteristic of the species occur. *Litosiphon Alariae, Ectocarpus fasciculatus,* and Myrionemaceae are frequent on Alaria—*Chantransia Alariae* rare. The laminae of *L. digitata* commonly bear a copious growth of Ectocarpi, Ceramia, *Callithamnion tetragonum,* and other small plants, while the stipes are usually clean. The rugged stems of *L. Cloustoni,* on the other hand, are densely clothed with Florideae, which show a tendency to definite sequence from above downwards as pointed out by Berthold ('82) and Börgesen ('05). As a rule this sequence is as follows:—

Rhodymenia palmata.
Polysiphonia urceolata.
Delesseria sinuosa.
Delesseria alata.
Heterosiphonia coccinea.

But in addition to the differences due to seasonal variations many irregularities were noted. Other characteristic epiphytes are:—

Codium tomentosum.	Ptilothamnion pluma.
Callophyllis laciniata.	Ptilota plumosa.
Rhodymenia palmetta.	Plumaria elegans.
Lomentaria articulata.	Rhodochorton parasitica.
Plocamium coccineum.	Cruoriella Dubyi, *r.*
Nitophyllum laceratum.	Cruoria pellita *r.*
N. uncinatum (autumn).	Petrocelis Hennedyi *r.*
N. Bonnemaisoni, *r.*	Dermatolithon pustulatum.

Saccorhiza is usually fairly clean, as is also *L. saccharina* in exposed localities.

Comparison with other Countries.—As far as Alaria, *L. digitata,* and *L. Cloustoni* are concerned, the above vegetation agrees well with that described by Börgesen for the Faeröes, though in that region it ascends somewhat higher on the shore. Saccorhiza is entirely absent; but this is compensated for by the presence of two additional species, *A. Pylaii* and *L. faeroensis,* the latter being confined to sheltered coasts. Börgesen, in an interesting paragraph on the effect of wave-action on Laminariae, points out that the pliable stipes and fronds of Alaria and *L. digitata* are able to resist the violent conditions of a steep shore, and where the breaking of the waves is felt; whilst the stout and comparatively rigid stems of *L. Cloustoni* are suited to the strong pull of the rollers in deeper water.

The Swedish vegetation described by Kylin is very different. Alaria is absent, and the vertical rocks are clothed with *L. digitata* and *L. saccharina* var. *bullata*. In the most open spots *L. digitata* var. *cuneata* is dominant. The *L. Cloustoni* vegetation is entirely separate from *L. digitata*, being found only in the deeper part of the sub-littoral region, appearing first in about 15 m. of water. Boye's account of the Norwegian flora (according to Börgesen's summary) agrees with that of the Faeröes; and Kylin's notes on the vegetation near Bergen ('10) indicate the preponderance of Alaria and *L. Cloustoni*. The Iceland vegetation resembles that of the Faeröes, but is enriched by the presence of *L. nigripes* and *Saccorhiza dermatodea*. In the south of England Alaria is rare except in Cornwall, but apart from its absence the Clare Island vegetation agrees well with that noted in Dorset. The exposed rocky coasts of Ireland are, however, more favourable for an extensive Laminaria vegetation, and are highly suitable for a growth of Alaria.

Encrusting Alga Vegetation (sub-littoral).

The Lithothamnium vegetation of the littoral region extends downwards into the deepest parts of the sub-littoral, but, owing to the difficulty of dredging amongst a dense growth of *Laminaria digitata* and *L. Cloustoni*, it is difficult to ascertain the amount of growth and the relative abundance of the species. An extensive coating of calcareous algae is, however, present, and on exposed coasts probably occupies a large part of the available rock-surface, though soft encrusting species, such as *Cruoria pellita*, Cruoriella, and Peyssonnelia, occur with it. *Lithophyllum incrustans* enters the sub-littoral; but, as far as could be seen, the Lithothamnium band at the lowest tide-level consists mainly of *L. polymorphum*, and this extends downwards for several fathoms. Other species dredged were *L. laevigatum* and *L. compactum*. The fruticulose calcareous algae, such as *L. calcareum* and *L. fasciculatum*, are characteristic of sheltered shores (p. 69).

B.—*Sheltered Coast Series.*

(a) *Littoral region.*

Several of the associations found on sheltered coasts have been already dealt with. In some cases the principal differences noticeable in passing from the open shores to quieter conditions have been pointed out, so that re-description is unnecessary. In other cases, though the associations have been described, their growth in sheltered localities requires special notice; yet other communities are peculiar to such regions.

Hildenbrandtia–Verrucaria Association.

Brief notes may be added to previous remarks with regard to this association (p. 19). On the sheltered shores of Clew Bay the same species are present, especially on boulders and smooth rocks. Where these are absent a discontinuous growth on stones and pebbles occurs, and in such spots Hildenbrandtia is joined near low-water mark by *Porphyrodiscus simulans* and *Rhododermis elegans* (plants hardly distinguishable in the field), and also by *Ralfsia clavata*. *H. prototypus* itself, moreover, appears to extend to the sub-littoral region (cf. p. 20). The difficulties of obtaining satisfactory material and of distinguishing the species when collecting, make it no easy matter to gain a true idea of the different societies. It is certain, however, that in these localities the *Ralfsia clavata* vegetation is one with the Hildenbrandtia association, and that it forms a part of it. It is further evident that a vegetation composed of soft encrusting algae and lichens extends uninterruptedly from high-water mark down to the Lithoderma association of 5–8 fathoms. The details require working out, but roughly the principal species form zones as follows :—

Hildenbrandtia prototypus (upper littoral).
Verrucaria mucosa (middle littoral).
Ralfsia clavata (lower littoral).
Cruoriopsis Dubyi (shallow sub-littoral).
Lithoderma fatiscens ? (shallow sub-littoral).

Fucaceae Association (sheltered).

The growth of Fucaceae on flat sheltered shores is exceedingly luxuriant, and often forms a conspicuous feature of the landscape. The indispensable factor is good anchorage. On flat shores, where wave-action is slight stones are sufficient to supply this necessity, but where rocks and stones are wanting Fuci are conspicuous by their absence. The association was studied especially in Achill Sound, the north part towards Inishbiggle and Bellacragher Bay having been examined, as well as the southern portion towards Achillbeg. As far as was seen the Fucus growth in Clew Bay is of a precisely similar nature.

The association is composed of the usual five species in their normal sequence (see p. 23), and where fresh-water streams occur, the sixth species, *F. ceranoides*, invariably appears. In some places the zones are fairly sharply defined; in others they are much less distinct, and each zone overlaps the next. A certain amount of irregularity exists too as to the order in which Ascophyllum and *F. vesiculosus* occur. The former usually commences above

the latter; but not infrequently *F. vesiculosus* forms a very wide zone reaching from *F. spiralis* down to *F. serratus*, with Ascophyllum scattered amongst it, or forming more or less of a band in the upper part. The reason for this is explained later. At times one or more of the species may be absent, and this may almost always be traced to lack of suitable means of attachment at the appropriate level. In Achill Sound, for instance, the association often stops abruptly with Ascophyllum or *F. vesiculosus*, owing to the absence of stones at the level at which *F. serratus* should occur. In other places Pelvetia and *F. spiralis* are only feebly developed owing to the lack, in the upper part of the shore, of stones of sufficient size.

Some idea of the width of Fucus association in Achill Sound will be gained from the following readings:—

A. Sloping shore near Achill Bridge with a narrow band of Fucaceae:—

	Width of zone.
Pelvetia,	2–3 feet.
F. spiralis,	5–6 ,,
F. vesiculosus,	10 ,,
F. vesiculosus and Ascophyllum mixed,	10 ,,
F. vesiculosus,	10 ,,
F. serratus,	10 ,,

B. Flat shore with a very wide Fucus association; about 1 mile south of Achill Bridge:—

	Width of zone.
Pelvetia,	5 yards.
F. spiralis,	10 ,,
Ascophyllum,	40 ,,
Ascophyllum and F. vesiculosus,	30 ,,
F. vesiculosus,	50 ,,
F. vesiculosus, F. serratus,	50 ,,

The above figures represent fair average readings for sloping and flat shores respectively, and serve to show that the horizontal range varies directly with the amount of slope. On very flat shores even wider bands exist. At Mulranny, for example, on a flat stretch of rocks and stones at high-water level, a growth of Pelvetia 80 yards wide was noted: this was followed by a sudden increase in the fall, and the succeeding band of *F. spiralis* was only 3–4 yards in width.

With regard to exposure, all the species composing the association can tolerate the extreme shelter of the inner part of Clew Bay. On passing from this region to the more open, beyond a slight change in form, there is no

marked difference in the vegetation as long as Ascophyllum remains. A slight exposure, however, is sufficient to affect this species, and with its disappearance the association is robbed of one of its most conspicuous elements. Ascophyllum begins to disappear on the outer sides of the islands, but persists in all cases on the inner sides. West of the islands it is only found in certain places, though this perhaps is largely due to the lack of good mooring. But, in spite of this, there is no question whatever that in the Survey-area Ascophyllum is far more susceptible to exposure than *F. vesiculosus.* This is in agreement with observations in other parts of the British Isles, and also with accounts that have been given of the Norway Fucus-vegetation (Boye, '94, and Kylin, '10). The conditions described for the Faeröes, where Ascophyllum is the less susceptible of the two, are very remarkable, and, as far as known, unique. The result of exposure in producing a change in form in the various constituents of the association is very marked. It is best seen in *F. spiralis. F. vesiculosus* also produces a wealth of form, but the variations are more difficult to connect with external conditions. Remarks on these points occur in the notes on each species given later.

Fucus Farms.—The botanical features of the plots, planted with stones in order to obtain a growth of Fucus for use as manure, may be dealt with here. The farms are formed on flat stretches of sand exposed at low water. They may either extend from the shore, or be laid out as isolated patches in the middle of the strand. The rapid colonization, and the luxuriance of the subsequent vegetation, prove beyond question the effect of anchorage.

The stones are covered mostly by *F. vesiculosus,* though a small amount of Ascophyllum sometimes occurs. At the lowest levels there are occasionally encircling belts of *F. serratus,* but the stones are not as a rule placed sufficiently low for this species. *F. vesiculosus* is very luxuriant, forming large tufts, bright yellow in summer and deep green in winter, with numerous bladders and abundant fruit. *F. serratus,* when present, grows equally vigorously, with fine broad fronds often a yard in length. The plants are cut in February after two full years' growth, and the stones turned over for a new crop of sporelings to develop.

It is somewhat remarkable that this artificially produced vegetation consists of a practically pure association of *F. vesiculosus;* forming thus a striking contrast to vegetation obtaining on mud-flats (e.g., Belfast Lough, Southampton Water). The latter are colonized by mussels, and these support a pure growth of *Ulva Lactuca.* Ulva, and many other adaptable algae, are present in Clew Bay, but Fucus has complete sway on the stone plots. It would be interesting to know whether Fucus would develop if stones of sufficiently large size could be maintained on the mud-flats of Belfast Lough.

A few notes are appended on the species composing the association.

(a) *Pelvetia canaliculata.*—This is less variable than any other species. In the sheltered parts of Clew Bay and in Achill Sound, it usually occurs on the irregularly scattered stones, and consequently the zone is interrupted. The growth is entirely flooded at spring-tides, but at neap-tides the upper part of the belt is unmoistened, the plants remaining quite dry, and brittle for several days in succession. Though Pelvetia may form a zone several yards wide, its vertical distribution is not more than 1½–2 feet. It fruits freely during summer and autumn; but the growth being more interrupted and not so luxuriant as on open shores, the orange-yellow band is not so conspicuous.

(b) *F. spiralis.*—Not only is *F. spiralis* found in all the sheltered parts of Clew Bay, but it is capable of growing on peat and loam, and ranges from such situations to the roughest and most exposed parts of the open coast (cf. Börgesen, '05, p. 746). Leaving aside its growth on peat (see p. 124), we find that on flat shores the plants are usually stone-attached, and do not form so dense a vegetation as when growing on rock. For this reason they become drier during the long exposure to the air, and are shorter and less branched. When the shore is composed of rocks and large stones, the growth is more vigorous; and under these conditions the plants attain their maximum size, the fronds being wide, much branched, and bearing large fleshy conceptacles. This form remains as long as the conditions are sheltered, but when exposure is experienced, or where a current strikes the shore, the plants become shorter, though they usually retain their bushy habit.

The belt formed is much wider than on steep open coasts, and its width is proportional to the degree of slope. In Achill Sound it varies from a few feet to 10 yards, and usually forms a pure growth, though *F. vesiculosus* and Ascophyllum occasionally intrude into the lower part. The fruiting season on quiet shores appears to extend over a slightly longer period than on those which are more open. In Clew Bay it commences in May, and does not cease till autumn. On sheltered shores also, a difference in colour is noticeable during the autumn, the plants turning a bright rusty brown. The same peculiarity has been observed on the south coast of England; and it serves to distinguish at a glance *F. spiralis* from *F. vesiculosus*, the latter being usually yellow or only slightly brown. In some places two sharp zones of colour are produced. Another feature, which on flat shores is very characteristic of *F. spiralis*, is the presence of long blister-like swellings on the fronds. These are invariably present in the inner part of Clew Bay, and are entirely absent from the short forms found on Clare Island. Sauvageau has lately examined *F. spiralis* (= *F. platycarpus*, Thur.) with great thoroughness ('08).

(c) *Ascophyllum and F. vesiculosus.*—The irregularities in the vertical range of Ascophyllum and *F. vesiculosus* have been noted by several writers. Börgesen calls attention to the difference in the observations of Strömfelt in Iceland, and Rosenvinge in Norway; and records irregularities noted by himself in a single locality in the Faeröes. He comes to the conclusion that the difficulty may be explained by the factor of exposure and small differences in local topography. No doubt this solution is correct with regard to many localities; but in Achill Sound it was found inadequate, and a further explanation had to be sought for. It has always been assumed that in England the Ascophyllum zone begins slightly above that of *F. vesiculosus*, and Miss Baker ('09) gives figures which support that view. This sequence is found on the stone embankments of Achill Bridge and in other places; but on the shores in Clew Bay, as often as not, the reverse order obtains. The explanation, so far as the sheltered waters of the Survey area are concerned, was found to be largely one of anchorage. Ascophyllum requires a stronger mooring than Fucus; and on the sandy shores of Clew Bay where the stones in the upper part of the beach are small they are insufficient for Ascophyllum, though well able to provide a mooring for a short growth of Fucus. The absence therefore of the Ascophyllum-zone, or the presence of scattered plants only, is explained by the absence of rock and large stones at the right level, or the presence of isolated rocks only. In many parts of the Sound the anchorage is sufficiently good to allow Ascophyllum to flourish at all levels, and then the normal sequence is almost invariably maintained. Very small stones suffice for both *F. spiralis* and *F. vesiculosus*; but it is unusual to find even young plants of Ascophyllum on stones. The last-named shows a decided preference for boulders, from which it hangs in festoons. The stone-attached Fucus-vegetation is essentially one of very sheltered water, and could not exist were there much wave-action. Where the stones are light the growth is small, and if, by reason of a long spell of quiet weather, an extra amount of foliage should be produced, a number of plants will be displaced with the first ruffling of the water.

Ascophyllum fruits in late winter and spring. In summer and autumn a large amount of vegetative growth takes place; and young receptacles are laid down in autumn. The latter begin to ripen in March, the main crop of spores being liberated in April and May. The effect of exposure has been dealt with above.

The *Fucus vesiculosus* belt is the widest. On flat shores it ranges from 20 to 80 yards, in the upper part usually accompanied by Ascophyllum, but near low water often pure. No attempt was made to determine all the forms; but the most abundant is the ordinary type. Var. *vadorum* is also common,

and var. *laterifructus* not infrequent. In many localities var. *axillaris* is found, which under certain conditions passes into *F. volubilis*, Huds. The latter in its typical form was not noted in the area; but the salt-marsh plant var. *baltica* is abundant. This, together with a peculiar variety named *muscoides*, is dealt with later (p. 80).

(d) *Fucus serratus*. Whilst Ascophyllum enjoys hanging from boulders, *F. serratus* prefers to lie flat. Occasionally it is found growing on sand-covered rocks, and then rests on the bare sand. It is found on all sheltered coasts where there is appropriate anchorage; but in many parts of Clew Bay this is wanting; and the pebble-attached association sets in below *F. vesiculosus*. *F. serratus* forms a band which unites the littoral and sub-littoral regions. The fronds are wider on sheltered than on exposed coasts; and on the whole it is the least variable Fucus.

Sub-vegetation.—When growing on sloping rocks a luxuriant undergrowth of various algae is found; but when attached to stones, or where much sand occurs, extraneous species are scarce. Amongst those almost constantly present are:—

In upper part.	*In lower part.*
Hildenbrandtia.	Cladostephus spongiosus.
Catenella.	Ulva.
Gelidium pusillum.	Ceramium rubrum.
Cladophora rupestris.	Chondrus.
	Gigartina.
	C. rupestris.

On the more open shores where clean rocks are prevalent, the Laurencia-Gigartina vegetation often forms the main undergrowth, though upward extensions of the Corallina-Lithothamnium association are also frequent. Amongst these, such sub-littoral or shade-loving plants as *Chylocladia articulata*, *Delesseria alata*, and Plumaria occur, with many odd plants of various communities. In sandy places a *Rhodochorton floridulum* vegetation is often developed, and this ousts many of the other species.

Epiphytes.—These are likewise fewer in very sheltered than in moderately open localities. In the quiet reaches of Clew Bay, Pylaiella is always present, and forms in spring and summer large floating masses. Other frequent epiphytes are:—

Dictyosiphon foeniculaceus.	Ectocarpus siliculosus.
Ceramium rubrum.	E. tomentosus.
C. Boergesenii.	E. fasciculatus.

In late summer blue-green algae are much in evidence, *Calothrix confervicola* and *Rivularia atra* occurring everywhere, often accompanied by

large masses of *Lyngbya majuscula*. The more open parts of the bay show, with the exception of Dictyosiphon and Cyanophyceae, which are rare or absent, the same epiphytes (see also p. 25).

For the comparison of the present association with that of other countries, see p. 26.

The Lichina Association (sheltered).

Locally distributed on sheltered and semi-sheltered localities (Clew Bay, Achill Sound, Bellacragher Bay). See notes on p. 26.

Porphyra Association (sheltered coasts).

The growth of Porphyra found in many sheltered places, though not noted by previous writers, is very characteristic and worthy of record. It is found on two types of shore, viz. (1) gently sloping beaches of low rocks and stones, and (2) sandy bays where half-buried rocks are present. The growth occurs more or less throughout the year, though it appears to be more abundant in spring and autumn than in summer. On both shores it is usually accompanied by various forms of *Enteromorpha intestinalis* and *E. linza*.

On beaches composed of stones and flat rocks the association usually fills up the gaps between Fucus. The latter is confined to the larger rocks, whilst Porphyra, which extends from below *F. spiralis* down to low-water mark, occupies the smaller stones and rocks, though it also occurs epiphytically on Fucus. The amount of growth noted varied considerably on different occasions, as did also the size and form of the plants. In summer it is mostly confined to the lower levels, where it may form a distinct belt. This type of growth is well seen at Louisburgh (immediately east of the Bunowen River), also on the inner side of Bartraw and on Annagh Island, where wave-action is entirely absent. Other parts of Clew Bay, which appeared equally suitable, were entirely devoid of Porphyra. In the localities named a strong current runs along the shore, so that the conditions though quiet are not by any means stagnant, and this fact may in part explain the vigorous growth, and its absence elsewhere.

The second type of growth referred to, namely that on rocks in sandy bays, is somewhat remarkable, because the expanded membranaceous thalli have to endure the constant friction of the sand. In spite of this, however, a very vigorous and characteristic vegetation is found. The growth is most noticeable at the sides of low bare rocks or those crowned with a mass of Fucus. It may be seen thus in many spots in our area, and has been noticed in other parts of the British Isles. But in addition to this, Porphyra occurs on rocks more or less hidden by sand, so that at first sight the growth might be taken for loose fronds that have become embedded. The plants are in reality

attached to low-lying rocks, and are thus not only exposed to constant sand-movement, but are liable to be completely buried. On the other hand, with certain winds, nearly all the sand is removed by the tide; and the thalli lie on the bare rock. They are also liable to be covered by blown sand. Under average conditions it would appear that only a few inches at the base of the fronds are buried, and that the upper part remains free, lying flat on the damp ground: though one must assume that germination took place on rock. Associated with Porphyra are Enteromorpha *spp.*, especially the large flat forms approaching *E. linza*. This plant occurs in the damper positions, being most abundant in the lower part of the association, and reaching down to the sublittoral region. In August the Enteromorpha growth was in all cases much less than in May.

The zone formed by Porphyra on sheltered coasts is more extensive than in the open. In the sandy bays described above the plant escapes a certain amount of desiccation, and the result of this is seen in the fact that whilst on bare rocks it does not exceed the *F. spiralis* level (at all events during summer), on sand-covered rocks it frequently reaches Pelvetia. The lower limit also is further than that of the exposed association, for the plant is frequent at low-water mark, and occasionally extends well into the sub-littoral region.

The form assumed in sheltered localities is that of the divided and lanceolate type, var. *laciniata* J. Ag. This is specially well developed on damp rocks and on margins of pools. On drier rocks and with increased exposure there is a tendency for the fronds to become short and umbilicate. The sand-rock form of the association is well seen at Mulranny, also between Old Head and Leckanvy, whilst a small patch exists in the bay on Clare Island. Though not noted, forma *linearis* probably exists in winter in the upper levels, as in exposed localities.

A similar vegetation of Porphyra would, judging by the localities described by Rosenvinge, appear to be widespread in Denmark ('09, p. 65).

Laurencia-Gigartina Association.

Fairly well developed in many parts of Clew Bay outside the islands. See p. 33.

Corallina-Lithothamnium Association.

At times feebly developed in the more open parts of Clew Bay. See p. 39.

Corallina-Cladostephus Community.

In company with the Laurencia community of sheltered coasts there often occurs a similar vegetation of short dense growth, but composed largely of

Corallina, Gelidium, and Cladostephus, and having a tendency to approach the *Rhodochorton floridulum* association. The presence of *Cladostephus spongiosus* together with *Corallina officinalis* is very characteristic of this vegetation, and hence the name selected.

The community in question is essentially one of flat, sheltered rocks, avoiding the clean rocks and turbulent conditions enjoyed by Laurencia, but thriving with more slope and slightly more exposure than *R. floridulum*. It occupies the same bathymetric range as *Laurencia pinnatifida*, and though capable of growing in the shallow sub-littoral region, it more often gives place to Gigartina or Laminaria. At Portlea it is intimately associated with Rhodochorton, but the two communities are usually sharply defined, and distinguishable at once to the eye, as well as to the tread.

Though both Corallina and Cladostephus are rock-attached, a thin layer of sand is often found on the surface of the substratum. Corallina, under the conditions obtaining, is short and more or less erect, its stiff branches easily retaining sand and fine debris, so much so that the presence of blackened sand and particles of decayed matter is almost characteristic of the community. At the same time it is not truly psammophilous. A vegetation of the same nature (though differing slightly floristically) has already been described by me in connexion with the growth of Ulva, and the origin of the blackened sand is explained ('11, pp. 124 and 128).

The Corallina-Cladostephus sward is seldom so extensive as that of *Rhodochorton floridulum*, being patchy, and only occasionally forming broad belts. *Gelidium aculeatum* is sometimes present in quantity, and *C. squamata* is common, especially in the more open regions. A very heavy epiphytic vegetation exists, of which *Enteromorpha clathrata*, Ulva, Leathesia, *Ceramium flabelligerum*, and *C. rubrum* are the most abundant. *Callithamnion Hookeri* also is found in summer on Cladostephus. In addition to the above, a large number of sporelings occur. These succeed better on this vegetation than on Rhodochorton (where sporelings are exceedingly numerous); and though the plants do not attain their maximum size, they usually fruit, and are sufficiently large to give distinct patches of colour. Much *Cladophora sericea* and *C. albida* is present in spring; *Ceramium rubrum* in various forms is abundant in summer; whilst in October (1910) a form of *Enteromorpha clathrata* was very conspicuous. In summer Ulva also is present in great quantity, as has already been pointed out (Cotton '11, p. 128), being saxicolous or epiphytic.

On Clare Island the association occurs on a small scale at Portlea and Kinnacorra; and on the mainland at many spots in the outer part of Clew Bay (Roonah, Louisburgh, Mulranny). A similar vegetation occurs on the

south coast of England; and though not recorded from other countries, it probably exists, at all events, on the north of France.

Rhodochorton floridulum Association.

Small patches of this are occasionally found on rocky shores; but it is characteristic of the sand and low-rock series described later (p. 65).

Sand-Pool Vegetation.

Occasionally met with, but typically developed on sandy shores (see p. 67).

Cave Vegetation.

The caves of sheltered coasts are dealt with on p. 46.

(b) *Sub-littoral Region.*

Laminaria Association (sheltered).

The Laminaria vegetation of sheltered shores is fairly well developed. It is found in many parts of Clew Bay, in Bellacragher Bay, and in parts of Achill Sound. The characteristic species are *L. saccharina* and *L. digitata*, the latter being, as a rule, confined to localities where current is present. In the deeper and more open parts, *L. Cloustoni* exists; but with the appearance of this species *L. saccharina* drops out, and the association passes gradually into the exposed type.

Whilst on exposed coasts the Laminaria vegetation is typically in belts, on sheltered coasts it is commonly discontinuous, and occurs rather in plots. This is mainly owing to the scattered nature of the anchorage. It is found wherever rocks or large stones occur; and the amount is determined by the extent of the stony area. In Clew Bay, the hard bottom is found in three kinds of ground, each of which supports a different type of Laminaria vegetation. As the latter are determined by definite ecological conditions, and as, in Clew Bay, they scarcely overlap, it is reasonable to regard them as three sub-associations.

The sub-association of *Laminaria saccharina* (most often var. *latissima*) occurs in the inner part of the bay, where the conditions are quiet and the current weak. The fronds are long and very broad—in extreme cases up to a yard across. Occasionally the association is pure (except for small species forming the undergrowth); but as a rule other algae intrude, such as *Cystoseira granulata* and *Halidrys siliquosa*. Rarely the association merges into the Zostera beds. The second sub-association is characteristic of ground

where there is a strong current, and is found typically in the channels of 3 to 5 fathoms between the outer islands. It consists entirely of *L. digitata*. The bottom is scoured by the tide; but the larger stones and blocks of rock support a vigorous growth. The plants are remarkably strong, and in the deeper parts the fronds often attain a great length. Epiphytic species are few; but in such localities the peculiar plant known as *Rhodymenia palmata* var. *sarniensis* is occasionally met with. The third type of Laminaria vegetation, characterized by the presence of *L. Cloustoni* in addition to *L. digitata*, is found only outside the islands. It extends over large areas in about 7 fathoms, and passes gradually into the exposed vegetation that occurs further out.

Representatives of these same sub-associations are found elsewhere. *L. digitata* is abundant near the south entrance of Achill Sound; and in the quiet waters of Bellacragher Bay a distinct *L. saccharina* vegetation exists, which in several places extends to the shore. In other countries, the sheltered type of Laminaria vegetation has not received much attention. In the Faeröes it is well developed, and shows similar variations to those in Clew Bay, though with floristic differences. *L. faeroensis* takes the place of *L. saccharina* in quiet bays, and *L. Cloustoni* forms the vegetation of channels. The Laminaria zone described by Joubin ('09) includes patches of *L. saccharina* attached to stones on a soft bottom, which obviously correspond to the sub-association of that species dealt with above.

Encrusting Alga Vegetation.

Occasionally found, but more often on exposed coasts (see p. 50).

II.—*Sand and Sandy-mud Formation.*

The present formation is characterized by a large quantity of movable sand or sandy-mud, in which the vegetation is liable to be partially or completely embedded. In its extreme form, the shore consists entirely of this matrix, the algae being immersed in sand, forming, in fact, a sand-binding community. But the sand formation passes by transitions into the rock-formation on the one side, and to mud-flats on the other.

As an example of a sand-binder we may take Microcoleus, whilst *Vaucheria Thuretii* supplies an instance of a plant that fixes sandy-mud. Both form extensive associations. *Rhizoclonium riparium* also may under certain conditions form a surface-covering on a shore of pure sand. In the majority of sand-beaches, however, all vegetation is absent and only begins to show when solid ground is reached. Where low half-buried rocks occur a

psammophilous vegetation is found, of which Rhodochorton is a good example. With extreme shelter, this can form a mossy carpet on pure sand; but as a rule it is only found on sand-covered rocks, or on small intervening sand-spaces. The alga is probably in the first instance attached to rock, but as the plants grow they form adventitious rhizoids and accumulate sand. Being saxicolous, Rhodochorton extends to rocky shores, where sand is scarce or even absent. As an association, however, it is only found where this material is plentiful. Several other psammophilous species accompany Rhodochorton.

The Corallina-Cladostephus community represents the last stage in the transition from sand to rock. Though frequent on sandy shores, a bed of rock is essential for its growth, hence it has been dealt with under the rocky-shore formation. The sand-pool vegetation is, on the other hand, described in the present section, as the characteristic species, though attached to rock, are markedly psammophilous. The sub-littoral associations call for no special comment, except that the last three are not strictly psammophilous, though in our district they are confined to sandy areas. They are placed under this heading for convenience, and therefore provisionally.

The associations and communities recognized in the sand and sandy-mud formation are as follows:—

(a) *Littoral Region.*

Sand and sandy-mud series:
- Rhizoclonium riparium.
- Microcoleus chthonoplastes.
- Vaucheria Thuretii.
- Vegetation of vertical banks.

Sand and low-rock series:
- Rhodochorton floridulum.
- Corallina-Cladostephus.
- Porphyra umbilicalis.
- Sand-pool vegetation.

(b) *Sub-littoral Region.*

Rhodochorton floridulum.
Zostera marina.
Fruticulose Lithothamnium.
Pebble-attached association.
Encrusting algae.
Channel-vegetation.

(a) *Littoral Region.*

Rhizoclonium riparium community.

The only community found on pure sand in our area is that of Rhizoclonium, though for this also a small amount of binding material is advantageous. The vegetation is found immediately below high-water line, and is occasionally very conspicuous, specially in spring and summer. At Mulranny, where the shore is unusually flat, Rhizoclonium covers extensive areas, patches an acre in extent having been noted.[1]

The underlying sand (or sandy-mud) is for the most part firm, often bound together by Microcoleus, but in other spots it is loose and apt to become dry. In either case Rhizoclonium lies as a loose covering, thus feeling the effect of wind and tide, often being more or less buried. In some localities the upper part of the association is during neap-tides not wetted at all, and in this way differs from the somewhat similar filamentous vegetation which lies on wet mud, e.g. on the *Vaucheria Thuretii* association in Achill Sound (p. 64). *Rhizoclonium riparium* is usually a pure dominant, but amongst it (especially in the damper parts ?) occur *Enteromorpha prolifera*, *E. clathrata* var., and *Cladophora fracta*. The blue-green species, so common in the corresponding association on the salt-marsh, are absent.

A very similar type of growth to that described above has been noted in Poole Harbour, and on a small scale near the mouth of the River Bann. (See also salt-marsh formation, p. 79.)

Microcoleus chthonoplastes association.

Of the sand- and mud-binding algae one of the most important is *Microcoleus chthonoplastes*, a microscopic species of world-wide distribution. The plants are often completely hidden in the substratum; but their presence can be detected by the way in which the soil holds together, and peels off in crusts, when lifted up. Though Microcoleus has not been previously recorded as forming an association as such, the plant-community has as a fact been long known, and for a description one cannot do better than quote Gomont's note in his revision of the Oscillarieae ('09, p. 92) :—

" Le *Microcoleus chthonoplastes* se rencontre quelquefois à l'état de filaments isolés mélangés à d'autres Algues, . . . mais il occupe aussi à lui seul de vastes étendues sur les côtes marécageuses ou sablonneuses. Il joue un rôle des plus utiles dans l'exploitation des marais salants en recouvrant le fond des bassins ou *oeillets* d'un tapis compact qui permet d'enlever les cristaux

[1] The flatness of the shore at this spot may be judged from the fact that the Pelvetia zone, which is only about 1 foot deep, is in places over 80 yards wide.

de sel sans mélange de vase. En cet état il forme des assises diversement colorées, accumulées sur une épaisseur parfois considérable et dont les supérieures, qui sont les seules vivantes, peuvent être détachées par larges plaques et roulées comme des morceaux de drap. Ce végétal mérite donc complètement le nom de chthonoplastes (constructeur du sol) qui lui a été donné par les premiers observateurs."

In Clew Bay the Microcoleus association was usually found where there was a certain amount of mud. It occurs in large patches at Mulranny and also in the Belclare neighbourhood. In the small bay to the north-west of Achill Bridge it forms a broad band just below high-water line, binding the upper layer of mud into a firm sheet. It was also noted in several localities in fairly pure sand, but only as covering small areas.

Various other blue-green algae enter into the composition of the association, notably :—

In upper parts :	In lower parts :
Lyngbya aestuarii.	Vaucheria Thuretii.
L. lutea.	Rhizoclonium riparium.
Microcoleus tenuis.	Enteromorpha torta.

Vaucheria Thuretii Association.

This vegetation takes us further still from the pure sand, being found only where there is a considerable proportion of mud. Future work will probably show that it should be regarded as an association in the mud-formation. *V. Thuretii* forms a dense mossy growth embedded in the matrix, and appears to cover very extensive areas. Several samples were taken both from Clew Bay and from the muddy inlets north of the bridge at Achill Sound; and in each case the mossy tuft consisted of this species, often in beautiful fruiting condition, and practically pure. The growth is always immersed, the tips of the filaments alone showing, thus differing markedly from *V. coronata*, which forms a clean velvety growth. Felts composed of Rhizoclonium, Chaetomorpha and *Cladophora fracta* often lie on top of the Vaucheria, and these, in many cases, appear to be attached, and not merely drifted fragments; so that it is possible that careful study would reveal definite societies of other species amongst the general vegetation of Vaucheria.

The vertical range of *V. Thuretii* is determined by the extent of the sandy mud. It flourishes in the lower part of the littoral region, and probably descends to low-water mark. Its upper limit is usually immediately below *F. spiralis*, but whether this was due to the lack of sufficient mud or to other causes in addition (such as long exposure to the air) was not ascertained. On

the banks of rivers and where the water is brackish a zone of *V. coronata* is the characteristic vegetation near high-water line, but in Achill Sound that species is absent, and *Microcoleus chthonoplastes* is the dominant alga.

Vegetation of Vertical Banks.

Vertical peat-banks, abutting on the shores of Clew Bay and Achill, exhibit a similar vegetation to that described later for the salt-marsh formation (see p. 82).

Rhodochorton floridulum Association.

This association, though not hitherto described, is very distinct and of common occurrence in many parts of the British Isles, including the Clare Island district. It is characteristic of sandy shores where rocks are present, and is found on moderately open as well as sheltered coasts. *Rhodochorton floridulum* is the most important of a group of finely branched, upright-growing algae, which retain quantities of sand, if they do not actually bind it together. Other members of the group are :—

Cladophora arcta,	Ceramium strictum,
Polysiphonia fibrata,	C. ciliatum.

In suitable localities the association extends from the *Fucus spiralis* belt down to low-water line, but it also descends into the sub-littoral region, being found abundantly between the islands in Clew Bay. It prefers flat or slightly sloping shores; on steep shores the sand is washed away, and the plant is practically absent. Being of small size, Rhodochorton cannot fix sand on the same scale as phanerogamic plants, nor does it occur on sand apart from rocks, except in very sheltered areas, or where it is submerged and beyond the effect of rough water. It is, however, capable of covering flat or sloping rocks with a dense mossy growth; and of carpeting the intervening sand-spaces so that they completely resist normal wave-action. In its young state the plant is probably attached to rock, but as growth proceeds, sand collects, and the abundant production of rhizoidal filaments helps to retain it. The growth forms either pads which may measure a foot or so across, or vast sheets more or less interrupted, but extending at times over a very wide area. When well-grown, the Rhodochorton sward is about 3 cm. high; but in favoured spots pads up to 6 cm. have been met with. Though sometimes exposed to the full light, especially on the lower part of the shore, Rhodochorton grows best with partial shade. But even when exposed to light it is the ends of the branches only that feel the full effect of sun and air, as the base of the plant is covered with sand.

Of the other species entering into the association *Polysiphonia fibrata*, *Ceramium strictum*, *C. ciliatum* form conspicuous patches in spring and summer, their tufts of rhizoids growing down into the sward, and attaching themselves to the sand-grains. *C. ciliatum* is found more or less all the year round, and is of a shorter and denser habit than when growing in pools. In spring the association often assumes a bright green colour due to the presence of *Cladophora arcta*. This species retains the sand well by means of hooked branches and rhizoids which grow downwards from the main shoots. It occurs not only within the Rhodochorton vegetation, but outside it, often forming on its flanks large unmixed patches. A dwarf form of *Sphacelaria cirrhosa* is also frequent, but, because of its small size, is apt to be overlooked. Though a filamentous species, it is distinct from the others, being attached by a basal disk, and not by rhizoids. In late summer, especially in the more sheltered localities, Rhodochorton is much discoloured by the presence of cyanophyceous epiphytes. Of these *Calothrix confervicola* is the most common, being at times so abundant as to create large black patches. *Aphanotheca pallida* is also frequent. On the margins, where the association joins the Corallina-Cladostephus vegetation, many other algae appear, and it is probable that the borders of the two communities are in a continual state of change.

Young plants of *Ulva Lactuca* are at times present in great quantity, especially in spring, but this species is in no way a sand-binder, possessing only a foliose thallus and a basal disk. In the same way we may dismiss many other intruders, the Rhodochorton sward being, in fact, a general nursery ground, the sporelings succeeding each other in regular sequence as the seasons come round.

With regard to distribution, the present community is probably very widely spread in the British Isles. *Rhodochorton floridulum* is one of the few species that form extensive associations on the flat sandy shores of Sussex; and it has been found growing in the same way in Dorset and Devon. Harvey states that at Kilkee (Co. Clare) "it often carpets large spaces on the rocks"; and Ralfs writes in a similar strain as to the plant at Land's End (*in litt.*). It is also abundant on the shores of Belfast Lough. With regard to the Survey area, the association is found at Portlea on Clare Island (rocks giving the necessary shelter), and on a small scale in several other bays, where protection is afforded by a heavy growth of Fucus. On the mainland, where for the most part no special protection is required, it is very widely spread, probably coming next to that of the Fucaceae in the amount of area covered. According to Harvey the plant is washed ashore in quantity during autumn; and the hemispherical cushions are collected (under the name of "figs") for use as manure (Phyc. Brit.).

Corallina-Cladostephus Community.

This vegetation is frequently very well developed on sandy shores where low rocks are present (*e.g.*, Old Head). It retains a certain amount of sand, but is usually found on raised or sloping rocks where the quantities deposited are small. The community clearly forms a connecting link between the sand- and rock-formations; but as both the species composing it are distinctly saxicolous, and do not form rhizoids, it is regarded as belonging to the latter, and is dealt with on p. 58.

The Porphyra umbilicalis Community.

Though attached only by a basal disk, and clearly belonging to the rocky-shore formation, *P. umbilicalis* var. *laciniata* is frequently found, fringing the sides of half-buried rocks, on sandy beaches. Its growth in this habitat is described on p. 57.

Vegetation of Sand-Pools.

A very interesting psammophilous flora occurs in pools amongst low rocks on sandy shores. The plants are not small and filamentous, such as Rhodochorton or Vaucheria (pp. 65 and 64), but large and bushy; hence, though partially embedded in sand, they are invariably fixed to underlying rock. Polyides and Gracilaria may be taken as typical examples; but some six or eight other species occur, all being sand-loving plants, and found as a rule in the sub-littoral region. When, as is often the case, ordinary rock-pools are absent, the constancy of this sand-pool vegetation is very manifest.

Algae which thrive under such conditions have, as would be expected, much branched thalli of erect habit. The fronds are more or less terete, and in many cases tough. But other forms occur, especially where the amount of sand is not excessive. Sand-pools are found at Old Head, and between that spot and Leckanvy; also to a certain extent near Mulranny. The typical flora is as follows:—

Polyides rotundus, *c.*
Ahnfeltia plicata, *c.*
Gracilaria confervoides, *c.*
Polysiphonia elongata, *c.*
P. atro-rubescens, *c.*
Furcellaria fastigiata.
Gymnogongrus Griffithsiana, *r.*
Gelidium crinale, *r.*
Cladostephus spongiosus.
Corallina officinalis.
Rhodochorton floridulum.

The last three are not characteristic of this vegetation only; but they are exceedingly common if the sand-layer is not thick, and, as shown above, they form part of the littoral flora of the shore in question. The species of

Gymnogongrus and Gelidium were, however, not found outside sand-pools. Where the sides are steep, ordinary saxicolous species naturally occur; but as a rule the sides are shelving and the pools shallow. When fresh water exudes between the rocks, the Rhodophyceae are replaced by Chlorophyceae—i.e., *Chaetomorpha aerea*, *Enteromorpha intestinalis*, *Cladophora sericea*, *C. rupestris*, and *Ulva Lactuca*; Gracilaria, however, usually remains, being able to withstand a considerable quantity of fresh water.

Where the sand-layer is very thin a number of other species are found, and being characteristic of sandy shores, the most usual amongst them are listed below :—

Ulva Lactuca (very thick form).	Porphyra umb. laciniata.
Enteromorpha Linza.	Helminthora divaricata (on Polyides).
Monostroma Grevillei (epiphytic).	Gelidium *spp.*
Scytosiphon lomentarius.	Chondrus crispus (broad form).
Punctaria latifolia.	Gymnogongrus norvegicus (*r*).
Chordaria flagelliformis.	Chylocladia kaliformis.
Eudesme virescens.	Laurencia pinnatifida.
Leathesia difformis.	L. hybrida.
Chorda filum.	Polysiphonia nigrescens.
Cystoseira granulata.	Spermothamnion Turneri (epiphytic).
Halidrys siliquosa.	Dumontia filiformis.
Dictyota dichot. *var.* intricata.	Lithophyllum incrustans.

(b) *Sub-littoral Region.*

Rhodochorton floridulum Association.

As before mentioned, this psammophilous species descends into the sub-littoral region, covering large areas where the bottom is flat and very sheltered, as in the inner part of Clew Bay. The association apparently exists in certain spots as an unmixed growth; but as a rule it is more or less interspersed amongst Lithothamnium or other algae (see p. 65).

Zostera Association.

The soft bottom of the inner part of Clew Bay is admirably suited to the growth of Zostera, and in the muddy parts especially, extensive beds are found. The characteristic algal epiphytes are also well-developed, being most marked in spring and early summer.

Ostenfeld in his report on Zostera ('08) points out that, as a general rule,

the size of the plant is more dependent on the nature of the bottom than on the depth in which it grows. He shows that the form with short, narrow leaves is found on firm sand, and that the long, broad-leafed form is characteristic of soft mud, rich in food substances. A slight difference between the algal vegetation of the sand and mud Zostera was observed in Clew Bay, but not with sufficient care to warrant comment, except to note that the latter proved the most productive in the way of algae.

In spring, masses of Ectocarpi occur, together with innumerable tufts of *Cladophora lanosa*; whilst in summer and autumn species of Bangia and Chantransia are more abundant. *Ascocyclus orbicularis* is almost always present, being noted in quantity in spring, summer, and autumn. At the margins of the Zostera-meadows, and in spots where largest ones exist other plants, such as Halidrys, *Laminaria saccharina,* and *Cystoseira granulata,* are met with; and the association then tends to approach that which Ostenfeld has termed the "mixed Zostera vegetation" (l.c., p. 33). Of the larger epiphytes the following are usually frequent in their respective seasons:—

Cladophora lanosa.	Myriotricha densa.
Castagnea Zosterae.	Scytosiphon lom. *var.* zostericola.
Punctaria tenuissima.	Laurencia obtusa *var.* crucifera.
Desmotrichum undulatum.	Polysiphonia violacea.
Ectocarpus confervoides.	Ceramium strictum.
E. siliculosus.	Giraudia sphacelarioides, *r.*
E. *sp.*	Leptonema fasciculatum, *r.*
Litosiphon pusillus.	Mesogloia lanosa, *r.*

Whilst among microscopic species may be mentioned:—

Calothrix confervicola.	Melobesia farinosa.
Chantransia virgatula.	Rivularia atra.
C. Thuretii.	Isactis plana, *r.*
Ascocyclus orbicularis.	Erythrotrichia Bertholdii, *r.*
Rhodophysema Georgii.	

The Fruticulose Lithothamnium Association.

Probably no group of seaweeds is more generally recognized as forming extensive colonies or associations than the Lithothamnia. Submerged beds, often known as "coral-banks," occur in the arctic, temperate and tropical regions. In the latter they are frequently exposed at low water, and play

an important part in the formation of coral reefs. But notwithstanding the many references, both systematic and biological, to this type of vegetation, it is not by any means easy to compare the Lithothamnium flora of one country with that of another. This is owing to the deceptive nature of morphological characters, and to the many erroneous determinations in the past. Foslie has left reliable records for recent years, and the anatomical classification elaborated by Dr. Lemoine promises more success for the future.

Between the outer islands of Clew Bay areas of *Lithothamnium calcareum* ("coral-banks") are common. They are found on a soft but firm bottom, consisting usually of stones and shells on sand, though occasionally Lithothamnium may be dredged where there is a thin layer of mud. The usual depth in which the banks occur is 1–5 fathoms, and here and there the plants may be gathered by hand during the lowest tides. The association is composed of the following species:—

Lithothamnium calcareum, *dom.*
Lithophyllum fasciculatum, *locally sub-dom.*
L. incrustans.
L. incrustans *var.* subdichotomum, *rare.*
Lithothamnium norvegicum, *rare.*

In many places *L. calcareum* forms a pure growth extending over a considerable area, but in others it is mixed with *L. fasciculatum*, and sometimes all four species occur mixed together. A characteristic growth of epiphytes accompanies the vegetation, of which *Polysiphonia subulifera*, *Pterosiphonia parasitica*, *Aglaozonia reptans*, *Spacelaria cirrhosa*, *Rhodochorton floridulum*, and Gelidium *sp.* are the most constant. Dictyota, *Chylocladia kaliformis*, and *Laurencia obtusa* are also abundant in summer.

With trivial variations this is the type of fruticulose Lithothamnium vegetation found throughout Clew Bay. It presents one remarkable floristic feature, namely, the presence of *L. fasciculatum*, a species which is only known from the west of Ireland. Another interesting plant is *L. incrustans*, var. *subdichotomum*, an alga which was formerly regarded as *L. dentatum*, but shown by Dr. Lemoine in the present report to be a detached and rolling form of the common species, *L. incrustans.*

Other Lithothamnium banks in Ireland and Great Britain.—It was of interest to find that the Clew Bay association agreed exactly in its composition with that which had been described for Roundstone. The latter district is the original station for *L. fasciculatum*; and Foslie, when working out the European Lithothamnia, paid a special visit to the locality and

published an account of his trip ('99). He found *L. fasciculatum* still plentiful, as it was also in September, 1911. The dominance of *L. calcareum* in both Roundstone and Clew Bay is normal for the British Isles.

The remarkable "coral beaches" at Mannin Bay and Ballyconneely Bay (Co. Galway) are due to the presence of extensive Lithothamnium associations in the neighbourhood. When driving from Clifden to Roundstone in September, 1911, the former spot was examined; but time did not permit of exploration by dredging. It was evident, however, that the material washed up is *L. calcareum*, and that the beach, a fairly wide one, is composed almost entirely of broken particles of this species. The photographs on Plate IV, kindly taken by Dr. G. H. Pethybridge, show two views of the beaches in Mannin Bay. A few low rocks occur in part of the bay as shown in the lower illustration, but elsewhere there are stretches of pure "coral sand." The greater part of the sand is composed of small particles (see Plate V, fig. 1); but at high-water line and in certain other places coarser pieces and knolls accumulate, with a certain quantity of broken shells. Dr. Pethybridge informs me that at low-water mark the particles are exceedingly fine and resemble ordinary sand; but it is probable that they have the same origin. The Lithothamnium fronds are completely bleached, and the beach is thus dazzlingly white in the sun. Though the coral sand is carted for use as manure, fresh supplies are constantly washed up, so that it is evident that the bank outside is extensive. A similar beach is said to exist in Bantry Bay.[1]

In the British Isles *L. calcareum* is certainly the dominant fruticulose species, beds being known from several localities (Studland and Falmouth in the south of England, and Bute in Scotland), and under certain conditions it is washed ashore in quantities. A fine bed in 14 fathoms was once dredged by me off Fowey (Cornwall). Another species, *L. racemus*, appears to exist as an association at Falmouth, since it is washed ashore in plenty; but this is the only station for the plant in England, and records of Lithothamnium banks in England or France formed by species other than *L. calcareum* require verification.

Comparison with other countries.—*L. calcareum* is also frequent in France. It is abundant in Normandy, and in Brittany as far south as Croisic. Lemoine ('11) states that it is known from Denmark, Portugal, Naples, Morocco, and Algeria. In all these localities it probably occurs in associations similar to

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[1] Several other remarkable beaches occur in the west of Ireland. A shore consisting exclusively of broken shells is found at Knockboy (Co. Galway), which, like the coral-sand beaches, is exploited for manure (Johnson and Hensman, '99); whilst Dog's Bay, near Roundstone, is famous for its beautiful sands, composed almost entirely (up to 90 per cent.) of Foraminifera.

these found in the British Isles. At Morlaix and Concarneau there is "coral sand" or "Mäerl," and, as in Ireland, this is used for manure. Lemoine ('10) has also published a detailed account of the biology of the plant. She notes that at Concarneau the bottom of the bay is practically covered with *L. calcareum*, and fragments of living fronds are continually cast up by the waves. Several "coral beaches" occur on the islands of the Glenan Archipelago, but there, as at Mannin Bay, the fragments washed ashore are mostly dead.

In the Arctic seas, Kjellmann writes of large areas, in 10 to 20 fathoms, covered with Lithothamnia, of which *L. glaciale* and *L. soriferum* are abundant. At Mussel Bay in Spitzbergen, *L. glaciale* is said to cover the bottom to an extent of 4 to 5 square miles; whilst off the north of Norway and on the coast of Iceland, *L. Ungeri* is abundant. In the former country banks of *L. norvegicum* also occur. The association is represented in Greenland by *L. Ungeri*. In the south of Norway the floristic features are more in agreement with those of Britain, and *L. calcareum* becomes prominent. An association composed largely of this species has been described by Gran for Kristianiafiord ('93).

Reference must be made (though it is outside our usual circle of comparison) to Madame Weber van Bosse's account of the Lithothamnia of the "Siboga" Expedition ('04). A very luxuriant vegetation exists in the shallows and reefs of the Malay Archipelago, and several communities on different types of ground are referred to. A description is given of a locality where the Lithothamnium knolls are rolled backwards and forwards between the islands by the tidal current, whilst in other parts of the same channel they are heaped up in banks. Two photographs are reproduced of an extensive bank of *L. crubescens* var. *Haingsisiana*, which Madame Weber describes as being "covered as far as the eye can reach by the pretty, beautifully pink-coloured knolls, which are heaped so close together, that while walking one crushes them continually, making a peculiar noise as of broken china" (*l.c.*, p. 5).

Geological Importance.—In localities where masses of Lithothamnium accumulate on the sea-bottom, these algae play an important part in rock-formation, and masses of limestone containing well-preserved Lithothamnia occur in various geological strata. Structureless limestone also may be derived from the same source, for Walther, working at Naples, showed that the structure of recent Lithothamnium nodules is gradually obliterated by the action of percolating water. The literature on the subject is scattered; but Seward's paper ('94) gives a general summary with a full bibliography; and a brief but up-to-date account has just been published by Lemoine ('11 *b*).

The Pebble-attached Association of Quiet Bays.

This association represents a definite type of sub-littoral vegetation, which is found on a soft bottom strewn with stones and pebbles. A very large number of species go to form it, and they are for the most part characterized by finely divided bushy fronds, though heavier and less bushy plants are found on the larger stones and on the occasional pieces of rock. In some localities almost every stone down to the smallest pebble bears a tuft of one or more algae. The latter consist of members of the Green, Brown, and Red groups; and, though they vary considerably in different localities, the mixture of colour is a marked feature and suggests comparison with Kjellmann's "Bunte Formation." But both the constituents of that association, and the depth at which it occurs, are different from those here described. The present vegetation corresponds rather to Börgesen's Stictyosiphon association and to Boye's Dictyosiphon-Spermatochnus-Corallina formation, though Dictyosiphon is not always present. The species are annual or short-lived, which in part accounts for the varied aspect presented during the season.

The association extends from just above low-water mark down into 3 or 4 fathoms. Its shallower regions may be studied in detail by wading at spring tides, when the bushy fronds of Polysiphonia, Cladophora, Spermatochnus, Dictyosiphon, etc., may be examined *in situ*. Dredging in deeper water shows a very similar type of growth, though some species disappear and others become more abundant. The colour of the red species improves with increased depth. The association, which reaches its maximum development in May, is well seen in many of the inner parts of Clew Bay, and has been studied specially on the west side of Annagh Island, and, in a slightly modified form, in Bellacragher Bay. In brackish localities an increase of Chlorophyceae is apparent.

As it occurs in Clew Bay the principal species are as follows:—

(*a*) In spring—

Enteromorpha clathrata.
Cladophora Rudolphiana.
Striaria attenuata.
Stictyosiphon subarticulatus.
Dictyotosiphon foeniculacea.
Ectocarpus siliculosus.
Pylaiella littoralis.
Cystoclonium purpurascens.
Delesseria hypoglossum.
Lomentaria clavellosa.
Nitophyllum punctatum.
Polysiphonia urceolata.
P. elongata.
P. nigrescens.
P. atro-rubescens.
Ceramium rubrum.
Griffithsia corallina.

(*b*) In summer Striaria, Dictyosiphon, Delesseria, and Griffithsia largely disappear, but the other species remain; and in addition we find:—

Cladophora rectangularis.	Polysiphonia subulifera.
Spermatochnus paradoxus.	P. violacea.
Castagnea virescens (shallow water).	P. fibrillosa.
	Brongniartella byssoides.
Dictyota dichotoma.	Ceramium *spp.*

As autumn advances one species after another becomes detached and disappears, though Dictyosiphon, Ectocarpus, and *Polysiphonia nigrescens* remain. A day's dredging in February showed that most of the spring species had started growth; but the vegetation on the whole was very scanty compared with that of spring and summer. It should be noted that a few of the species above listed may be largely epiphytic on the others, and that in summer the upper part of the association is very poor.

Very many other algae, both littoral and sub-littoral, enter into this vegetation. Several of these are characteristic of other associations, e.g. Gracilaria, Polyides, and *Rhodochorton floridulum*. Callithamnia likewise are very plentiful, and the encrusting alga association is often found as an undergrowth.

Encrusting Alga Association (sheltered).

In spite of unwillingness to change names, a new term is introduced here. The Lithoderma formation described by Kjellmann has been recorded by other observers; but the difficulty of determining encrusting species makes it often impossible to be certain if Lithoderma is really dominant, or whether other algae of similar appearance are not equally common. With regard to Clew Bay, it is not certain that Lithoderma is even present; though, judging from sterile specimens, it is probably abundant. A wider and more general term has therefore been selected.

The association is found on a soft bottom overlaid with shells and flat stones, which, instead of supporting a bushy vegetation like the last-named, are practically covered with encrusting algae. Of these, the first four in the following list are conspicuous and easy to recognize; the remainder are probably common, though not so readily detected:—

Ralfsia verrucosa.	Petroderma maculiforme, *r.*
Aglaozonia reptans.	Lithothamnium hapalidioides, *f.*
Cruoriella Dubyi.	L. Lenormandi, *var.* sublaevis, *f.*
Lithophyllum incrustans.	Melobesia zonalis, *r.*
Ralfsia clavata, *f.*	Peyssonnelia *sp.*, *r.*
Lithoderma fastiscens?, *f.*	

The above vegetation characterizes much of the inner part of Clew Bay. At times it forms an undergrowth to the pebble-attached association; but as a rule it appears to exist as a separate community, except for a certain admixture of *Rhodochorton floridulum* and *Sphacelaria cirrhosa*. In winter *Cordylecladia erecta* is also plentiful. The February visit was most useful in obtaining fruiting material, but even then many of the Brown encrusting plants proved sterile. A January visit would perhaps have been more productive. Outside the islands the species mentioned mostly disappear, the rocks and stones being clothed with plants which belong rather to the exposed Lithothamnium association (e.g., *L. laevigatum* and *L. compactum*).

It is difficult to compare the Clew Bay growth with that of other localities, especially with regard to the relative abundance of the different algae, but it appears to be richer in species than any of the Lithoderma associations hitherto described (Kjellmann, '78, Börgesen, '05, Kylin, '07). In England much dredging has been done by various workers, and Plymouth Sound, which is as sheltered as Clew Bay, has been well explored. The records, however, are poor, and there is no means of satisfactorily comparing the vegetation. It is interesting to note that Harvey dredged Peyssonnelia abundantly in Birturbuy Bay, whereas in Clew Bay *Cruoriella Dubyi* is by far the most frequent species.

Channel Vegetation.

On each visit a record was kept of the species collected in the shallow channels at Achill Sound. Though far from exhaustive, the lists serve to indicate the most conspicuous algae during the different seasons of the year, and since no record of the seasonal development of this type of vegetation exists, they appear to be worthy of publication. Kuckuck ('97) briefly describes the seasonal variation in Heligoland; but his paper deals with an open shore. It will be noted that the flora of the channels resembles that of the pebble-attached association of quiet bays—a fact which is not surprising, since the general surroundings are similar, and in both cases the plants are attached to stones on sand. In the channels, however, there is rapid current, whereas in the bays the water is slack. The accompanying table comprises lists of the four seasons of the year:—

Achill Channels.

The most conspicuous and abundant species are in each case placed first, the general list, in systematic arrangement, following. Detached species from deeper water not included.

Abbreviations as on p. 90.

February, 1911.	April, 1911.	July, 1909.	October, 1910.	
Red Algae dominant.	Red Algae dominant.	Brown Algae dominant.	Very bare.	Blue-green Algae dominant.
Gracilaria confervoides. Polysiphonia elongata. Rhodomela subfusca. Griffithsia corallina, *y.* Ceramium rubrum *var.*	Striaria attenuata. Lomentaria clavellosa. Chylocladia kaliformis. Nitophyllum punctatum. Griffithsia corallina. Ceramium rubrum.	Dictyosiphon foeniculaceus. Spermatochnus paradoxus, *dom.* Chorda filum. Cystoclonium purpurascens.	Calothrix confervicola, *dom.* Enteromorpha *sp.* (E. clathrata?), *ab.*	
Ulva Lactuca.	Ulva Lactuca.	Lyngbya majuscula.	Aphanotheca pallida.	
Enteromorpha *sp.*	Enteromorpha compressa.	Enteromorpha clathrata.	Dermocarpon *spp.*	
C. rupestris, *r.*	E. clathrata.	E. Rudolphiana.	Calothrix *spp.*	
	Cladophora Rudolphiana.		Lyngbya majuscula.	
Stictyosiphon tortilis.	C. arcta.	Litosiphon pusillum.		
Cladostephus spongiosus.	C. lanosa.	Scytosiphon lomentarius.	Enteromorpha intestinalis *var.*	
Chorda filum.		Asperococcus bullosus.	Cladophora Rudolphiana.	
Cystoseira granulata.	Desmarestia viridis.	Ectocarpus siliculosus.		
Dictyota dichotoma.	Dictyosiphon foeniculaceus.	Pylaiella litoralis.	Litosiphon pusillum.	
	Stictyosiphon tortilis.	Cladostephus spongiosus.	Dictyosiphon foeniculaceus.	
Porphyra umbilicalis.	Punctaria latifolia.	Castagnea virescens.	Pylaiella litoralis.	
Gelidium pusillum.	Scytosiphon lomentarius.	Leathesia tuberiformis.	Chorda filum, *old.*	
Gigartina mamillosum.	Asperococcus bullosus.	Cystoseria granulata.	Cladostephus spongiosus.	
Cystoclonium purpurascens.	A. fistulosus.	Dictyota dichotoma.	Cystoseira granulata.	
Lomentaria clavellosa.	Ectocarpus siliculosus.			
Chylocladia kaliformis.	E. granulosus.	Chondrus crispus.	Chantransia *spp.*	
Nitophyllum punctatum.	Cladostephus spongiosus.	Gigartina mamillosa.	Porphyra umb. *var* lacuniata.	
N. laceratum.	Spermatochnus paradoxus, *y.*	Rhodophyllis bifida.	Chondrus crispus.	
Laurencia pinnatifida.	Castagnea virescens, *u.*	Gracilaria confervoides.	Gigartina [illegible]	

P. violacea.
P. atrorubescens.
P. nigrescens.
Callithamnion corymbosum.
Dumontia filiformis.
Dilsea edulis.
Polyides rotundus.

Cystoseira granulata.
Dictyota dichotoma.

Porphyra umb. *var.* laciniata.
Chondrus crispus.
Gigartina mamillosa.
Cystoclonium purpurascens.
Gracilaria confervoides.
Lomentaria clavellosa.
L. articulata.
Plocamium coccineum.
Delesseria sanguinea.
D. hypoglossum.
D. ruscifolia.
Rhodomela subfusca.
Laurencia obtusa.
L. pinnatifida.
L. hybrida.
Polysiphonia urceolata.
P. elongata.
P. violacea.
P. atro-rubescens.
P. nigrescens.
Spondylothamnion multifidum.
Rhodochorton floridulum.
Callithamnion roseum.
C. byssoides.
C. corymbosum, *ab.*
C. polyspermum.
Seirospora Griffithsiana.
Dumontia filiformis, *obl.*
Dilsea edulis.
Polyides rotundus.

Nitophyllum punctatum.
N. laceratum.
Delesseria hypoglossum.
D. ruscifolia.
Laurencia pinnatifida.
Chondria tenuissima.
C. dasyphylla.
Polysiphonia urceolata.
P. elongata.
P. violacea, *r.*
P. fibrillosa.
P. nigrescens.
P. subulifera.
Brongniartella byssoides.
Griffithsia corallina.
Callithamnion *spp.*, *r.*
Ceramium rubrum.
Dudresnaya verticillata.
Dilsea edulis.

Polysiphonia urceolata.
P. nigrescens.
Callithamnion corymbosum.
Polyides rotundus.

III.—*The Salt-Marsh Formation.*

The conditions obtaining on the salt-marsh resemble those of the sand-, rather than the rock-formation; but they differ in several important particulars. In the first place, the salt-marsh formation is situated above the level of high-water at ordinary neap-tides; and in the second, the substratum contains more or less humus consisting of mud or alluvial deposits, and in the Clare Island area peat is frequent. By reason of its bathymetric position, the marsh is only flooded at spring-tides, and hence the algal vegetation instead of being moistened daily by the tide is liable to desiccation on the one hand, and to prolonged soakings of fresh-water in the form of rain on the other. Further, there is continual competition with flowering-plants. As a result of the edaphic conditions, we find that the algae are not attached by a basal disk as in saxicolous plants, nor are they completely buried as is the case with many psammophilous species; but they either lie loosely on the substratum or are apparently rooted in the ground, after the manner of flowering-plants. The lack of fully saline conditions shows itself in the predominance of brackish species, green and blue-green algae being abundant. The salt-marsh often passes by easy transitions to sandy shores, mud-flats, or to the banks of rivers.

From the floristic standpoint, the algae of the salt-marsh are generally uninteresting; but among the Fucaceae remarkable forms occur, several of which have long taxed the energies of systematists; but with increased attention to ecological considerations their elucidation appears more hopeful. The Florideae are represented (amongst macroscopic forms at all events) by two species only, viz., *Catenella Opuntia* and *Bostrychia scorpioides*. Cyanophyceae are abundant; and as far as filamentous genera are concerned, they fall into fairly well-marked species; the chroococcaceous series have not been specially examined. Phoeophyceae are often conspicuous, and figure largely as regards bulk, being represented almost entirely by members of the Fucaceae. The latter vary widely in different localities, and are often of considerable interest. The Chlorophyceae are well represented; and, as is usual under brackish conditions, they are often difficult to determine. Rhizoclonium, Chaetomorpha, and the smaller species of Enteromorpha are abundant, and show much variation in form. These green algae are doubtless largely modified by the peculiar conditions of the salt-marsh—a result which is not surprising, when one considers the profound modifications amongst the less plastic group of the Fucaceae. The variation displayed by *Enteromorpha intestinalis* on flat shores when fresh-water is present is most extraordinary. With regard to edaphic conditions, a certain amount of variety will be found

on the same marsh. In the Clew Bay district the substratum consists of peat, or of a loamy soil derived from the boulder-clay ; patches of mud also occur. With the exception of the dwarf Fucus, most of the algae associations described below occur on each of these types of ground. The mud-flora is the most distinct, and where soft it differs markedly ; but otherwise the nature of the substratum does not appear to exert a great influence in this particular district. With a detailed study certain differences would doubtless be detected. The vegetation of the mud-patches of the salt-marsh approaches on the one hand that of the mud-banks of the tidal streams, and on the other that of the mud-flats below high-water mark. Several of the salt-marsh species lie on the ground, or on other vegetation ; but Bostrychia is epiphytic on Statice, Atriplex, and similar plants ; consequently the presence of these algae is in part dependent on the character of the phanerogamic vegetation. But the converse is also true. Hill ('09, p. 102) and Baker ('12) have shown the importance of the Rhizoclonium covering in connexion with the germination of Salicornia seeds ; and the same matted growths doubtless protect seedlings and young plants from excessive insolation.

The Clew Bay salt-marshes agree well as to their flora with the general description given above. The four types of vegetation distinguished were :—

1. Rhizoclonium association.
2. Fucus vesiculosus *var.* muscoides association.
3. Bostrychia-Catenella vegetation.
4. Vegetation of vertical banks.

The areas specially explored were those on or near Annagh Island, and below the hotel at Mulranny. Small patches of ground supplying similar vegetation were also examined in Bellacragher Bay and at Leenane.

Rhizoclonium Association.

Rhizoclonium riparium is the dominant species in the felt-like sheets of green algae which are often so conspicuous on the salt-marsh. These sheets are found typically on bare soil (sand, loam, or peat), and at Mulranny are continuous with the Rhizoclonium association, which occurs on the sand from half-tide level and above. On the marsh, Rhizoclonium is also abundant in shallow pools, and it invades (especially in warm, damp weather of spring) areas colonized by phanerogams. When Rhizoclonium alone is present, the growth is light-green ; but when, as is often the case, Enteromorpha occurs in addition, the colour is deeper, and does not turn pale to the same extent on drying. Brown and black streaks in the felt indicate the presence of

Cyanophyceae; in Clew Bay usually *Lyngbya confervoides* and *L. majuscula* respectively.

The Rhizoclonium association is more general in some localities than in others, and varies considerably according to the time of the year. Where bare soil is scarce the growth is scanty; where plentiful the felt is, except in spots where strong tidal action obtains, usually abundant. In spring and early summer *Rhizoclonium*, *Percursaria*, and Enteromorpha *spp.* are very luxuriant; later in the season Cyanophyceae develop, and the felt-like growth, as a whole, is not so extensive. The following species compose the association in its wide sense:—

Rhizoclonium riparium, *dom.*	Lyngbya majuscula, *l.ab.*
Enteromorpha torta, *f.*	L. confervoides, *l.ab.*
E. Ralfsii, *f.*	Cladophora fracta } in shallow depressions.
Percursaria percursa, *ab.*	Chaetomorpha linum } in shallow depressions.
Pylaiella litoralis, *f.*	Capsosiphon aureolus } in shallow depressions.
Lyngbya aestuarii *l.ab.*	

With certain weather-conditions the Rhizoclonium-felt is partially destroyed. After a high tide, for instance, with a strong S.W. wind, much of the growth at Mulranny is rolled up into rope-like masses; whilst sheets 2 or 3 yards square have been observed deposited on the *Glyceria maritima* sward, having been lifted bodily out of the shallow depression in which they grew.

Fucus vesiculosus *var.* muscoides Association.

The carpet formed by this remarkable dwarf Fucus occurs above the uppermost Pelvetia (i.e. slightly above the mean high-tide level), and is thus only flooded during spring-tides. It is characteristic of peaty shores. Where the shore slopes, the Fucus vegetation forms a distinct narrow band; but where it is flat and salt-marsh conditions obtain, it is much more extensive, and may pervade a large area of the marsh. As a band, it is widely distributed in our area, being frequent in Achill Sound and Bellacragher Bay. On the salt-marsh it is usually found on the best-drained areas.

The association forms a dense mossy turf in which *Glyceria maritima* is usually abundant, and scattered plants of *Statice maritima*, *Glaux maritima*, and *Salicornia maritima* also occur. Occasionally, however, small patches of pure Fucus may be noted. The "turf" is composed of fastigiately branched plants which are densely crowded together, with more than half their total length (2–3 inches) buried in the peat. The growth is very erect; but the upright shoots are often found to arise from a more or less creeping stem.

On firm, well-drained areas, the branches are cylindrical or nearly so, and the whole very short and compact. On wetter areas the shoots are flatter and the growth lax, but it is frequently checked by competition with Rhizoclonium and Enteromorpha. In other cases, the phanerogamic vegetation in damp soil becomes rank and tall, and then Fucus, when present, tends to assume the form of var. *balticus* (e.g., at Leenane). Fruiting specimens are always rare.

The plants apparently live for many years, and increase entirely by vegetative methods, proliferations being often abundantly produced from all parts of the shoots. During the spring-tides a certain amount of sand and silt is doubtless deposited, and new shoots continue to arise, whilst the basal portions gradually die away. It is difficult to trace the basal end of the shoot for more than 1 or 1½ inches below the surface of the soil. The fact that the plants are largely embedded enables them to avoid desiccation even in the hottest weather during the nine or ten days which elapse between each spring-tide. The same fact also meets the difficulty with regard to the presence at so high a level of the mid-littoral species *F. vesiculosus*. In the case of var. *volubilis*, no one can doubt that the large, vesicled forms (*vide* Baker, '12) are derived from *F. vesiculosus*; yet under the peculiar conditions of the salt-marsh they occur well above the limit recognized as normal for that species. Thus the high level at which var. *muscoides* is found is no objection to its being a variety of the same species.

In certain localities, the presence of scattered plants of *Statice maritima* is a characteristic feature. The mossy carpet of Fucus appears to modify the growth of Statice, so that it forms small rosette-like plants instead of the familiar clumps. The leaf-scars may be traced for some distance below the ground-level, and the plants are evidently of considerable age. In May and June the pink blossoms of Statice against the background of Fucus produce a striking effect. The photograph on Plate VI was kindly taken by Mr. G. Massee from a tuft brought home in May, 1911.

As far as has been ascertained, no vegetation of this nature has been previously described; certainly not from an ecological standpoint. It is plentiful at Roundstone, and is doubtless widespread in the west of Ireland. The plant is characteristic of firm peaty soil, and is probably to be found in our islands wherever peat runs down on a flat shore.[1] On the muddy ground near the mouth of the Bunowen, where there is a covering of Boulder-clay, the var. *muscoides* vegetation is completely absent.

[1] Since writing the above I have seen similar associations in the west of Scotland (Loch Linnhe).

Bostrychia-Catenella Vegetation.

The usual growth of *Bostrychia scorpioides* and *Catenella Opuntia* as epiphytes on flowering plants occurs in our area, though not in such profusion as in some localities.

The former is very plentiful, and is especially found as a dense growth under the leaf-rosettes of *Statice maritima*. At Mulranny the older plants seldom lack this Bostrychia-pad. On woody plants, such as Atriplex and Limonium (specially when growing at the sides of streams and channels), it hangs loosely from the lower branches. Catenella is, on the whole, scarce on the marsh, but locally it is abundant.

It is worth noting that both these plants occur near high-water mark on the banks of the Newport River, and in parts of the upper reaches of Clew Bay. They grow here on bare rocks and boulders, showing that brackish-water and long exposure to the air are important factors. A certain amount of shade is usually provided by Pelvetia.

Vegetation of Vertical Banks (peat or loam).

The vertical peat-banks which occur on the Annagh Island and Mulranny salt-marshes possess a characteristic flora showing well-marked zonation. The same vegetation is even better developed on the peat-banks bordering on the shores of Achill Sound. On the salt-marsh, the banks are seldom more than 3 feet in height, and are much broken up; but at Achill they are higher, and often extend for some distance along the shore. The same type of vegetation, showing the same sequence, is also found on the loam-banks of the Bunowen, but with certain characteristic differences, due to the presence of fresh water (see p. 85). The fresh-water channels of the salt-marsh are also distinct, their banks being muddy and possessing a different flora.

In a general way the vegetation of the peat-banks is disposed in four bands, which invariably occur in this sequence from above downwards:—

1. Phoeococcus adnatus.
2. Rivularia nitida.
3. Vaucheria coronata and Calothrix fasciculata.
4. Rhizoclonium riparium (with scattered plants of F. spiralis, *var.* nana).

The three lowest bands are usually each about 1 foot deep; but the Phoeococcus band is narrow, and is not infrequently absent. Practically all the tidal banks are clothed with this vegetation; but at times (especially where moisture is retained), a growth of *F. vesiculosus* var. *muscoides* intrudes from the grass above. The essential conditions appear to be regular flooding with salt-water, coupled with complete shelter.

Vaucheria and Calothrix, which form a velvet-like growth of light and dark green respectively, occur often in equal proportions; but at times Vaucheria is dominant. Rhizoclonium forms a dense felt, through which emerge numerous plants of *F. spiralis* var. *nana*. At Achill Sound (as on the banks of the Bunowen) a band of *Rivularia Biasolettiana* sometimes occurs above Phoeococcus. An average reading would be as follows :—

	Feet.	Inches.
Rivularia Biasolettiana, ...	0	1
Phoeococcus adnatus, ...	0	2–6
Rivularia nitida, ...	1	0
Vaucheria and Calothrix, ...	1–2	0
Rhizoclonium and F. spiralis *var.* nana, . .	1–2	0

When a vegetation-zone exists below the Rhizoclonium band, it consists of *Enteromorpha intestinalis* and *F. spiralis*, the latter being larger and stronger than when it occurs at a higher level.

A large number of readings were taken at Mulranny, Annagh Island, and Achill, and, though the amount and luxuriance of the different species differed considerably, the general zonation was invariably the same. Neither was any difference noticeable on the banks composed of loam, except for the fact that *F. spiralis* was practically absent, the soil being apparently too soft for it to obtain a foot-hold.

The period of submersion can only be ascertained by observations on the spot. At Achill Sound, the neap-tides reach the level of *F. spiralis*, though the salt water soaks up through the peat to Vaucheria and Rivularia. With spring-tides the whole vegetation is flooded, and one may see the top zone of Phoeococcus covered with two feet of water. Slight variations due to local topography are of course frequent.

Comparing the above vegetation with that found on the banks of the Bunowen, one notes that *F. spiralis* replaces *F. ceranoides*, and that *Enteromorpha minima* is absent. The upper zones are the same in both—a fact which is easily understood when the source of moisture is considered. A similar series of plant associations doubtless occurs in other districts where sheltered banks exist. At Mersea Island (Essex) bands of Cyanophyceae in regular sequence have been noted, but on a much smaller scale than at Achill. The firm peat of the west of Ireland is doubtless more suitable for permanent growth than the soft banks of the Essex coast.

iv. *River-Mouths and Fresh-water Streams.*

The method which has been adopted for describing the flora of previous sections cannot easily be followed in dealing with the vegetation occurring at

mouths of rivers. Though certain species are found to be constant, it is difficult to obtain generalizations as to the position and sequence of the plant-societies; and a detailed account is more apt to be merely descriptive of a particular locality. Opportunities for comparison are fewer, not only owing to the small number of streams available, but on account of the different physical conditions afforded by each. In Clew Bay, for instance, there are but three rivers, the floras of which are very different. The Newport river has banks strewn with rocks and stones on which Fucus develops; whilst the banks of the Bunowen are loamy and possess a vegetation of Chlorophyceae and Cyanophyceae. The Westport river is again different. There is also a stream at Belclare which issues as a waterfall amongst rocks in the midst of a luxuriant growth of *Fucus ceranoides*, and then disperses itself on a muddy shore. In contrast to the above the hill-side streams that descend into Bellacragher Bay and Achill Sound are fairly constant in their flora. For the above reasons it is more satisfactory to treat the vegetation of each stream as such, and not to attempt a general account.

The Newport River.

This river is tidal for about 3 miles, and has fairly wide banks which support two well-marked plant-communities, namely, an Enteromorpha association and a Fucaceae association of brackish type. The conditions with regard to salinity in such a river are unusually complicated. During heavy rains, the banks may be flooded with fresh water brought down by the stream to a much higher level than usual, and the algae composing the vegetation must be able to endure, not only regular change due to tide, but also prolonged submersion in fresh water.

(1) *Enteromorpha Association.*—This consists chiefly of *E. intestinalis*, *E. prolifera*, and *E. clathrata*, together with the numerous intermediate forms characteristic of brackish waters. The growth is most irregular and perplexing, and, as the Ulva investigations had shown, any attempt to name all the forms occuring is at present hopeless. Time, therefore, was not wasted on the genus.

(2) *Fucaceae Association.*—Fucus was more interesting, the most extensive growth of *F. ceranoides* seen in the district occurring here. Starting from the mouth of the river, there is a vegetation composed of Pelvetia, *F. spiralis*, Ascophyllum, and *F. vesiculosus*. On walking towards Newport *F. ceranoides* soon appears. This takes the place of *F. spiralis*, and lower part of the Pelvetia belt. The latter, however, remains a little longer, especially on boulders. *F. ceranoides* meanwhile increases, and gradually usurps the

position held by Ascophyllum and *F. vesiculosus*, till, at ¼ mile below Newport, the association consists entirely of this species. Ascophyllum is the last to disappear, persisting on boulders, especially in the lower part. At Newport Bridge, *F. ceranoides* forms a very fine growth, of which some 50 or 60 yards are exposed at low-water; as far as could be seen, it extends right across the river. The association continues above the railway bridge (the exact distance was not noted), where it is covered with perfectly fresh water for many hours at a time. The upper part of the *F. ceranoides* belt (at the Pelvetia level) consists of very short plants, in some cases barely an inch high. Amongst it exists a certain amount of Catenella and Bostrychia, especially on slabs of rock. At a lower level the growth is large and vigorous, and shows as usual great blistering of the thallus.

Bunowen.

Rising in the mountains near Croaghpatrick, and flowing through the town of Louisburgh, the Bunowen cuts a sinuous course through the boulder-clay on the plain, and immerges on the sandy shore west of Old Head. The banks for the last mile are loamy and steep, until about ¼ mile from the shore, where they tend to become flatter as the river widens out. In wet weather the volume of water is largely increased; the deep brown stream being perfectly fresh when the tide is on the ebb. Many algae therefore, which are normally left dry and first moistened by the returning tide, are not infrequently immersed for hours in fresh water.

Vertical Banks.—Beginning about ½ mile from the shore, we find at low-water banks 3–5 feet high. Where current is felt, there is constant erosion, and algae are practically absent: but in bays and bends a short vegetation exists, showing definite zonation. The sequence of the bands is usually as follows, beginning at, or slightly above, the average high-water level:—

Phoeococcus adnatus, ...	2–3 ins. high.
Rivularia nitida, ...	1–1½ foot „
Rhizoclonium riparium and Enteromorpha intestinalis *var.*	1 „ „
Do. with Pylaiella litoralis (F. ceranoides scattered),	1 „ „

This vegetation extends more or less interruptedly for some distance till a bend and widening of the stream is reached. Several creeks and backwaters then appear, as well as flat, muddy slopes; and the extra shelter is favourable for Vaucheria, which now becomes prominent. The average

sequence and depth of the bands on loamy or peaty banks about 4 feet high is as under :—

Rivularia Biasolettiana (rarely present), . .	1 inch.
Phoeococcus adnatus (not always present), .	2 inches.
Rivularia nitida, ...	9 ins.–1 foot.
Rhizoclonium and Enteromorpha, . . .	2 feet.
Vaucheria coronata and E. intestinalis *var.*, .	1 foot.

In narrow creaks (which possess little light), *Vaucheria coronata* clothes the entire surface of the banks, growing very luxuriantly up to extreme high-water level. It forms here a loose furry growth (due to copious branching) instead of the short velvet pile found in open places. Where the banks are flat the growth spreads out horizontally, and the clear zonation is lost. Phoeococcus and *Rivularia nitida* usually disappear (cf. Bellacragher Bay, p. 89), Rhizoclonium, Percursaria, and Enteromorpha taking their place, and running in amongst *Statice maritima*, *Glaux maritima*, and *Glyceria maritima*, so that the whole forms a miniature salt-marsh.

With regard to seasonal development and other details, *R. nitida*, Rhizoclonium, Enteromorpha, *Vaucheria coronata* are found at all seasons. *R. Biasolettiana* is perhaps mostly a winter and spring species, it being noted in quantity in May only. Phoeococcus forms, on the loamy banks of the Bunowen, a narrow band (cf. Achill, p. 83), and is in places entirely absent. It reaches its maximum development in late summer and autumn, and occurs above the average high-water mark. *R. nitida* is likewise most conspicuous in autumn; in favoured spots the greenish-black band, a foot deep, stretches for many yards; in others it is intermittent, due possibly to the crumbling away of the soil. The Rhizoclonium-Enteromorpha association is practically uninterrupted, and is more luxuriant in spring, forming a bright apple-green belt; in summer it becomes bleached, and the Enteromorpha constituents are dominant. Monostroma *sp.* (= *M. crepidinum?* see p. 107), noted in spring, summer, and autumn, is scattered irregularly throughout this growth; but it is never copious, and is apt to be overlooked. The lower part of the association, which consists of narrow varieties of *Enteromorpha intestinalis*, merges into the *Vaucheria coronata* zone. The last-named often stretches a long distance as a pure growth, forming a dark-green, very short, velvet pile. It fruits abundantly, no difficulty being found during any visit in obtaining the characteristic oogonia. If stones exist, *P. ceranoides* may occur near low-water level; but its growth is poor.

Flat Sloping Banks.—Close to the mouth, the vertical banks give place first to firm mud and then to stony banks, with more or less sand. The

former, as already indicated, is clothed with *V. coronata*, Rhizoclonium, and Enteromorpha; but many other algae occur, all the species mentioned for the salt-marsh Rhizoclonium association (p. 79) being noted. Beautiful dark patches of Capsosiphon were found in May on stones at half-tide level. *V. coronata* disappears as one nears the sea; but another species with filaments 2–3 inches long, only found sterile, becomes frequent in pools. A fine Microcoleus association (see p. 63) is also present in the sand and sandy mud found between the loamy ground and the stone-covered banks.

With the appearance of stones and boulders the Fucaceae vegetation sets in. At first it consists of pure *F. ceranoides*, but *F. vesiculosus* soon follows, appearing first on the uppermost boulders (where it would obviously receive the least amount of fresh water), and gradually increasing till at the embouchure the two species occur in equal proportions. A second plant-association is represented on the stones, namely—*Enteromorpha intestinalis*. This exists as a pure, luxuriant growth in the bed of the stream. In a modified form, it ascends the banks under the Fucus-covering, and in spots forms a green band above it.

F. ceranoides accompanies the river on to the flat sandy beach, and is found on the rocks to the east of the main stream, where it is doubtless under the influence of the fresh water. The association of Porphyra, which occurs below (p. 58), must also receive a certain amount of brackish water.

Bellacragher Bay Streams.

The streams which descend from the high hills and peat bogs of Curraun Achill seldom if ever dry up, though the amount of water brought down varies greatly. A well-marked vegetation is present at the outlets, which is quite distinct from that of ordinary streams, and which is probably characteristic of small mountain torrents. It consists of *F. ceranoides*, and a species of Monostroma (No. 91, see p. 107), and does not appear to have been previously described. As a rule there is a large deltoid mass of *F. ceranoides*, with a smaller patch of Monostroma in the upper part; but the physical nature of the shore modifies the horizontal distribution of the algae, so the deltoid form is often more or less lost.

F. ceranoides shows first on the stones in the stream near the ordinary high-water line; and on descending the shore it spreads out laterally over the flanks, and continues to low-water mark. Though a large portion remains immersed all day in fresh-water, it is completely covered by each tide. The plants fruit abundantly, but do not attain to so large a size as those found on river-banks (*e.g.* Bunowen and Newport).

The Monostroma vegetation is at its best in spring (April and May). It then occurs in deltoid patches, reaching from above *F. ceranoides* to about half-tide level. It covers the rocks and stones in the stream with a dense covering; and also spreads out on either side, growing chiefly on the Fucus. The plants in the streams remain submerged; but those outside are exposed at low-water, and in fine weather dry up rapidly, appearing as a brittle skin, which crackles in the hand. As summer advances, the flank-growth disappears; but in the streams themselves Monostroma was found in plenty during each visit.

v. *Vegetation of Brackish Bays.*

The vegetation of inlets surrounded by mountains from which streams descend possesses several distinctive features, and must be recognized as affording a definite vegetation-type. Certain species of diatoms are abundant, also Cyanophyceae; whilst the complete absence of several of the larger algae, and the prevalence of others, are also noticeable.

Other factors, besides the addition of fresh water, have, however, to be considered. Being more or less land-locked, the tide is slight, and the conditions exceedingly tranquil: consequently the aeration of the water is probably very poor. Mineral salts moreover are brought down by the streams, and in our area peaty acids and other compounds from the peat-bogs are doubtless plentiful, the streams being deep brown in times of much rain.

Bellacragher Bay was selected as a spot for systematic investigation. It is land-locked, and, except for a few months in summer, receives a large amount of fresh water. Samples of water taken in August showed almost normal salinity, but this was after the dry summer of 1911. This inlet is, therefore, not an extreme case; but the features shown may be useful for this very reason. Bays of much feebler salinity doubtless occur in Ireland, as they do abundantly in the west of Scotland.

The following associations are represented in Bellacragher Bay:—

Hildenbrandtia-Verrucaria.—Very well marked on stones and pebbles from half-tide downwards, ascending higher in damp places.

Fucaceae.—All five species present. Fronds of *F. serratus* narrow. *F. ceranoides* forming delta-like patches at the bottoms of streams, but not general in any part of the bay.

Lichina.—Very feebly developed. *L. confinis* most frequent.

Laurencia-Gigartina.—Poor. Isolated patches in sub-littoral region common.

Laminaria.—Sub-association of *L. saccharina* on big stones and blocks of rock frequent. Plants usually long, but not wide, 10 to 12 ft. by 1 ft.

Encrusting Algae.—*Lithothamnium polymorphum* belt well developed, usually with *Corallina officinalis.*

Pebble-attached association.—Extensive and well developed, but poor in species. Examined by wading at extreme low-water.

Zostera.—Local.

Special features.—Two societies not referred to elsewhere are very prominent in the littoral region. (1) *Rivularia nitida,* the species of vertical peat-banks (p. 82), occurs as a broad horizontal band. It is noticeable throughout summer, but in October forms a black band along the whole shore. (2) *Cladophora rupestris,* as narrow strips or effused patches, is also very abundant, indicating the presence of fresh water. It is remarkable that Enteromorpha, which usually serves this purpose, is, except as a short growth near high-water line, almost absent. Associations of Porphyra and Rhodochorton, which might have been expected, were completely absent.

A general coating of the diatom *Cocconeis Scutellum* is especially characteristic of the vegetation of this bay. Species of Cladophora, Ectocarpus, Polysiphonia, etc., are in spring so completely covered as to be utterly unrecognizable. The plants appear quite black owing to a ring of brown substance round the valves of the diatom. The ring is apparently secreted from the peaty water by Cocconeis. Mr. W. West, who kindly identified the diatom, tells me such a copious deposit is unfamiliar to him.

Fresh-water streams.—See p. 87.

With regard to the flora, the lists kept show that a very large number of species occur in the bay, but in small quantity only. Many species were only found once, but, on account of the poorness of the tide, the low-littoral flora is compressed into a very small space. The dominant associations—Fucaceae, Laminaria, Zostera, and pebble-attached—practically cover the ground, and there are no pools. This type of vegetation is probably not peculiar to Bellacragher Bay, as from cursory observations elsewhere (Killary, Roundstone, also in Scotland) it appears to be frequent in brackish bays of like nature. In summer Cyanophyceae are abundant, especially *Lyngbya majuscula, Calothrix aeruginea, C. confervicola,* and *Anabaena torulosa. Stictyosiphon subarticulata, Dictyosiphon foeniculaceus, Striaria attenuata,* and *Chylocladia kaliformis* are dominant on pebbles in spring: whilst in summer *Cladophora Rudolphiana, Enteromorph clathrata* var., and Spermatochnus occur in extraordinary profusion. Of species apparently absent, the following may be noted:—*Mesogloia vermiculata, Nitophyllum punctatum, Griffithsia corallina, G. setacea,* and *Monospora pedicellata.*

III.—THE ALGAL FLORA.

1.—Systematic List of the Flora.[1]

The subjoined list includes all species, and the most noteworthy varieties found during the Survey, with the addition, in brackets, of those recorded previously by other observers. Notes on habitat are given when of interest, and local distribution is indicated, except where the species is of general occurrence. Critical notes on the list are given later (pp. 102 *et seq.*).

The classification adopted is that of Batters' "Catalogue of British Marine Algae" (1902), except for the group Melobesieae, for which Lemoine's scheme (10) has been used. The nomenclature also of that catalogue has been followed, except in the case of certain old names revived by Batters. When these names appeared invalid or doubtful, the usual and more familiar nomenclature has been employed. Critical work naturally has necessitated a few additional name-changes.

The following signs and abbreviations are used:—

* = new to Ireland.	*r* = rare.
† = new to British Isles.	*f* = frequent.
CI = Clare Island.	*c* = common.
CB = Clew Bay.	*ab* = abundant.
AS = Achill Sound.	*l* = local.
BB = Bellacragher Bay.	*y* = young.

CYANOPHYCEAE.

Coccogoneae.

Chroococcus turgidus *Naeg.*—CI, CB, *f.* Isolated specimens on various algae.
*Aphanocapsa pallida *Rabenh.*—CI, CB, *f.*
*Dermocarpa violacea *Crn.*—CI, CB, *f.* On various filamentous algae.
Pleurocapsa fuliginosa *Hauck.*—CI *r.* On bare rocks near high-water line.
* amethystina *Rosenv.*—CI, CB, *r.* On *Rhodochorton floridulum* and Corallina.
Hyella caespitosa *Born. et Flah.*—CB *f.*

Hormogoneae.

Spirulina subsalsa *Oersted.*—CI, CB, *f.*
var. oceania *Gom.*—CI *r.* On *Halichondria panicea.*
*Oscillaria margaritifera *Kütz.*—CI *r.*
* nigro-viridis *Thw.*—CI *r.*

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[1] The additions to the Irish list are calculated from a revised and annotated copy of Mr. J. Adams' "Synopsis." With regard to the Cyanophyceae, several species, which do not figure in the marine section of the Synopsis, have been previously recorded from Ireland, but from fresh-water or brackish localities. These were listed by Mr. Adams in the fresh-water section.

*Oscillaria Corallinae *Gom.*—CI *f.* On *Lithothophyllum incrustans.*
* laetevirens *Crn.*—CI *r.* On *Gelidium repens.* See note.
brevis *Kütz.*—CI *r.*
* sancta *Kütz.*—CI *r.* See note.
limosa *Ag.*—CI, CB, *f.* See note.
*Phormidium fragile *Gom.*—CI *r.* With Ectocarpus on Patella.
tenue *Gom.*—CI *r.*
† persicinum *Gom.*—CI *r.* See note.
† subuliforme *Gom.*—CI *r.* See note.
*Lyngbya Meneghiniana *Gom.*—CI *r.* On *Codium tomentosum* in pools.
aestuarii *Liebm.*—CB *c*, AS *f.*
majuscula *Harv.*—CB, AS, *f.*
† confervoides *C. Ag.*—CB *f.* See note.
* semiplena *J. Ag.*—CI, CB, AS, *r.*
* lutea *Gom.*—CI *f.* On rocks near high-water line.
Symploca hydnoides *Kütz.*—CI *r.* On Corallina in shallow pools.
† dubia *Gom.*—CI *r.* On brackish rocks.
*Plectonema Nostocorum *Born.*—CI, CB, AS, *l.* In *Rivularia nitida.*
tenebrans *Born. et Flah.*—CI, The Bills, *r.* In shells of Balanus.
Battersii *Gom.*—Roonah Point *r.* With *Calothrix scopulorum.*
* norvegicum *Gom.*—CI *r.*
*Microcoleus chthonoplastes *Thur.*—AS, CB, *ab.* See note.
* tenerrimus *Gom.*—AS *r.*
Calothrix confervicola *Ag.*—*ab.*
* consociata *Born. et Flah.*—CB *r.* On *Fucus vesiculosus* var. *muscoides.*
scopulorum *Ag.*—CI *ab*, CB *r.*
pulvinata *Ag.*—CB, AS, *f.*
* parasitica *Thur.*—Old Head *r.* In *Nemalion multifidum.*
* aeruginea *Thur.*—CI *r*, Old Head *r.* See note.
fusca *Born. et Flah.*—Mulranny *r.* See note.
crustacea *Thur.*—CI *r.* On limpets in high-water pools.
fasciculata *Ag.*—AS *f.* On peat-banks.
† endophytica *sp. nov.*—Annagh Island. See note.
Isactis plana *Thur.*—CB *f*, BB *l.* On stones, and on stems of *Laminaria digitata.*
Rivularia Biasolettiana *Menegh.* (= R. coaduncta *Fosl*).—Bunowen River *f.*
atra *Roth.*—*ab.*
nitida *Ag.*—CB, AS, BB, *ab*, CI *r.*
bullata *Berk.*—CI *f*, Mulranny *f.* On exposed rocks at half-tide level.
*Brachytrichia Balani *B.* and *F.*—CI *r.* In cave at Portlea.
[Mastigocoleus testarum *Lagerh.*]—Roundstone (coll. Johnson, 1893).
*Microchaete grisea *Thur.*—CB *r.* On shells in 5 fathoms.
Anabaena torulosa *Lagerh.*—CB, BB, *f.* On various algae.

CHLOROPHYCEAE.

PROTOCOCCINAE.

Chlorochytrium inclusum *Kjellm.*—*c.* In *Dilsea edulis.*
[Halosphaera viridis *Schm.*].—*f.* See note.
*Codiolum gregarium *A. Br.*—CI *f*, Old Head *r.* On rocks near high-water line.
*Petrocelidis *Kuck.*—CI, Old Head *f.* In *Petrocelis cruenta* and *Cruoria pellita.*

CONFERVOIDEAE.

Prasiola stipitata *Suhr.*—CI, CB, The Bills. *l.* On bird cliffs *ab*, on bare rocks *l.*
crispa *var.* marina *Börg.* (= Gayella).—CI *l*, Caher I., The Bills.
*Protoderma marinum *Rke.*—CB, AS, BB, *f.* On pebbles, near low-water mark.
*Ulvella fucicola *Rosenv.*—Old Head *r.* On *F. vesiculosus*, probably frequent.
*Monostroma orbiculatum *Thur.*—CB *f.* See note.
sp. No. 95 (M. crepidinum *Farlow*?).—Old Head, Mulranny, *l.* See note.
sp. No. 91.—AS, BB, *f.* See note.
Grevillei *Wittr.*—CI, AS, *c.* Epiphytic near low-water mark.
var. Cornucopiae *Batt.*—CI, AS, *r.* On Corallina.
*Capsosiphon aureolus *Gobi.*—Old Head, Mulranny, *l.*
Percursaria percursa *Rosenv.*—*c.*
Enteromorpha clathrata *J. Ag.*—*c.*
paradoxa *Kütz.*—CB *r*, Roundstone (coll. McCalla). See note.
* torta *Reinb.*—CB *f.*
prolifera *J. Ag.*—CB *r.* Attached to stones on flat sandy shores.
compressa *Grev.*—*ab.*
Linza *J. Ag.*—*c.*
intestinalis, *Link.*—*ab.*
micrococca *Kütz.*—CI *r.* On rocks near high-water line.
minima *Näg.*—CI *c.* On rocks near high-water line.
Ulva Lactuca *L.*—*ab.* See note.
Ulothrix flacca *Thur.*—CB *f.* See note.
* consociata *Wille.*—Roonah *f.* See note.
† pseudoflacca *Wille.*—CI, Old Head, Roonah, *f.* See note.
† subflaccida *Wille.*—CB, AS, *r.* See note.
*Phoeophila dendroides *Batt.*—BB *r.* In old *Chylocladia katiformis.*
Bulbocoleon piliferum *Pringsh.*—CI *r.* In old *Chordaria flagelliformis.*
Blastophysa rhizopus *Rke.*—AS *r.* In old Ralfsia *sp.* on Achill Bridge.
Endoderma viride *Lagerh.*—CI, CB, *f.* In Nitophyllum and Delesseria *spp.*
Wittrockii *Wille.*—*f.* In *Pylaiella litoralis.*
Flustrae *Batt.*—*r.* In Flustra *sp.*
Tellamia contorta *Batt.*—CI, Roonah, *f.* In Littorina.
intricata *Batt.*—Roonah *r.* In Littorina.
Urospora mirabilis *Aresch.*—CI *f.* See note.

Chaetomorpha litorea *Cook.*—Mulranny. See note.
[tortuosa *Kütz.*]—CI *r.*, Roundstone.
linum *Kütz.*—CB, AS, *c.* See note.
aerea *Kütz.*—CI *c.* In high-level rock-pools.
melagonium *Kütz.*—CI *r*, Achill Bridge *r.*
[crassa *Kütz.*]—Achill (coll. Hanna, 1899).
[Rhizoclonium Kochianum *Kütz.*]—Roundstone (*teste* Batters).
implexum *Batt.* non *Kütz.* (= R. tortuosum *Kütz.*)—CI *c.*
riparium *Harv.*—*ab.*
† Kerneri *f.* endozoica *Wille.*—CI., Achill Bridge, *r.* See note.
Cladophora prolifera *Kütz.* See note.
pellucida *Kütz.*—CI *r.* In deep or shady rock-pools.
Hutchinsiae *Harv.*—CB *f.*
[Macallana *Harv.*]—Roundstone (coll. McCalla).
rectangularis *Harv.*—CB *r.* Dredged in 3 fathoms.
Neesiorum *Kütz.*—CI *r.* Rock-pools.
rupestris *Kütz.*—*ab.*
[*var.* distorta *Harv.*]—Roundstone (coll. McCalla).
sericea *Kütz.*—*ab.*
glaucescens *Harv.*—CI *r.* In rock-pools.
flexuosa *Harv.*—See note.
albida *Kütz.*—CI *f.* On rocks and in pools.
var. refracta *Thur.*—CI *f.* On rocks and in pools.
Rudolphiana *Harv.*—CB, AS, BB, *f.* See note.
fracta *Kütz.*—CB, AS *c.*
[cornea *Kütz.*]—Roundstone (coll. Painter, 1883).
corynarthra *var.* spinescens *Batt.*—BB *l.* See note.
arcta *Kütz.*—CI *c.* See note.
uncialis *Kütz.*—CI *f.* On exposed rocks.
lanosa *Kütz.*—CB *c.* Epiphytic.
Gomontia polyrhiza *Born. et Flah.*—CB, AS, *f.* In various shells.

SIPHONEAE.

*Ostreobium Quekettii *Born. et Flah.*—Roonah *r.* In shells. Probably frequent.
Bryopsis plumosa *Ag.*—CI, AS, *f.*
[hypnoides *Lamour.*]—Roundstone (coll. Harvey).
Derbesia marina, *Kjellm.*—CI *v r.* See note.
Vaucheria Thuretii *Woron.*—CB, AS, *c.* See note.
coronata *Nordst.*—CB, AS, Bunowen River, *c.* See note.
littorea *Bang. et Ag.*—CB *c.* See note.
Codium adhaerens *Ag.*—CI *f.* In rock-pools, and on steep, damp rocks.
amphibium *Moore.*—CI *v r*, Roundstone. See note.
tomentosum *Stackh.*—CI *c*, CB, *r.* See note sub *C. mucronatum.*
† mucronatum *var.* atlanticum *var. nov.*—CI *c*; CB, BB, *r.* See note.

FUCOIDEAE.

Phoeosporeae.

Phoeococcus adnatus *West, comb. nov.*—CB, AS, *c.* See note.
Desmarestia viridis *Lam.*—CI, CB, *f.*
aculeata *Lam.*—*c.*
ligulata *Lam.*—CI *r.*
[Dresnayi *Lam.*]—Roundstone (*teste* Johnson, 1899).
Dictyosiphon foeniculaceus *Grev.*—CB, AS, BB, *c.*
hippuroides *Kütz.*—CI, CB, *c.*
Phoeostroma pustulatum *Kuck.*—CI *r.* See note.
Litosiphon pusillum *Harv.*—CI *r*; CB, AS, *c.* See note.
Laminariae *Harv.*—CI *f.* On Alaria.
Phloeospora brachiata *Born.*—CI *f.* On *Rhodymenia palmata.*
Stictyosiphon tortilis *Rke.*—CB, BB, *c.*
subarticulatus *Hauck.*—CB *c.*
† adriaticus *Kütz.*—Bartraw *r.* See note.
Striaria attenuata *Grev.*—CB *c*, AS *r.* In shallow sub-littoral region.
Punctaria plantaginea *Grev.*—CB *r.*
latifolia *Grev.*—CI, CB, *f.*
tenuissima *Grev.*—CB *f.* On Zostera.
undulata *J. Ag.*—CB *r*, BB *r.* On Zostera.
*Phyllitis zosterifolia *Rke.*—CI *r.*
Fascia *Kütz.*—CI, CB, AS, *l.*
Scytosiphon lomentarius *J. Ag.*—*c.*
Asperococcus fistulosus *Hook.*—*c.*
bullosus *Lamour.*—CB, CI, *c.*
*Streblonema sphaericum *Derb & Sol.*—CI *r.* In *Nemalion multifidum.*
*Ectocarpus clandestinus *Sauv.*—CI *l.* On *Fucus serratus*, October, 1910.
luteolus *Sauv.*—CI *f.*
* microspongium *Batt.*—CI *r.* On *Ralfsia verrucosa.*
tomentosoides *Farl.*—CI *r.* On Himanthalia and Laminaria.
velutinus *Kütz.*—CI *f.* On Himanthalia.
* Battersii *Born.*—CB *r.* On *Taonia atomaria.*
simplex *Crn.*—CI *c.* On *Codium tomentosum.*
* Holmesii *Batt.*—CI, AS, *r.* In caves and on dark ledges.
globifer *Kütz.*—CI *r.* On exposed ledges.
Mitchellae *Harv.* (= E. virescens *Thur.*)—CI *r.*
confervoides *Le Jol.*—*c.*
var. arctus *Kjellm.*—CB *f.*
siliculosus *Kütz.*—*c.*
fasciculatus *Harv.*—CI *c.* On Laminaria and Himanthalia.
tomentosus *Lyngb.*—*c.*
Hincksii *Harv.*—CI *r.* On *Laminaria digitata.*

Ectocarpus [Landsburgii *Harv.*].—Roundstone (coll. Harvey).
granulosus *Ag.—f.*
[Sorocarpus uvaeformis *Pringsh.*]—*f.* Roundstone (*teste* Johnson, 1899).
Pylaiella litoralis *Kjellm.—ab.*
Isthmoplea sphaerophora *Kjellm.*—CI *f.* On *Plumaria elegans.*
Myriotrichia clavaeformis *Harv.—c.*
filiformis *Harv.—c.*
* densa *Batt.*—CB *r.* On Zostera.
repens *Hauck.*—Old Head *r.* On Eudesme.
†Dichosporangium Chordariae *Wollny.*—CI *r.* See note.
Myriactis pulvinata *Kütz.*—CI *c.* On *Cystoseira ericoides* and *C. granulata.*
Areschougii *Batt.*—CI *r.* On Himanthalia.
* stellata *Batt.*—CI *f.* On Dictyota in pools.
* Haydeni *Batt.*—CI *r.* On Scytosiphon in pools.
Elachista fucicola *Fries.—ab.*
flaccida *Aresch.*—CI, Old Head, *c.* On *Cystoseira granulata* and Halidrys.
scutulata *Duby.*—CI *c.* On Himanthalia.
*Leptonema fasciculatum *Rke.*—CB *r.* On Zostera.
Giraudia sphacelarioides *Derb. & Sol.*—CB *r.* On Zostera.
Sphacelaria cirrhosa *Ag.—c.* See note.
britannica *Sauv.—r.* See note.
* plumula *Zan.*—CB, Roundstone.
Cladostephus spongiosus *Ag.—c.*
verticillatus *Ag.—f.*
Halopteris filicina *Kütz.*—CB *r.*
Stypocaulon scoparium *Kütz.—r.*
Myrionema strangulans *Grev.—c.*
* Corunnae *Sauv.*—CI *r.*
papillosum *Sauv.—f.*
* aecidioides *Sauv.*—CI *r.*
* saxicola *Kuck.*—CI *r.* See note.
* reptans *Fosl.*—Old Head *r.* See note.
Ulonema rhizophorum *Fosl.*—CI *c.* See note.
Hecatonema maculans *Sauv.*—CI *f.*
* reptans *Kylin.*—CI, CB, *f.* See note.
* speciosum *comb. nov.*—CI *f.* See note.
*Microspongium globosum *Reinke.*—CI *f.* See note.
*Chilionema Nathaliae *Sauv.*—CI *r.*
* ocellatum *Sauv.*—CI *r.*
Ascocyclus orbicularis *Magn.*—CB *c.* On Zostera.
* foecundus *comb. nov.*—CI, Old Head, *f.* See note.
* Saccharinae *sp. nov.*—CI *r.* See note.

Ralfsia clavata *Farl.*—CI, CB, *f.*
verrucosa *Aresch.*—*c.*
* ?L. fatiscens *Aresch.*—CB *r.* See note.
†Petroderma maculans *Kuck.*—CB *r.* See note.
Spermatochnus paradoxus *Kütz.*—CB, AS, BB, *c.*
Stilophora rhizodes *J. Ag.*—AS *r.*
Chordaria flagelliformis *Ag.*—*f.*
Mesogloia vermiculata *Le Jol.*—CI *f.*
* lanosa *Crn.*—CB *r.* Dredged in 3 fathoms.
Griffithsiana *Grev.*—CB, AS, *r.* Washed ashore.
†Acrothrix gracilis *Kylin.*—CB, AS, *r.* See note.
Castagnea virescens *Thur.*—CI *c*; Old Head *f.*
Zosterae *Thur.*—CB, BB, *f.* On Zostera.
Microcoryne ocellata *Strömf.*—BB *r.* On *Dasya arbuscula.*
Petrospongium Berkeleyi *Näg.*—CI *f.* On rocks, and on *Ralfsia verrucosa.*
Leathesia tuberiformis *Aresch.*—*ab.*
crispa *Harv.*—CI *vr.* See note.
Sporochnus pedunculatus *Ag.*—CI, AS, *r.* Washed ashore.
Chorda filum *Stackh.*—CB, AS, *c.*
tomentosa *Lyngb.*—CI *r.* In narrow channels.
Laminaria saccharina *Lamour.*—*c.*
var. latissima (*Turn.*) *Batt.*—CB *c.*
var. Phyllitis *Le Jol.*—CI *c.*
digitata *Lamour.*—*c.*
var. stenophila *Harv.*—CI *c.*
var. vallida *Fosl.*—CB *f.*
Cloustoni *Edm.*—CI *c.*
Saccorhiza polyschides *Batt.* (= S. bulbosa *De la Pyl.*)—CI *f.*
Alaria esculenta *Grev.*—CI *c.*
Cutleria multifida *Grev.*—CB *f.* Dredged 3–5 fathoms.
(*forma* Aglaozonia reptans *Crn.*—CB *ab.* Dredged 3–5 fathoms.)

FUCINEAE.

Fucus ceranoides *L.*—CB, AS, BB, *c.* See note.
spiralis *L.*—*ab.* See note.
var. platycarpus *Batt.*—CB, AS, *ab.*
var. nanus *Stackh.*—CB *c.* See note.
vesiculosus *L.*—*ab.* See note.
var. evesiculosus *Auct.*—CI *ab.*
var. laterifructus *Grev.*—AS *c.*
var. vadorum *Aresch.*—CB *c.*
var. balticus *J. Ag.*—CB, AS, *c.*
† *var.* muscoides *var. nov.*—CB, AS, *c.*

Fucus serratus *L.—ab.*
var. angustifrons *Stackh.*—CI *f.*
Ascophyllum nodosum *Le Jol.*—CI *r*; CB, AS, *ab.*
var. Mackaii (*Turner*) *comb. nov.*—Roundstone Bay *f.* See note.
Pelvetia canaliculata *Decne et Thur.—ab.*
Bifurcaria tuberculata *Stackh.*—Dog's Bay, Roundstone. Rock-pools.
Himanthalia lorea *Lyngb.*—CI *ab.*
Halidrys siliquosa *Lyngb.*—CB, BB, *c.*
Cystoseira ericoides *Ag.*—CI *c.*
granulata *Ag.*—CB *c.* In pools, and in shallow water.
[discors *Ag.*]—Roundstone (*teste* Johnson, 1899).
fibrosa *Ag.*—CI *r.* In rock-pools.

TILOPTERIDEAE.

[Tilopteris Mertensii *Kütz.*]—Roundstone (coll. McCalla).

DICTYOTACEAE.

Dicytota dichotoma *Lamx.—ab.*
var. implexa *J. Ag.*—CI *c.*
Taonia atomaria *J. Ag.*—CB *r.* See note.
Dictyopteris membranacea *Batt.*—CB *r.* See note.

FLORIDEAE.

PORPHYREAE.

Conchocelis rosea *Batt.*—CB *f.* In shells.
Goniotrichum elegans *Le Jol.*—Off Annagh Island *r.* On *Champia parvula.*
Erythrotrichia carnea *Le Jol.—f.*
Bertholdii *Batt.*—Achill *f.* See note.
* investiens *Born.*—See note.
Boryana *Berth.*—CI *r.* On *Laurencia pinnatifida.*
* Welwitschii *Batt.*—CI *r.* See note.
Bangia fuscopurpurea *Lyngb.—c.*
*Porphyra coccinea *J. Ag.*—CI *r.* See note.
leucosticta *Thur.*—CI *f.* On Fucus *spp.*
umbilicalis *Kütz.—ab.* See note.
var. laciniata *J. Ag.—c.*
var. linearis *Thur.—c.*

NEMALIONINAE.

*Colaconema Bonnemaisoniae *Batt.*—AS *r.* In *Bonnemaisonia asparagoides.*
Chantransia virgatula *Thur.*—See notes.
* *var.* luxurians *Rosenv.*—CI *c*, CB *r.*
* *var.* tetrica *Rosenv.*—CI, CB, *r.*
var. secundata *Rosenv.—ab.*
† Thuretii *Kylin.*—CB, AS, *c.* See note.

Chantransia endozoica *Darb.*—CB *r.* See note.
Alariae *Jons.*—CI *r.* See note.
[Daviesii *Thur.*]—Roundstone.
Nemalion elminthoides *Batt.*—CI *f.* See note.
multifidum *J. Ag.*—CI *c.*
Helminthora divaricata *J. Ag.*—Old Head *c*, CI *r.*
Scinaia furcellata *Bivona.*—CB *r.* See note.
Choreocolax Polysiphoniae *Reinsch.*—Old Head *r.* On *Polysiphonia fastigiata.*
*Harveyella mirabilis *Schm. et Rke.*—CI, CB, *f.* On *Rhodomela subfusca.*
Pterocladia capillacea *Born.*—CI *r.*
Gelidium crinale *J. Ag.*—Old Head *r.* In sand-pools.
pusillum *Le Jol.*—CI, CB, *f.*
pulchellum *Kütz.*—CI *f.*
latifolium *Born.*—CI *r.*
* aculeatum *Batt.*—*f.* See note.
corneum *Lamour.*—*f.*

GIGARTINAE.

Chondrus crispus *Stackh.*—*c.*
Gigartina mamillosa *J. Ag.*—*c.*
Phyllophora rubens *Grev.*—CI *l*; Roonah, Old Head, *c.*
Brodiaei *J. Ag.*—Mulranny *r.* See note.
Traillii *Holmes and Batt.*—Roonah *r.* In caves.
membranifolia *J. Ag.*—CI, Roonah, *f.*
Gymnogongrus Griffithsiae *Martius.*—Old Head *r.* In sand-pools.
norvegicus *J. Ag.*—Old Head *r.*
Ahnfeltia plicata *Fr.*—*f.*
Actinococcus subcutaneus *Rosenv.*—Mulranny *r.* On *Phyllophora Brodiaei.*
aggregatus *Schm.*—Old Head *r.* On *Gymnogongrus Griffithsiae.*
peltaeformis *Schm.*—Old Head *r.* On *G. norvegicus.*
Colacolepis incrustans *Schm.*—Old Head *r.* On *Phyllophora rubens.*
Sterrocolax decipiens *Schm.*—*r.* On *Ahnfeltia plicata.*
Callophyllis laciniata *Kütz.*—*f.* Washed ashore.
Callocolax neglectus *Schm.*—*f.* On *Callophyllus laciniata.*
Callymenia reniformis *J. Ag.*—CI *r.* Washed ashore.
* Larterae *Holmes.*—CI *r.* Washed ashore. See note.
Cystoclonium purpurascens *Kütz.*—*c.*
Catenella Opuntia *Good.* and *Wood.*—CI *r*, CB, AS, *c.*
Rhodophyllis bifida *Kütz.*—CI *f.* Washed ashore.

RHODYMENINAE.

Sphaerococcus coronopifolius *Grev.*—CI *f.* Washed ashore.
Gracilaria confervoides *Grev.*—CB, AS, *c.* See note.
* *var.* procerrima *Batt.*—See note.

Calliblepharis ciliata *Kütz.*—CI *f.* Washed ashore.
jubata *Kütz.*—CI *f.* Rock-pools.
Rhodymenia Palmetta *Grev.*—CB *f.* On stems of *Laminaria Cloustoni.*
palmata *Grev.*—*c.*
* *var.* sarniensis *Grev.*—CB *r.* On stems of *Laminaria digitata.*
Cordylecladia erecta *J. Ag.*—CB *f.*
Lomentaria articulata *J. Ag.*—*c.*
clavellosa *Gaill.*—*f.*
Champia parvula *Harv.*—CB *r.*
Chylocladia kaliformis *Hook.*—*ab.*
ovalis *Hook.*—*c.*
Plocamium coccineum *Lyngb.*—*ab.*
Nitophyllum punctatum *Grev.*—CB, AS, *c.*
Bonnemaisoni *Grev.*—CB, AS, *r.* Washed ashore.
* *var.* crassinerva *Batt.*—CI *r.* On *Laminaria Cloustoni.*
uncinatum *J. Ag.*—CB *l.* See note.
laceratum *Grev.*—*c.*
var. uncinatum *Batt.*—*f.* See note on *N. uncinatum.*
Gonimophyllum Buffhami *Batt.*—*f.*
Delesseria sinuosa *Lamour.*—*c.* On stems of *Laminaria Cloustoni.*
sanguinea *Lamour.*—*f.*
alata *Lamour.*—*c.*
[augustissima *Griff.*]—Galway (coll. Reilly, *teste* Harvey in Phyc. Brit.).
ruscifolia *Lamour.*—CI *r*, CB, AS, *c.*
hypoglossum *Lamour.*—*c.*
Bonnemaisonia asparagoides *Ag.*—CI, CB, *r.* Washed ashore.
* hamifera *Ag.*—CI, AS, Roonah Pt., *r.* Washed ashore. See note.
Bostrychia scorpioides *Mont.*—CB, CI, *l.*
Rhodomela subfusca *Ag.*—*f.*
Laurencia obtusa *Lamour.*—CB, AS, *c.* See note on *L. hybrida.*
hybrida *Lenorm.*—*c.* See note.
pinnatifida *Lamour.*—*ab.* See note on *L. hybrida.*
Chondria tenuissima *Ag.*—CB *r.*
dasyphylla *Ag.*—CB, AS, *f.*
Polysiphonia macrocarpa *Harv.*—CI *f.* See note.
fibrata *Harv.*—CI *c.* Especially on flat, semi-exposed rocks.
urceolata *Grev.*—*c.*
elongata *Grev.*—CI *r*; CB, AS, *ab.*
elongella *Harv.*—AS *r.*
violacea *Grev.*—CB, AS, *f.*
fibrillosa *Grev.*—CB *f.*
furcellata *Harv.*—CI, Roundstone, *r.*

Polysiphonia fastigiata *Grev.*—CI *f*; CB, AS, *ab.* See note.
atro-rubescens *Grev.*—CI *r*, CB *ab.*
nigrescens *Grev.*—CB, AS, *c.*
Brodiaei *Grev.*—*c.*
subulifera *Harv.*—CB, AS, *l.* See note.
fruticulosa *Spreng.*—*c.*
Pterosiphonia parasitica *Schm.*—*f.* In deep pools and in sub-littoral region.
thuyoides *Schmitz.*—CI *f*, Roonah *ab.*
Brongniartella byssoides *Bory.*—CB *ab.*
Dasya corymbifera *Cru.*—CB *r.* Dredged in 5 fathoms, and washed ashore.
arbuscula *Ag.*—CI *f*, Bellacragher Bay *r.* See note.
Heterosiphonia coccinea *Falk.*—*f.*
Spondylothamnion multifidum *Näg.*—CI *r*, CB *f.*
Spermothamnion Turneri, *Aresch.*—CI *f*, Old Head *ab.*
† *var.* subverticillatum, *comb. nov.*—CB *f.* See note.
Ptilothamnion pluma *Thur.*—CI, CB, *f.* On stipes of *Laminaria Cloustoni.*
† lucifugum *sp. nov.*—CI *r.* See note.
Griffithsia corallina *Ag.*—CB, AS, *ab.* See note.
setacea *Ag.*—CI *r*, CB *f.*
Halurus equisetifolius *Kütz.*—*f.*
*Bornetia secundiflora *Thur.*—CI *very rare.* See note.
Monospora pedicellata *Sol.*—CI *r*, CB *f.* In rock-pools and in sub-littoral region.
Rhodochorton membranaceum *Magn.*—CB *r.*
Rothii *Näg.*—CI *f*, Roonah *f.* In shady situations only.
parasiticum *Batt.*—*f.* On stipes of *Laminaria Cloustoni.*
floridulum *Näg.*—*ab.*
Callithamnion byssoides *Arn.*—CB, AS, *r.* See note.
polyspermum *Ag.*—*f.*
scopulorum *Ag.*—CI *f.* See note.
roseum *Harv.*—AS, BB, *f.*
[tripinnatum *Agardh.*]—Roundstone *f* (coll. McCalla).
Hookeri *Ag.*—CI *c.* On *Cladostephus spongiosus.*
arbuscula *Lyngb.*—CI *c.* On steep exposed rocks. See note.
tetragonum *Ag.*—CI *r.* On blades of *Laminaria digitata.*
corymbosum *Lyngb.*—CB, AS, *c.* See note.
granulatum *Ag.*—CI *r.* See note.
Seirospora Griffithsiana *Harv.*—AS *r.*
* hormocapa *Batt.*—AS *very rare.*
[Compsothamnion thuyoides *Schm.*]—Roundstone (coll. McCalla).
Plumaria elegans *Schm.*—*c.*
Ptilota plumosa *Ag.*—*c.* On stipes of *Laminaria Cloustoni.* See note.
Antithamnion cruciatum *Näg.*—CI *very rare.* On vertical rocks near low-water.

Antithamnion crispum *J. Ag.*—*f.* See note.
Ceramium tenuissimum *J. Ag.*—CB *f.*
strictum *Harv.*—*f.*
var. zostericolum *Le Jol.*—CB, BB, *f.*
diaphanum *Roth.*—*f.*
Deslongchampsii *Chauv.*—CI *r.*
Boergesenii *Petersen.*—*c.* See note.
rubrum *Ag.*—*ab.* See note.
var. pedicellatum *J. Ag.*—*c.*
var. secundatum *Petersen.*—CI *f.*
† atlanticum *Petersen.*—CI, The Bills, *r.* See note.
flabelligerum *J. Ag.*—CI *f.*
echionotum *J. Ag.*—CI *r.*
ciliatum *Ducluz.*—*c.*
acanthonotum *Carm.*—CI *c.*

CRYPTONEMINAE.

Gloiosiphonia capillaris *Carm.*—CI *r.* See note.
Dumontia filiformis *Grev.*—*c.*
Dudresnaya verticillata *Le Jol.*—CI *r*, CB *f.* Washed ashore.
Dilsea edulis *Stackh.*—CI, Roonah, *c.*
Schizymenia Dubyi *J. Ag.*—CI *r.* See note.
Halarachnion ligulatum *Kütz.*—*f.* Washed ashore.
Furcellaria fastigiata *Lamour.*—*c.*
Polyides rotundus *Grev.*—CB *c.*
Petrocelis cruenta *J. Ag.*—CI *c.* On smooth rocks near low-water.
* Hennedyi *Batt.*—CB *r.* On stipes of *Laminaria Cloustoni.*
Cruoria pellita *Lyngb.*—CI, CB, *r.* In caves, and dredged in 5–7 fathoms.
adhaerens *J. Ag.*—Dredged in 4 fathoms. See note.
Cruoriella Dubyi *Schm.*—CB *ab.* See note.
Peyssonnelia *sp.*—CB *r*; Roundstone *c.* See note.
Hildenbrandtia prototypus *Nardo.*—*ab.*
*Porphyrodiscus simulans *Batt.*—CB *r.* See note.
*Rhododermis polystromatica *Batt.*—CB *r.* See note.
Rhodophysema Georgii *Batt.*—CB, AS, *c.* On Zostera.
Schmitziella endophloea *Born. and Batt.*—CI *r.* In *Cladophora pellucida.*
Choreonema Thuretii *Schmitz.*—CI *r.* See note.
Melobesia farinosa *Lam.*—CB, AS, *c.* See note.
zonalis *Fosl.*—CB *f.* See note.
Lithophyllum (Dermatophyllum) pustulatum *Fosl.*—CI *c.* See note.
var. Corallinae *Fosl.*—CI *c.* See note.
var. Laminariae *Fosl.*—CB *f.* See note.
hapalidioides *Fosl.*—CI, Roonah, *f.* See note.

Lithophyllum hapalidoides *var.* confinis *Fosl.*—CB *r.* See note.
incrustans *Phil.—ab.* See note.
† *var.* subdichotomum *Heydr.*—CB, Roundstone, *r.* See note.
lichenoides *Ellis.*—CI, CB, *c.* See note.
[*var.* agariciformis] *Fosl.*—Roundstone *r.* See note.
fasciculatum *Fosl.*—CB *l.* See note.
Lithothamnium calcareum *Aresch.*—CB *c.* See note.
* norvegicum *Kjellm.*—CB *f.* See note.
laevigatum *Fosl.*—CI, CB, *r.* See note.
polymorphum *Aresch.—c.* See note.
compactum *Kjellm.*—CB *r.* See note.
Lenormandi *Aresch.—c.* See note.
* *var.* sublaevis *Fosl.—f.* See note.
var. squamulosa *Fosl.—f.* See note.
Sonderi *Hauck.*—CB *f* ?. See note.
Epilithon membranaceum *Hedyr.*—CI, CB, *f.* See note.
Corallina officinalis *L.—ab.*
squamata *Ellis.—c.* See note.
rubens *Ellis et Soland.—c.*

The above list contains the names of 437 species and 36 varieties. Of these 3 species and 2 varieties are new to science; 18 species are additions to the flora of the British Isles, and in all 92 species and 11 varieties are new to Ireland. For further details consult Part iv. of the present report.[1]

2.—Notes on the List.

Oscillaria laete-virens Crn.

The cells of the Clare Island specimens are slightly longer than usual in proportion to their width, the filaments being 4 μ wide, and the cells 6–8 μ long.

Portlea, May, 1911; with *Gelidium repens* on the under-side of boulders.

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[1] Marine Fungi.—Four species of marine fungi were observed, and may be noted here. (See Report No. 13 of the present series.)

Ostracoblabe impleza Born et Flah.—A shell-boring species. CB rare.
Epicymatia Balani Winter.—Common on barnacles. CB and CI.
Mycosphaerella Ascophylli Cotton.—Constantly present on receptacles of Ascophyllum.
Leptosphaeria Chondri Rosenvinge.—Very rare, and second record for British Isles. On Chondrus, washed ashore on Clare Island. (For notes on the above fungi see Cotton, '09.)

Miss J. Stephens drew my attention to an endophytic organism growing in the sponge *Terpios fugax*, and giving it a deep blue colour. The organism is apparently a Schizomycete (see Topsent, Arch. Zool. exp. et gen. (3) viii 1900). *Terpios fugax* is rare on Clare Island, but not uncommon at extreme low-water mark on the islands of Clew Bay.

Oscillaria sancta Kütz.

A fresh-water species, common in Britain; but with the exception of specimens sent out by Holmes ("Algae Rariores," No. 268) it has not been recorded for our islands from a marine habitat.

Portlea, October, 1910; May, 1911; on various algae at mouth of cave.

O. limosa Ag.

As in the case of many Cyanophyceae, *O. limosa*, though usually a fresh-water species, should certainly be included in a list of marine algae. It was found intermixed with other brackish species on piles at the side of a stream at Mulranny (Aug., 1911).

In addition to the above record, a cyanophyceous growth on the sand, both in Achill Sound and at Mulranny, appears to be referable to this species. At Achill the growth occurred between the Fucus plants in the "farms" in the middle of the Sound; and at Mulranny it was found amongst Rhizoclonium and Vaucheria on the upper part of the tidal region. The filaments are straight, non-attenuated, non-capitate, bright blue-green in colour, and measure 10–16 μ in diameter. In some cases a distinct, somewhat mucilaginous sheath is present, a peculiarity which has been noted previously in *O. limosa*, and which led to a distinct species, *Lyngbya obscura* var. *aestivalis*, being described by Hilse. The only point in which the specimens differed from the normal fresh-water *O. limosa* was in the filaments being at times slightly torulose.

Phormidium persicinum Gom.

This very distinct species, which is new to the British flora, was described by Reinke in 1889, and has since been recorded from various localities in Europe and America. The rose colour, coupled with the exceedingly fine filaments (1·5–2 μ) and long cells (2–7 μ), mark it sharply off from other marine species. The previous record of this plant as British (Journ. Bot., xxxiv, p. 7) was an error, the plant found being *Phormidium Ectocarpi* Gom. (Batters, '00, p. 369).

Clare Island, October, 1910, forming a dense rose-coloured coating on *Codium tomentosum* in a rock-pool.

P. subuliforme Gom.

The plant referred to this species was found with *Calothrix scopulorum* on rocks near high-water line. First described by Grunow from St. Paul (Pacific), it has since been recorded from Nebraska and Iceland (Journ. Bot., xl, p. 245). Though not previously noted as marine, it agrees so well

with Gomont's description that it is here recorded under his name, though it is possible that further work may show that it is a distinct species. In St. Paul and Iceland it occurred in warm springs; but it is well known that many algae which usually grow in ordinary temperatures are also found in such positions.

Clare Island, Kinnacorra rocks, near high water, October, 1911.

Lyngbya confervoides C. Ag.

Well known on the north coast of France, but apparently not hitherto recorded as British. It closely resembles *L. aestuarii*, and might almost be regarded as a form of that species; Gomont, however, keeps them distinct. The Clew Bay specimens are rather slender, usually measuring 10–14 μ diam. The sheaths, even in old and empty filaments, remain quite hyaline.

Louisburgh and Mulranny, September, 1911, in brackish pools; probably common.

Microcoleus chthonoplastes Thur.

It is surprising that this well-known and cosmopolitan species should not have been previously recorded for Ireland, where it forms, as elsewhere, a definite though inconspicuous plant-association (see p. 63). Adams listed it in his "Synopsis" ('08), but excluded it in 1910 (p. 211), as no published record of the plant could be found. It is abundant in Clew Bay, and is doubtless common in other parts of Ireland. I took several samples from the banks of the river Bann in May, 1910.

Calothrix aeruginea Thur.

Apparently new to Ireland. Recorded by Adams in his "Synopsis," but removed in his second paper ('10, p. 211). Epiphytic on various algae, especially at Old Head.

C. fusca Born. et Flah.

A species usually regarded as being confined to fresh-water; but found in plenty on *Rhizoclonium riparium* in brackish pools at Mulranny. It was listed by Adams as an Irish fresh-water species.

C. endophytica sp. nov.[1] (Plate 10, figs. 1–3).

Plants endophytic in the thallus-cavity of Enteromorpha *sp.*, nearly black in the mass. Filaments simple or rarely slightly branched, very short.

[1] C. filis intra thallos Enteromorphae entophyticis, brevissimis 70–130 μ altis, 7–10 μ crassis, aeruginosis; vagina tenui, achroa, vel lutescente, sursum gelatinosa, diffluente; trichomatibus 7–8 μ crassis, attenuatis; articulis diametro brevioribus vel subaequilongis; heterocystis 1–2, basilaribus, rare intercalaribus.

70–130 × 7–10 μ; blue-green to olive-green; base not thickened. Sheaths thin, colourless, or becoming slightly yellow with age; diffluent above or absent. Trichomes 7–8 μ thick, attenuated, but not ending in a hair (dried specimens only examined); cells usually shorter than wide. Heterocysts 1–2, basal or rarely intercalary.

In *Enteromorpha torta* Reinke (?). Salt-marsh, Annagh Island, Oct., 1910.

This species gives to the Enteromorpha filaments in which it grows a deep, almost black, colour, which caused them to stand out conspicuously against a background of Rhizoclonium. The plant-mass was distinguishable in the field from Oscillaria and Lyngbya, and was collected as a very dark species of Enteromorpha. On examination, however, the tubes were found to contain blue-green filaments, which for the most part were tightly packed along the whole length of the Enteromorpha fronds. A good supply of material was collected, all of which showed the same phenomenon, so that there can be no question of accidental growth.

Its remarkable habitat renders the plant very distinct; and except for *C. parasitica*, no species of similar habit has been described. In the latter, the filaments are embedded in the thallus of Nemalion; but they occur in fascicles, and project at right angles from the host-plant. The cells of the present species vary considerably in length; and the lateral walls may be straight or markedly torulose. In October, 1910, the plant was plentiful on the salt-marsh; but in May, 1911, it was searched for in vain.

Haplosphaera viridis Schm.

Mr. G. P. Farran tells me that this species has been noted in the plankton of the Clare Island district during the cooler months of the year.

The following table, drawn up from Gough's list ('04), is of interest in showing the marked seasonal development of the plant:—

Skullmartin (Co. Down), March, April.
South Arklow (Co. Cork), February–April; September, October.
Coningbeg (Co. Wexford), January–May; September–December.
Fastnet (Co. Kerry), February, March; (July) September–December.

Codiolum gregarium Braun.

Much diversity of opinion exists as to the limits of the species of Codiolum. All the Clare Island forms occurring commonly on the rocks in company with *Calothrix scopulorum*, I have referred to *C. gregarium*. The plants vary much in size and length of stalk; the head in the larger specimens being about 250 μ long by 50–70 μ broad, and passing either

gradually or abruptly into the stalk: but in any one gathering many intermediate forms are found. It agrees well in form with Braun's specimens (Rabenhorst, "Alg. Eur.," No. 1841), but is somewhat smaller. It also appears to agree with the Berwick gatherings (Holmes, "Algae Rariores," No. 33), which Batters ('89, p. 44) referred to *C. gregarium*, but which, in 1902, he placed under *C. pusillum* Foslie. Judging by Börgesen's figure of the original material ('02, fig. 107), it would appear that Batters' earlier view was the more correct. The specimens of *C. pusillum* distributed by Wittrock and Nordstedt, and by Hauck and Richter (Exsicc., Nos. 457 and 472 respectively), agree with Börgesen's figure in possessing an extremely long head, and such specimens are easily distinguished from the normal form of *C. gregarium*.

With regard to the other species, the Clare Island observations tend to show that names have been proposed far too freely; and it is clear that nothing but a special study with careful and systematic collecting throughout the year will bring about a true understanding of the genus.

MONOSTROMA.

In common with many algae of brackish regions the Monostromas present endless trouble to the systematist; but it would seem that few of these genera would so readily repay careful study in the field. The characters upon which the species are founded—the size, shape, and thickness of the frond, and the size and form of the cells—are known to vary much with external conditions. If the ecology of the plants could be studied, and their growth traced through from the earliest attached stages to the loose floating forms, it is certain that many puzzling intermediates could be placed, and that several of the so-called species would have to disappear.

Of the numerous forms noted in Clew Bay, *M. orbiculatum* was recognizable; and two others that were sufficiently distinct and frequent to be worthy of record, could not be satisfactorily determined, and are hence referred to by collecting-numbers only.

M. orbiculatum Thur.

A plant common during April and May in the brackish pools of the salt-marsh near Belclare. It is at first attached to stones, sticks, or leaves and shoots of flowering plants, but finally becomes free. It often grows in dense tufts, and may reach as much as 1 foot to 18 inches across. The fronds are densely plicate, usually orbicular, but sometimes partly sub-lanceolate; on detachment they become very irregular, but, owing to spring-tides flooding the pools, it is difficult to be certain as to the origin of free-swimming plants.

No. 91.

This well-marked plant occurs abundantly at the bottom of the hill-side streams which flow into Achill Sound and Bellacragher Bay. It grows attached to stones or other algae such as *F. ceranoides*, and though flooded by every tide, it is for the greater part of the day immersed in fresh water. A certain amount of growth occurs above the average high-water line; and this is bathed in salt water at spring tides; but the plants are small, and the growth very poor, compared with that of half-tide level. The lower limit is at or slightly above low-water mark. Monostroma gives the stony beds of the Bellacragher torrents a deep green colour in spring; but in other streams (*e.g.* to the north of Achill Bridge) the beds are muddy, and the alga occurs only on the stone fords or where there is good means of attachment. The growth is found in spring, summer, and autumn; in February, also, a certain amount was visible. The maximum is reached in April and May, at which season it extends to the stones and Fuci on the flanks of the streams (see also p. 87).

The plants themselves are of a deep green colour, growing in rosettes or dense tufts, regularly orbicular at first, but becoming more or less lobed or even lanceolate later. They are usually 5–8 cm. across; but lobed specimens reach a length of 15–18 cm. The thallus is thin, that of the adult plant seldom measuring more than 20–25 μ thick, and the cells small, about 10–15 $\times$ 6 μ in section; but in young plants they are often larger. It adheres very well to paper, even in the dry air of the herbarium. The plant has only been found attached, as detached specimens are swept down by the stream and carried away; in a free state, it would probably reach a larger size.

With regard to affinities, the plant agrees in structure with Thuret's *M. laceratum*; but he describes this as floating in ditches with Obione. From *M. orbiculare*, so common near Belclare, it differs in its smaller size and thinner frond; but it is possible that this is due to its peculiar habitat. On the other hand, the plant may be regarded as a small attached form of *M. latissimum*, or as a distinct species peculiar to the situation referred to.

No. 95 (= *M. crepidinum* Farlow ?).

The second species left unnamed occurs on the banks of the streams on the sandy shore at Mulranny, and at the mouth of the Bunowen at Louisburgh. It is attached to the stems of Ascophyllum and *F. vesiculosus* (especially on the under branches), but is also found on the stones and rocks covered by these algae, and occasionally in the open. The plants are always

uncovered during low-tide, and have not been noted in pools; thus, though swept with a considerable amount of brackish water on the ebb-tide, its habitat differs considerably from that of the last species. It is not abundant, but has been found, with the exception of the February visit, each time the localities have been searched.

When young, the plants are more or less orbicular, but soon become deeply divided and very irregular. They occur in small clusters and are of medium size, an average specimen being 10–12 cm. in length; a few larger fronds were found floating in pools; but it was not quite certain if they were detached from this species or from *M. orbicularis*. The thallus is usually about 30 μ thick; and, unless growing in deep shade, is of a very pale colour (cf. No. 91).

The agreement with *M. crepidinum* is, in deeply-cut angular specimens, fairly close; but, in others, it is less marked, the fronds being large and irregular. The American specimens in the Kew Herbarium adhere very tightly to paper, which is not the case with any of the Clew Bay material. The lobed fronds appear to separate it from being a marine form of *M. orbicularis*.

Enteromorpha paradoxa var. **tenuissima** (Kütz.), Batt.

A few specimens of this beautiful species were found washed ashore at Old Head (August, 1911). Though in poor condition, they are without doubt referable to the plant named *E. Hopkirkii* by McCalla. The small chromatophores, and the monosiphonous ultimate ramulae, separate it from the majority of the richly-branched species; and its extreme delicacy distinguishes it from *E. erecta* Hook. The plant has suffered much at the hands of systematists, and its position will probably continue uncertain till the genus is thoroughly revised. I have followed Batters without investigating the point) who has united it with Kützing's *E. tenuissima*, which he regards as a variety of that author's *E. paradoxa*.

Ulva Lactuca L.

For recent work on the biology and ecology of Ulva, and especially its growth in polluted waters, see Reports to the Sewage Commission (Letts and Richards '11; Cotton '11 *b*). An account of the structure of the basal disk has also been published recently by Miss Delf ('12).

In the pure waters of Clare Island the plant is one of the most abundant species in the more sheltered rock-pools during summer and autumn. It is frequent on rocks also at Portlea and at Old Head; but in none of these localities does it attain a great size. Large specimens may be dredged in

Clew Bay, where the water is quiet and muddy; but here it is local, and not generally distributed. On the bridge near Murrisk it was noted attached to mussels, as at Belfast and Southampton.

ULOTHRIX.

The species of Ulothrix were kindly determined by Dr. N. Wille. Two new species are added to the British flora, but one of these may represent the plant named by Batters *U. implexa.*

U. flacca Thur.

Common on the flat sheltered shore of the mainland, but not found on Clare Island, the plant of exposed coasts being now regarded as a distinct species—viz., *U. pseudoflacca* Wille.

On my February visit especially, *U. flacca* was found in thin, felt-like masses, just below high-water line, on the muddy shores of Clew Bay and Achill Island. The filaments usually measured 40-50 μ diam.; and the cells contained a large ring-like chromatophore with 4–6 pyrenoids. *U. flacca* is not listed in the "Synopsis," but Mr. Adams tells me that the plant was included as a synonym of *Urospora isogona* (see *Urospora mirabilis*).

U. consociata Wille.

Apparently common in the district during winter and spring. It was found on boulders near high-water line at Portlea, and was abundant at Roonah in similar positions during February. Collins ('09, p. 186) designates this species *U. laetevirens* (Kütz.) Collins.

U. pseudoflacca Wille.

Not previously recorded for the British Isles, though doubtless passed over as *U. flacca.* On Clare Island it is the dominant species of the Bangia-Ulothrix-Urospora association, and is also frequent as an epiphyte on various algae, especially the stems of *Fucus vesiculosus.* On Ahahaskilla it formed a dense and tangled coating on *Lichina pygmaea.*

U. subflaccida Wille.

To this species a very slender plant, found on muddy stones near high-tide level, is referred by Wille. The filaments are only 7–10 μ diam., and possess band-like chromatophores, with one pyrenoid. From the description given by Batters ('89, p. 35) it appears probable that it is the plant referred by him to *U. implexa* Kütz.; but Professor Wille informs me that it is quite impossible, from the meagre description, to determine the identity of Kützing's species.

Bunowen River and Achill Sound, February, 1911

Urospora mirabilis Aresch. (= *U. isogona*, Batt., '02, p. 14.)

This is the common species on Clare Island, only a few filaments doubtfully referable to *U. Wormskioldii* being found in addition. The combination proposed by Batters is questionable. No type of *Conferva isogona* Eng. Bot., can be found; and even if it could, it is improbable that its specific identity could be recognized. The present plant was confused, in the older Irish records, with *Ulothrix flacca*.

Chaetomorpha litorea Harv.

Some small pieces of a Chaetomorpha collected at Mulranny appear to belong to this species. The cells are 90–110 μ diam., and 1–1½ times as long, and rather thick-walled. Carmichael's Appin gathering is not to be found at Kew, and consequently Wyatt Exsicc., No. 220, must be regarded as the type (see "Phyc. Brit.," Pl. 333). It is doubtful if the species is not merely a slender form of *C. linum*.

C. linum Kütz.

Adams records *C. linum* in ('08), but excludes it in ('10). In the second paper it was regarded as a synonym of *C. crassa*; but as it is most unlikely that all the Irish records of this common plant could be referable to that species, I have not considered the Clew Bay gatherings as an addition to the Irish flora.

Rhizoclonium Kerneri Stockm. f. **endozoica** Wille.

This addition to the flora of the British Isles appears to be not uncommon in the west of Ireland, being found on several occasions during the Survey. It is probably general on our shores, but its curious habitat—within the tissues of the sponge *Halichondria panicea*—doubtless accounts for its being overlooked.

The first specimens were collected under the bridge at Achill Sound, where patches of sponge of a deep green colour were noted. The latter were found to contain algal filaments which agreed with Wille's description of *R. Kerneri* f. *endozoica* that had just been published ('10, p. 291). Specimens were forwarded to Dr. Wille, who confirmed the point, and added, "Es ist doch sehr zweifelhaft ob die Alge zu *R. Kerneri* gehört, aber ich habe keine sichere Vermehrungsorgane gefunden, und möchte deshalb vorläufig nicht eine neue Gattung aufstellen." The alga was found later in sheets of Halichondria in the caves near the lighthouse on Clare Island, and was noted on both subsequent visits to Achill Sound, but in each case the specimens were sterile, so that no fresh light on the affinities of the alga could be gained. A curious bacterium-like plant living in the sponge *Terpios fugax* is recorded on p. 102 (foot-note).

Cladophora prolifera Kütz.

One of the interesting additions to the Irish flora, and found on The Bills rocks only. It is not uncommon on various coasts of southern Europe, and a single record exists for the British Isles, the plant having been washed ashore in profusion at Weymouth in November, 1884 and 1885 (see Holmes, "Alg. Brit. Rar.," No. 32). The Irish specimens were found in rock-pools on the shady side of the islets (July, 1910).

C. flexuosa Harv.

The plant referred to this species was collected in pools under the shade of boulders in Clare Island in July, 1910. It agrees very closely with the specimens in "Algae Danmonienses" (No. 227), on which the species was founded, though it is open to question whether the plant is not a form of some other species.

C. Rudolphiana Harv.

This species, though rare in England and Scotland, is, as noted by Harvey, abundant on the west of Ireland. It is *Conferva Kaneana* of McCalla ("Algae Hibernicae"). The Clew Bay specimens agree well with Harvey's figure and description, and are undoubtedly the same as his plants; but whether they are identical with *C. Rudolphiana*, as understood on the Continent and in America, is not certain. (See "Phyc. Brit.," Pl. lxxxvi.)

C. corynarthra Kütz., var. **spinescens** Batt. ('00, p. 370).

A curious plant, which appears to agree with variety *spinescens* of this little-known species, was found amongst stones and damp soil near high-water mark at the Mulranny end of Bellacragher Bay. Batters' specimens were collected at Roundstone, and occurred amongst the roots of Zostera. The Mulranny habitat is a remarkable one, the more so as the plant appeared to be confined to the stone-area referred to.

C. arcta Kütz.

The name *C. arcta* is used here in its wide sense, and includes several other so-called species. Kjellmann's work, though useful, left things in a most confused state. A point which has been largely overlooked is that the original *C. arcta* in its best-known and typical forms has hooked branches, though these are not so numerous as in some of the recently proposed species. Many of Miss Hutchins' Bantry Bay specimens (on which the species was founded by Dillwyn) exist at Kew; and the plant is common in England and Ireland. Hooked branches are always present. In certain forms (especially those in the north of Britain) the growth is less dense and the recurved

branches are more numerous. These are inseparable from *Acrosiphonia albescens* Kjellm., and *A. incurva* Kjellm., which Börgesen found so abundantly in the Faeröes. *C. Traillii* Batters is also hardly distinct from *C. arcta*. All these forms appear to exist on Clare Island; but they pass imperceptibly into one another. The species vary greatly with age, and with habitat, so that for a satisfactory revision it is essential that much time be spent in field work.

Derbesia marina Kjellm.

Two patches of this plant were found—(1) in a cave near Portlea, and (2) on the dark under-side of a slab, at Kinnacorra, attached to *Halichondria panicea*. In the latter case the alga formed tufts about 1 cm. high of a pale green colour. At the base there is a mass of creeping filaments, and from these spring upright shoots with numerous lateral branches coming off at an acute angle. The latter are much more slender than in the Finmark and Faeröese plants, being only 20–30μ diam., but they agree in possessing the short cells at the base.

The cave-specimens (which grew in or at the margins of shallow pools) were much less regular in growth, the branches springing from the main filaments at various angles, but they agreed in size and in presence of the short cells. The matted growth at the base is more copious and the upright filaments are shorter than in the plants from the open. Sporangia were found on the cave-specimens only. These were few in number and hardly mature; the largest measured 120–65μ, which is smaller than those recorded previously.

Kjellmann described *D. marina* (Lyngb.) in full; and Börgesen in dealing with its distribution records the plant from Lerwick ('02, p. 520, '03, p. 303). Up to the present this has been the only certain record for the British Isles. It appears probable from the Portlea specimens that Crouan's *D. repens* may be a form of the present species.

Vaucheria Thuretii Woron.

This species occurs half-buried in the mud on the lowest part of the shore; and it covers wide areas of the mud-flats in Clew Bay and Achill Sound (north end). It is distinguished by numerous small sessile antheridia found in the neighbourhood of each oogonium and on the same filament. At times the growth is so covered with mud as to be hardly visible, but even in this state it provides, on washing, excellent fruiting material. Found in fruit, May, July, September, at Annagh Island, Mulranny, and Achill Sound. (See p. 64.)

Vaucheria coronata Nordst.

Easily recognized when in fruit by the fecundation-tubes which crown the oogonia. It occurs on the upper parts of muddy shores in which it forms beautiful velvet-like sheets of a deep green colour. It is common at Louisburgh (Bunowen River), Annagh Island, and Mulranny, and was found in spring, summer, and autumn.

V. litorea Agardh.

Common on the muddy shores of the inner part of Clew Bay. It is monoecious, and fruits freely, Belclare material showing abundance of ripe oogonia in May, 1911. The latter are subglobose, and borne on the extremity of straight or recurved branches which in many cases appear to represent the main shoot, indicating that the branching is of a sympodial nature.

Codium amphibium Moore.

This rare species was found on a ledge at the mouth of a cave on Clare Island (1909 and 1911). In 1909 its identity was doubted, as it appeared possible that the specimens represented a crop of young plants of *C. tomentosum.* But in August, 1911, a much more characteristic growth was found in the same cave, the sheet measuring some 15 × 9 inches. A passing shower proved fortunate in showing that the patch occurred in a spot where rain dripped from the roof, which confirmed its claim to be amphibious.

A special search for the plant was made at Roundstone (from whence it was described in 1843) during September, 1911, but without success. The amount of suitable ground in the neighbourhood is large, and though not discovered in a one-hour search, it is quite possible that it still exists.

In the Clare Island specimens, the fronds are 5–8 mm. high, and 1·5–2 mm. thick; the full-grown utricles are clavate and thin at the apex; they measure, on the average, $500 \times 150\,\mu$. The creeping filaments forming the effused stratum at the base are freely branched, somewhat irregular, and contain much chlorophyll; they vary from 30–50 μ in thickness. Though a large number of fronds were examined, no fertile utricles were found. Outside Ireland, *C. amphibium* has been recorded from Cornwall and the Isle of Man.

C. tomentosum Stackh.

As great difficulties exist in many countries with regard to the limitations of *C. tomentosum*, a full description is here inserted. The species varies considerably, and has been recorded from all parts of the world; but as it was originally described from an English specimen, the British plants may be regarded as typical.

Description.—Plants rather slender, much branched, 9–15 inches high as a pool plant, 2–2½ feet when growing in deep water. Colour dark green. Fronds slender, 3–4 mm. thick, cyclindrical, often slightly flattened at the axils, dichotomous; surface often very tomentose, becoming smooth with age. Utricles cylindrical, small, 500–650μ long, by 120–170 (rarely to 220μ) wide, apex usually distinctly thickened, blunt; smaller utricles sometimes pointed, but never mucronate. Gametangia (♀) small, 200–250 × 40–70μ; gametes 20–22 × 10–12μ.

Habitat.—On rocks near low-watermark usually semi-exposed, or in deep or shady rock-pools; saxicolous or epiphytic: also in the sub-littoral region, often on stipes of *Laminaria Cloustoni.*

Season.—All the year round; many plants reaching maximum size in winter.

In comparison with many localities on the south and east of England, *C. tomentosum* is common in the west of Ireland. Very large plants were noted in February, both in pools and from deep water. One specimen on *Laminaria Cloustoni* measured a yard in length. In most cases the fronds are cylindrical, but in some there is a marked flattening, especially in specimens washed ashore from the sub-littoral region.

The chief points of distinction between the present species and *C. mucronatum* are (1) the slender branches (3–4 mm. thick), and (2) the small utricles (500–650 μ long) (cf. figures 1–2 and 3–5, Plate 8). Further, *C. tomentosum* does not assume a light green colour when growing in sunlight, and it apparently reaches its maximum size during winter, at which season *C. mucronatum* appears to be almost absent. The utricles moreover are often thickened, but never mucronate. Both species are more or less tomentose, but *C. tomentosum* more often so than *C. mucronatum.*

C. mucronatum *var.* **atlanticum** *var. nov.*[1] (Plates VII and VIII, figs. 3–5).

Plants robust, slightly branched, usually 6–9 inches high, rarely forming large tufts 12–18 inches high, and much branched from below. Colour deep green, bright green when growing in sunlight (due to the presence of bubbles between utricles). Fronds robust, 5–7 mm. thick, entirely cylindrical (not flattened below axils), dichotomous or dichotomously fastigiate, surface smooth or slightly tomentose when young. Utricles very large, cylindrical or slightly clavate, 800–1000μ long by 250–300μ wide, apex thin-walled, surmounted in the younger parts of the frond by a small, sharp or blunt mucro, in the older parts mucronate utricles often absent. Gametangia (♀) large, 300–400 × 80–120μ.

[1] Var. *atlanticum.* Utriculi parte frondis adultiore laeves vel mucrono brevissime acuto aut obtuso instructi, parte juniore mucronati.

Habitat.—Sunny rock-pools, common; rocks near low-water or shallow sub-littoral region, rare.

Season.—Spring to autumn. (Absent in winter?)

Distribution.—IRELAND, Co. Antrim (Giant's Causeway), Co. Donegal (Bundoran), Co. Mayo (Achill, Clare Island, Roonah Point, Old Head, Bellacragher Bay), Co. Galway (Dog's Bay), Co. Clare (Kilkee), Co. Cork (Bantry Bay, one spec. in Herb. Univ. Cambridge).

SCOTLAND, Ayrshire (Ballantrae, Herb. Ball, Dublin), Bute (Cumbrae, Herb. Batters), Orkney (Herb. Harvey, Holmes), Iona (Herb. Greville).

ISLE OF MAN (Port Erin, frequent in pools).

Exsicc.—*C. elongatum*, Ag., Holmes, "Algae Rariores," no. 282.

Distinguished from *C. tomentosum* by its more robust fronds, and the very much larger utricles which are often mucronate. The degree of mucronation is variable in different specimens, and also in different parts of the same specimen. In some individuals it is marked throughout the entire plant, in others in the younger parts only, whilst in a few cases it is absent except in the tips of the branches and in proliferations. In the latter mucronation is often very marked indeed.

The correct determination of this plant gives an additional species of Codium to the continent of Europe. Entirely absent from England, and also, as far as can be ascertained, from France and the Mediterranean, yet abundant on parts of the west of Ireland and known to occur in the Isle of Man and Scotland, it is to be regarded as one of the most interesting of the Clare Island discoveries. Its distinct field-characters, and the fact that it is no recent introduction, makes its previous non-recognition the more remarkable.

Before discussing the question of the Irish plant, it may be well to refer to *C. mucronatum* as generally understood. J. Agardh founded the species in 1886. He distinguished three varieties (with no definite typical form) as follows:—

var. *tasmanicum*, Tasmania and Australia.
var. *Novae Zelandiae*, New Zealand.
var. *californicum*, California.

The characteristic feature of the species was the mucronate utricle; and the varieties were based on the degree and form of mucronation. In addition to the countries mentioned, the plant has since been recorded from South Africa, Japan, and Cape Horn, but not from the North Atlantic.[1] There is a plentiful supply in herbaria of both Australian and Californian material. An examination

[1] The Japanese and South African specimens require verification.

of the Kew specimens tends to support Agardh's conclusion that all three varieties belong to one species, and shows that in a general way mucronation is correlated with robust habit and very large utricles (points not noted in the original diagnosis). The Irish plant does not agree exactly with any of Agardh's varieties. It resembles closely var. *Novae Zelandiae*, but differs in the usually blunter mucro, and also in the occasional partial absence of this structure.

Notes on the mucronation of the four varieties are given below, Agardh's description of the first three being amplified or slightly emended.

var. *tasmanicum*.—Utricles in youngest parts tapering to a long sharp point; in older parts broad, cylindrical, sharply mucronate. Distribution—E. and S.E. Australia and Tasmania.

var. *Novae Zelandiae*.—Utricles surmounted with a small, sharp mucro, in both young and old parts of the fronds, but usually slightly more marked in the younger. Distribution—New Zealand and E. Australia.

var. *californicum*.—Utricles surmounted with a long or short mucro, which, though sharp at first, is usually blunt later, and sometimes apparently articulate. Mucro very variable in length, sometimes partially absent. Distribution—Pacific Coast of N. America, (Japan ?)

var. *atlanticum*.—Utricles in younger parts surmounted with a very short, sharp or blunt mucro; in older parts utricles sometimes non-mucronate. Distribution—N. and W. of Ireland, Isle of Man, S.W. Scotland, Orkneys.

The above four varieties form an irregular series with regard to their mucronation. Var. *californicum*, although in some respects intermediate between *tasmanicum* and *Novae Zelandiae*, is apart from both in the bluntness, articulation, and occasional great length of the mucro.

Identification of the Irish Plant.—It is certainly remarkable that so conspicuous a species should have so long escaped attention. Known from Kilkee, and plentiful in the pools at Dog's Bay, Roundstone, it is almost incredible that such acute observers as Harvey and McCalla should not have detected it. A single specimen collected in Bantry Bay by Miss Hutchins (Cambridge University Herbarium), and two collected in 1839 from the Ayrshire coast (Dublin National Museum), show that it is no recent introduction.

The plant attracted attention on the first day spent on Clare Island, and on one or two occasions only was there the slightest difficulty in distinguishing it at a glance from *C. tomentosum*. Its light-green colour in summer, and preference for shallow sunny pools, cannot fail to strike the collector, whilst its sturdy habit is also noteworthy. With the exception of the last, these characters are not of course visible in the dried specimen, and

hence herbarium botanists have been off their guard, and have not detected the microscopic characters which are even more striking and important.

Batters was the first to recognize the species as distinct. In 1897 he received a specimen from Kilkee collected by E. George, and this he identified with the Mediterranean *C. elongatum*. He did not apparently record the discovery; but in his "Catalogue" (1902) he lists *C. elongatum*, and gives Kilkee as the only locality. On my return to London after the first Survey visit, I examined Batters' specimen. In external form it agreed fairly well with small specimens of *C. elongatum*, and possessed large utricles, as does that species. The Clare Island gatherings differed somewhat; but it was established beyond question that the two plants were specifically identical. As there was no other European Codium to which the species could be referred, the name *C. elongatum* was accepted, though each subsequent visit rendered the identification more questionable. Occasional mucronation was noted; but this was regarded as an irregularity.

During the second season the matter was thoroughly investigated, and herbarium material of all known species of Codium was examined. As a result, the Irish plant was found to be constantly more or less mucronate, and to resemble very closely the Australian plant *C. mucronatum* J. Ag. As the position of this species in Europe would be extremely isolated, and since the Irish plant was decidedly less mucronate than the Australian, it was at first thought advisable to describe it as a new species. But on further investigation it was found that, as far as could be ascertained from dried material, it differed in no important particular from Agardh's species, the Australian gatherings varying largely amongst themselves as to degree of mucronation. Further, the Irish plant differed much less from var. *Novae Zelandiae* than does that plant from var. *tasmanicum*, whilst the Californian variety is far and away more distinct. On the other hand, it was undesirable, in the present state of our knowledge, to definitely link the European plant with var. *Novae Zelandiae*. I have therefore described it as a new variety, which may be distinguished from the last-named by the small size of the mucro, and by its partial absence in some cases.

The drawing on Plate VII shows its robust habit,[1] and on Plate VIII the form and size of the utricles are depicted. Though mucronation may at times be absent, the greater length of the utricles, and the absence of apical thickening, render these structures perfectly distinct from those of *C. tomentosum* (cf. figs. 1–2 and 3–5).

[1] Unless the specimen be carefully dried, the stout character of the branches may be lost, as is the case in many herbarium specimens. On the other hand, it is possible by excessive pressure to give specimens of *C. tomentosum* the appearance of *C. mucronatum*.

Biology and Ecology.—The bright green colour referred to is an optical effect due to the presence of air-bubbles between the utricles. Two explanations suggest themselves: (1) A physiological disturbance in the tissues due to the heating of the pools, and (2) the retention of oxygen given off during photosynthesis in bright sunlight. Plants growing in the shade are dark in colour, as were those collected in February. But in April, when there is sufficient sunlight to cause heating and rapid photosynthesis, the bright green appearance is, on the south shore of Clare Island, everywhere in evidence. At the Giant's Causeway, however, where the coast faces north, a few plants collected on May 1 were still dark. It is noteworthy that when *C. tomentosum* grows in sunny pools, which is very rarely the case, no gas is found between the utricles, and the normal colour is retained.

The habitat of our plant is well marked. It is distinctly an alga of sunny rock-pools, being found at any level, but more commonly at a quarter to three-quarter tide. It also occurs occasionally in the shallow sub-littoral region, or on bare rocks near low-water mark, where, though liable to be exposed to the air during the lowest tides, it may attain a large size. In this position it is dark in colour. In a general way the plant is frequent on the south shore of Clare Island; also at Roonah and Dog's Bay. It prefers moderately open rocky ground, but extends into Clew Bay as far as Old Head. Several plants were noted in the quiet, brackish waters of Bellacragher Bay; but they were decidedly unhealthy, the fronds being not only irregular in form, but exhibiting abnormalities in microscopic structure. The utricles were for the most part strongly mucronate, and showed a tendency to become irregularly thickened at the apex.

C. mucronatum var. *atlanticum* appears to be an annual. On the February visit young plants only were observed, and large plants are prevalent in summer, though a few sporelings may be found all the year round. *C. tomentosum*, on the other hand, attains its maximum size in winter.

Distribution.—The remarkable feature with regard to distribution is not so much its link with the Australian forms (our other species, *C. tomentosum* and *C. adhærens*, apparently occur in the Southern Hemisphere), but its isolated position in Europe. It is not known from the Mediterranean or from North Africa, and is apparently entirely absent from the remainder of the North Atlantic. Dr. Marshal Howe, who has collected largely on the American coasts and in the West Indies, writes in reply to an inquiry, that as far as he is aware "no mucronate Codium has ever been found on the Atlantic coast of North or South America, or on any of the outlying islands."

The distribution in the British Isles is given on p. 115. No English or French specimens have been found in any of the herbaria examined; neither

have friends in England or Wales, to whom I have written, been able to detect it on the shore. Professor Harvey Gibson kindly sent a plentiful supply from the Isle of Man; and stated that the plant is frequent in the pools at Port Erin (Bradda Head), but was not noted elsewhere. Judging from certain statements in his memoir ('00), it was probably established there in 1900. The herbaria examined were as follows:—Kew, British Museum (including Herb. Batters), Trinity College, Dublin (including Herb. Harvey), National Museum, Dublin; Birmingham University (Herb. Holmes), and Cambridge University; Edinburgh University (including Herb. Greville).

Phoeococcus adnatus West, *comb. nov.*

(*Gloeocystis adnata* Näg., Batters Cat., p. 9).

Owing to the difficulty in ascertaining the correct group to which it belonged, this alga caused considerable trouble, and was ultimately determined by Professor G. S. West. The plant was imperfectly described by Cooke and Rabenhorst under the name of *Gloeocystis adnata* Näg., and was listed thus by Batters (l.c.). It is recorded from four localities in England; and was added to the Irish flora during the Lambay Survey. In Clew Bay it is common, forming a definite zone of dull-yellow colour on the vertical peat-banks (p. 82). Professor West informs me that the species certainly belongs to the Phoeophyceae, and should be removed from Gloeocystis to Phoeococcus; also that he hopes to publish shortly an account of the genus, and will include observations on the minute structure of the present species.

Phoeostroma pustulatum Kuck.

The alga here referred to is the plant not uncommon on the tips of *Laminaria saccharina* var. *Phyllitis*, and which was identified as *P. pustulatum* by Batters (Journ. Bot., xxxiii, p. 275). It appears to differ slightly from Kuckuck's plant; and further investigation may show that it should be separated as a distinct species.

Litosiphon pusillus Harv.

Abundant on Chorda, Zostera, and not uncommon on other algae. Occasionally it is found on rock amongst such species as *Rhodochorton floridulum*.

Stictyosiphon adriaticus Kütz.

A few specimens of this species, which is new to British flora, were dredged in Clew Bay (in 3 fathoms) during May, 1911. They were noted as unfamiliar on dredging, and were ultimately referred to *Kjellmania sorifera* Reinke. Dr. Kuckuck, to whom a fragment was sent, confirmed the

identification; but tells me that Reinke's plant is synonymous with *Stictyosiphon adriaticus*. The branches in the latter alga, though usually regarded as opposite, are frequently alternate. The distribution of *S. adriaticus* is therefore much wider than was formerly thought, the plant being known not only from the Mediterranean, but from Kiel (Reinke), Cherbourg (Kuckuck, 1904, *in litt.*), and Clew Bay (1911).

Dichosporangium Chordariae Wollny.

(Hedwigia, xxv, 1886, pp. 127–130, tab. I, figs. 1–5, tab. ii, fig. 3.)

Though not previously detected in the British Isles, this minute endophyte is probably frequent in the old fronds of *Chordaria flagelliformis*, as it is in Heligoland. The Clare Island specimens were found in October, 1910, in fronds that were also infested with Bulbocoleon. The plant is not related to the original species of Dichosporangium (i.e. *D. repens* = *Myriotrichia repens* Kuck.); and there appears to be no reason why it should not be placed in Streblonema.

Sphacelaria britannica Sauv.

Professor Sauvageau, who kindly looked over the material of Sphacelaria, confirms the determination of this species, which is not uncommon on boulders in caves and in similar shady spots. The plant was added to the list of Irish algae by Batters, who found it at Lambay.

S. cirrhosa Ag.

Exceedingly common in our area, extending from the shallow-littoral region, through the littoral, and up to the highest rock-pools. It is usually epiphytic; but on semi-sheltered shores it forms an element in the sand-association of the *Rhodochorton floridulum*. In this condition it has often been mistaken in the past for *S. radicans*.

S. plumula Zan.

New to Ireland. A few specimens of this were dredged in 4 to 5 fathoms in Clew Bay and at Roundstone.

MYRIONEMACEAE.

The Myrionemaceae, as presented in our algological works, are in great confusion, but it is hoped that the monograph, shortly to be published, will bring about a measure of order. In the present report some of the results are forestalled, alterations in nomenclature being made when necessary, and an explanation given.

Myrionema saxicolum Kuck.

Some very beautiful specimens of this rare plant were found on limpet-shells on Clare Island in October, 1910. The sporangia and filaments were slightly larger than in the Heligoland material, but Dr. Kuckuck tells me it is undoubtedly the same species.

M. reptans Fosl.

(= *Ectocarpus reptans* Crouan; *Ascocyclus reptans* Reinke; *Phycocelis reptans* Kjellm.; *Chilionema reptans* Sauv.; *Hecatonema reptans* Sauv.; *Hecatonema fucicola*, Kylin).

Though no one has thrown more light on the Myrionemaceae than Professor Sauvageau, a few alterations with regard to his "Mémoire" have been found necessary. The present plant proves to be a Myrionema, and not a Chilionema; hence Foslie's name is restored. It is frequent in the south of England on Fucus *spp.*, but is apparently rare in Co. Mayo, having been searched for on many occasions, but found once only.

Ulonema rhizophorum Fosl.

It is most probable that Ulonema is merely a form of *M. strangulans* occurring on Dumontia, but some curious stages occasionally found make one hesitate to reduce it till the point has been more thoroughly investigated.

Hecatonema reptans Kylin (= *Ectocarpus reptans* Kjellm., non Crouan); *Streblonema reptans* De Toni).

The full synonymy of this species and *M. reptans* will be given in the Monograph. Suffice it to say here that I have examined Kjellman's type, and there is no doubt that it should be placed in Hecatonema. It is not uncommon in our district on *Cladophora sericea* and *C. rupestris*.

H. speciosum Cotton, *comb. nov.* (= *Myrionema speciosum* Börg.; *Hecatonema diffusum* Kylin).

The type-specimens of both these plants have been examined; and it is quite clear that *H. diffusum* Kylin is an early stage of Börgesen's *M. speciosum*. Hecatonema is, however, the most suitable genus. The plant is common in the British Isles, especially in spring, and was noted frequently in Clare Island on a variety of plants during both the April trips.

Microspongium globosum Reinke (= *Myrionema globosum* Fosl.; *Hecatonema globosum* Batters).

A difficult species to place; but when well grown it is evident that it is most suitably located in the genus Microspongium.

Ascocyclus foecundus Cotton, *comb. nov.* (= *Phycocelis foecunda* Strömf.; *A. sphaerophorus* Sauv.; *A. islandicus* Jons.).

Phycocelis foecunda has long baffled algologists. The type-specimen shows that it is an Ascocyclus, and identical with the plant so well described by Sauvageau as *A. sphaerophorus.* The number of ascocysts varies greatly in different specimens; but, as Strömfelt's name suggests, the sporangia are very numerous. Common on *Rhodymenia palmata.*

A. Saccharinae *sp. nov.*[1] (Plate X, figs. 4–9). *A. affinis* Cotton, '07, non Sved.

Plants forming dark brown circular spots 1–2 mm. diam., rarely 3–4 mm. Discoid thallus monostromatic or partly diplostromatic, 8–14 μ thick, not parenchymatous in centre; margin rather irregular; radiating filaments regular, 7–8 μ wide, by 1–2 times as long; chromatophores 4–6. Hairs numerous, basal; sheath well developed; adult cells 60–80 × 7–8 μ. Assimilating filaments few or absent, simple, cylindrical, 70–120 μ long, thin-walled; cells, 7–9 μ wide by 1–2 times as long. Ascocysts usually abundant, appearing very early on conspicuous wide margin of basal thallus, sessile, rarely stalked, thick-walled towards the base, typically clavate, 30–40 × 9–10 μ (on young plant sometimes globose, 15 × 20 × 10–14 μ). Unilocular sporangia unknown. Plurilocular sporangia very abundant, sessile, subsessile, or stalked, lanceolate or elliptic-oblong, rather small, 30–40 × 10 μ (on old plants 30–55 × 10–12 μ), 1–2 seriate; locali 4–6 μ high.

Habitat.—On *Laminaria saccharina.*

Fruiting Season.—Early spring till late autumn.

Distribution.—England (Swanage, Weymouth, Plymouth), Ireland (Clare Island).

This species, hitherto undescribed, is not uncommon on the south coast of England, and was found more than once on Clare Island. It occurs on young plants of *L. saccharina*, usually on the decaying tips of the fronds, where it forms dark-brown spots often intermixed with *Myrionema Corunnae.* It may, however, also occur on older fronds, in which case it is usually larger and often presents irregularities in microscopic structure.

The species most closely resembles *A. foecundus*, but it differs in the typically clavate ascocysts, although in young plants there is a tendency for these bodies to be subglobose. The spots formed are not so large, and the

[1] Maculae minutae, fuscae 1–2 (raro – 4) mm. diam. Discus unistratosus vel partim duostratosus, cellulis circa 12–16 × 6–8 μ, organa verticalia emittens (1) pilos numerosos, cellulis 60 × 80 × 7–8 μ, (2) fila assimilantia rara, breva, 7–9 μ lata, chromatophoris 4–6, minutis (3) sporangia plurilocularia numerosissima, sessilia vel breviter aut interdum longius pedicellata, elliptico-oblongata, 1–2 seriata, plerumque 30–40 × 10 μ.

plant is usually smaller in all its parts, especially in the basal thallus. It is, moreover, apparently to be found throughout the entire year, whereas *A. foecundus* has a much shorter season.

Ralfsia verrucosa Aresch.

Very common in many parts of our district. In shallow rock-pools on the upper part of the shore it forms large spreading sheets, which may completely cover the bottom. At a lower level it usually occurs on bare rock. Occasionally it was dredged from the shallow sub-littoral region.

Lithoderma faticens Aresch.

It is disappointing not to be able to record this plant (a species supposed to be widely distributed) with certainty for Ireland. Many Lithoderma-like plants were dredged in Clew Bay during summer, but these, as was expected, proved sterile. The special February trip provided a large number of specimens, some of which Dr. Kuckuck informs me can be doubtfully referred to Lithoderma. A few of the specimens obtained proved to be *Petroderma maculiforme*, which shows the risk of naming these plants from imperfect material.

Petroderma maculiforme Kuck.

A few specimens of this species (which is an addition to the British flora) were detected by Dr. Kuckuck amongst material dredged in Clew Bay during February. The plant resembles Lithoderma very closely in external appearance, but differs in the character of sporangia and other minor points.

Spermatochnus paradoxus Kütz.

Extremely abundant during July and August in the low-littoral of Achill Sound, Bellacragher Bay, and in the inner part of Clew Bay. It is epiphytic on many of the larger algae, and forms large tangled masses a yard or more square: in some of the channels of Achill Sound it is for a time completely dominant. In contrast to the present species *Stilophora rhizodes* is comparatively rare.

Mesogloia lanosa Crn.

Several plants of this rare alga were dredged near the lighthouse in Clew Bay during July, 1909. Its season is probably short, as it was not met with in any subsequent dredgings.

M. Griffithsiana Grev.

It was very satisfactory to find during the last days of the field-work the true *M. Griffithsiania*, since the specimens collected as this species in 1910

proved to be *Acrothrix mirabilis.* The plants are indistinguishable in the field, but with microscope the greater length of the peripheral filaments of the present plant are at once noticeable. Found floating near Achill Bridge and at Old Head, September, 1911.

Acrothrix mirabilis Kylin ('07, p. 93).

The specimens on microscopic examination were at first determined as *Mesogloia neglecta* Batters, with which they agree closely; butDr. Kuckuck informs me that they are identical with *A. mirabilis* Kylin, authentic material of which he has seen. Kylin's genus is based on a good character, and should be maintained; but if the two plants are synonymous, Batters' specific name should be employed, as he first detected and published the species (Journ. Bot., 1906, p. 2). A difficulty, however, presents itself, since the type of *M. neglecta* cannot be found in the Batters collection, and hence it is impossible to re-examine the points in which the Clew Bay material differs from the description. The discrepancies are trivial, but until we are certain that all the Mesogloiae of our shores are known, it seems wiser to let *M. neglecta* stand as a separate species, and not to link it with *A. mirabilis.*

The present plant bears a striking resemblance to *M. Griffithsiana*, and was assumed to be such on collecting. It is remarkable also that it was found in practically the same localities. Four plants in all were taken, two at Old Head and two at Achill Sound, July, 1910.

Leathesia crispa Harv.

A few specimens of *L. crispa* were collected during the first trip to Clare Island, but on no subsequent visit. In Journ. Bot., xlvi, p. 329, I have dealt with the synonymy and distribution of this species.

Fucus ceranoides L.

Invariably present where fresh-water streams occur on sheltered shores. (See pp. 83–88.)

F. spiralis L.

For remarks on the various forms assumed by this species see Fucaceae associations (pp. 23 and 51). One variety, however, requires special notice.

Var. **nanus** Stackh.—In many spots in Achill Sound, the sheltered form of var. *nanus* is found growing on vertical peat-banks at high-water mark. An unbroken series may at times be traced from the normal form. The plants measure 1–4 inches in length, are slightly (1–3 times) branched, and fruit freely at the proper season. In many of the receptacles examined the oogonia were unripe (May); but they appeared to be perfectly healthy

and not abortive. Occasionally specimens only 1 inch high were observed in fruit. In channels on the salt-marsh, the same plant occurs; but it is not so easily traceable to the normal *F. spiralis*, and is liable to be confused with *F. vesiculosus* var. *balticus*. It may be distinguished from that plant by its slightly wider, regularly bifurcating fronds, over which the cryptostomata are evenly distributed, and by its scattered habit. The fronds, moreover, are always fertile in summer; and their hermaphrodite conceptacles, with projecting paraphyses, are very marked.

F. lutarius Kütz., which has lately been described with great care by Sauvageau ('08), agrees with *F. spiralis* in possessing projecting paraphyses —a character which strongly suggests that it may be a reduced salt-marsh form of that species. In *F. lutarius* the conceptacles do not reach maturity, and the cryptostomata are marginal. A difference in form, together with an abundance of proliferating branches, is also noticeable; but this may be caused by its peculiar habitat (mud-banks). Proliferating specimens of *F. spiralis* var. *nanus* were frequently noted at Mulranny.

F. vesiculosus L.

See notes on *Fucaceae* association (pp. 23 and 51).

Var. **evesiculosus,** auct.—To var. *evesiculosus* auct. I refer the short non-vesicled form of *F. vesiculosus* which is abundant on Clare Island. The name is not altogether satisfactory; but till the British Fuci have been studied and described in greater detail, it appears the most suitable. The plant is abundant on, and characteristic of, exposed coasts in west Ireland, and also in south England. It is found likewise in the north of France, and is probably similar to that recorded by Sauvageau, under the above name, from north Spain ('97). A non-vesicled form of *F. vesiculosus* is described by Kylin for the exposed shores of west Sweden; but this variety, which he identifies as *compressus racemosus* Kjellm., is, judging from specimens kindly sent by him, a decidedly longer plant, of a much less sturdy habit.

Var. **balticus** J. Ag.—To this plant I have referred a dwarf Fucus tolerably abundant in Clew Bay, which is intermediate in size between *F. vesiculosus* var. *volubilis* (Huds.) and the very dwarf form described below as var. *muscoides*.

Great confusion exists with regard to the identity and nomenclature of these forms. The paper just published by Miss Baker ('12) clears up the uncertainty as to *F. volubilis* Huds. The many different forms assumed by this plant on the salt-marshes of Essex and Norfolk are described and illustrated; and I am indebted to Miss Baker for notes on the differences

between the Clew Bay and the East Anglian forms.[1] The specimens collected by Ray at Chichester and referred to by Hudson in his original description of *F. volubilis* (Fl. Angl., ii., 1778) are unknown; but there can be no doubt that Miss Baker is correct in referring the twisted plant described by her from Mersea Island and Blakeney to the *Fucus volubilis* of Goodenough and Woodward (1797), and of Turner ("Synopsis," 1802), who cite it from Frambridge Ferry and Wells, respectively—localities in the immediate neighbourhood of those she has investigated. Several Frambridge Ferry specimens exist, moreover, in the British Museum.

The smaller forms of this same plant, *F. volubilis* Hudson, have, on the other hand, often been referred to *F. vesiculosus* var. *balticus*. At Mersea Island, the dwarf forms are clearly linked by intermediates with the large twisted forms; but in Clew Bay it is otherwise, large plants being entirely absent. This being the case, I have thought it best to use the name *balticus*, which has already been employed for the Irish plant (Harvey, Johnson, Batters). At the same time the whole question of *F. balticus* requires investigation, as it is highly probable that more than one plant is included under that name. Svedelius ('01) shows that several dwarf Fuci occur in the Swedish Baltic, all of which he regards as varieties of *F. vesiculosus*. Before, therefore, the identity of our British plants can be settled, a careful examination of Agardh's plants and fresh gatherings if possible from the original locality are required. When the dwarf forms are not connected by intermediates with normal plants, there is great difficulty in ascertaining from which species they are derived. The distribution of the cryptostomata and the nature of the receptacles (if present) give the most hopeful clues, whilst a careful study of the ecology of the plants should aid the elucidation.

In Clew Bay var. *balticus* is usually found on the sides of narrow channels and creeks on flat peaty areas. The flat surface of these areas is commonly carpeted with var. *muscoides*, which grows densely crowded together, and is of a short bushy habit. At the margins where there is more space, the plants are longer and hang down. These marginal forms I refer to var. *balticus*. The fronds are narrow, 3–4 inches long, slightly or not at all twisted, and with cryptostomata for the most part marginal. They usually lie in the channels, and are thus in contrast to the upright-growing *muscoides*. The receptacles are small, seldom measuring more than 8×5 mm. and often less; they are dioecious, not markedly mucilaginous, with non-projecting paraphyses. Male receptacles are more frequent than female, but both are

[1] *F. volubilis* is, without question, a curious salt-marsh variety of *F. vesiculosus*; and when the systematic aspect of the British Fucaceae is next dealt with, it will have to be placed under that species.

rare; the oogonia appear to develop normally. The largest specimens of var. *balticus* noted were found on a little piece of wet marsh at Leenane (growing here on the flat as well as the vertical banks)—a fact which gives support to the view that soft ground and a large amount of moisture favour its development.

From the above it will be seen that the var. *balticus* of Clew Bay approaches very closely to the smallest forms of var. *volubilis* as described by Baker. At Mersea Island, however, receptacles are only found on the large plants; and the fronds are always much twisted. At Blakeney small plants fruit; but the receptacles are much larger than in the Irish specimens. In both these localities there is much mud; and the plants are free, or more or less imbedded. In Clew Bay the substratum consists of firm peat, and mud is absent.

Var. **muscoides,** var. nov.,[1] Plate VI, figs. 1 and 2.—Plants very short, fastigiately branched, densely crowded together, 5–6 cm. long. Branches cylindrical or compressed, 1–3 mm. wide, not twisted, with marginal cryptostomata. Receptacles very scarce, minute, 2–4 mm. diam., dioecious, paraphyses not projecting.

Habitat.—On firm peat, near extreme high-water mark.

With some reluctance I describe this Fucus as a new variety of *F. vesiculosus.* It approaches in form some of the Baltic filiform varieties of this species; but it differs in its peculiar habitat, and appears to be worthy of a special name. At the same time, though the evidence points to its being a variety of *F. vesiculosus,* the fact is not proved. By giving it *pro tem.* specific rank, complications in the future are less liable to occur; but this would necessitate the record of an additional new species in the list of novelties; whereas the plant is almost certainly merely a remarkable variety of an already known plant.

As previously stated, var. *muscoides* is connected with the Clew Bay form of var. *balticus,* of which it may be regarded as a very dwarf upright-growing form with filiform branches. The plants are packed very closely together, and form a dense mossy carpet, a feature which serves to distinguish the present variety from the filiform plants found in the Baltic. In a general way, the more closely packed the plants are, the smaller and more terete the fronds. The cryptostomata are conspicuous, and are, of necessity, marginal. The fastigiate branching is characteristic; but the branches are often very irregularly produced, and a crop of lateral proliferations is not infrequent.

[1] Frondes perpusillae, dense caespitosae, filiformae vel compressae, 5–6 cm. longae, 1–3 mm. latae, cryptostomatibus conspicuis, receptaculis rarissimis, minutis, ovoideis 2–4 mm. latis. Ad terram turfosam.

Receptacles are only known in the wider forms of the plant; they are unisexual, and apparently normal even in the smallest examples, ripe antheridia being noted in a receptacle only 2 × 2 mm.

The chief reasons for regarding var. *muscoides* as a form of *F vesiculosus*, are the unisexual conceptacles and the fact that it is clearly linked with var. *balticus*. It is true the specific identity of the latter is not quite certain; but the nature of its conceptacles precludes the possibility of its being a form of *F. spiralis*. The only other species with which var. *balticus* or var. *muscoides* could be connected is *F. ceranoides*, but as seen growing there is nothing suggestive of any link with the dwarf forms of that plant. A hybrid origin is possible, but scarcely probable, since var. *muscoides* occurs in profusion where *F. ceranoides* is completely absent. The principal objection to its being a variety of *F. vesiculosus* is its elevation on the shore (above *F. spiralis* and Pelvetia); but this, as pointed out in the ecological section, can be explained by the high water-content of the substratum.

Ascophyllum nodosum var. **Mackaii**, *comb. nov.*

From the historical standpoint this is one of the most interesting of the Irish seaweeds. It was first described from the Roundstone neighbourhood by Dawson Turner in 1808 ("Hist. Fuc.," Pl. 52), and is the earliest algal record from that well-known locality. It still occurs in profusion at Roundstone, being found in September, 1911, between the bridge and Ballinahinch. The plant cannot be certified from any other station in Ireland, and, with the exception of a few localities in W. Scotland, it is unknown elsewhere in the British Isles. Turner's remarks will, therefore, be of interest. He states:—

"For the present very interesting addition to the Catalogue of British Fuci we are indebted to Mr. James Townsend Mackay, to whom I am also obliged for the specimen here figured, and by whose name I have ventured to call it, as I find no description of it in any preceding author, in memory of the services that he has rendered to the botany of these islands, particularly by his discoveries in Ireland, the south-west districts of which, a part hitherto least known to naturalists, he has more than once, under the auspices of Dr. Scott, explored with extraordinary zeal and success. It was in one of these excursions, in the summer of 1805, that he met with the plant here figured, in a small creek at the upper end of Birtebui Bay, near the hill of Cahil, Cunnamara, but nowhere else. He informs me that he could not find a single specimen attached to the rocks, but it was all lying in loose balls upon the shore, and in such quantity as to entirely cover that part of the strand upon which it was thrown. With it was *F. nodosus*, which, though produced in great abundance upon rocks in the neighbourhood, seemed to exist at that place only in a similar manner, without being fixed to anything; both of

them being rolled up as if by the action of the waves, and in that state apparently continued to grow, and throwing out from the root, which was in the centre, a prodigious number of shoots in all directions, so as to give the thick and bushy appearance above described."

There can be no doubt that the present plant is merely a variety of *A. nodosum*, and is comparable to the peculiar detached forms of Fucus and Pelvetia which occur in other localities. (See Baker, '12, p. 283, and Oliver in Tansley, '11, p. 364.) Whether it originates in the manner described below for var. *scorpioides* I was unable to decide, but it appears highly probable. No intermediates between the detached form and the normal *A. nodosum* were found, but there was an evident link with var. *scorpioides*, and certain specimens were difficult to place. It is possible that the variety *Mackaii* arises only at certain seasons of the year, in which case a prolonged stay in the locality might be necessary in order to discover its origin.

The plants lie as loose densely branched tufts (up to a square yard in area) on the flat sandy mud between patches of rock, and when the tide returns they do not float, but become perfectly submerged. They appear to be seldom disturbed by wave-action. Air-bladders are numerous, but very small. A few tufts of *Polysiphonia fastigiata* were noted on some specimens, and also on var. *scorpioides*; but on the whole this epiphyte was absent. Many quiet land-locked areas exist in Achill Sound and Bellacragher Bay; but no examples of var. *Mackaii* were found, so that the Roundstone locality still remains the only positive station in Ireland for the plant.[1]

Although C. Agardh, as early as 1824, reduced *Fucus Mackaii* to a variety of *F. nodosus*, no one appears to have used the combination employed in the present report. Of late years there has been a tendency to follow Harvey, who regarded it as a distinct species. Holmes and Batters ('90) removed the plant to *Ascophyllum*; and their name, *A. Mackaii*, has since come into general use.

Var. **scorpioides** Hauck.—A few plants of this curious variety occurred in some muddy areas in the inner part of Roundstone Bay intermixed with var. *Mackaii*. They were more or less imbedded in the mud, and formed much smaller tufts than the latter. Reinke's explanation as to the origin of this form in the brackish waters of the Baltic Sea is as follows:—Isolated floating pieces of *A. nodosum* are washed in by currents from the more open Skagerack, and come to rest in the quiet creeks, where they put forth numerous small adventitious branches from the marginal cryptostomata of the thallus.

[1] Miss Knowles kindly informs me that specimens labelled *A. Mackaii*, collected in Larne and Belfast Loughs by D. Moore and J. Doran respectively, exist in the Dublin Museum. There is, however, some uncertainty as to both specimens, and though the districts have been fairly carefully worked, other observers have not noted the plant.

Through the growing out of such branches and the decay of the old fronds, colonies of young plants arise, which lack a discoid base, the latter being only produced by sporeling plants. The cylindrical form of the branches, the absence of air-bladders, and the complete sterility are induced, according to Reinke, by the low salt-content of the water; and he suggests that in less brackish localities such floating shoots of *A. nodosum* might give rise to *A. Mackaii.* (See Reinke, '89 and '92.)

Bifurcaria tuberculata Stackh.

It appears probable that the Roundstone neighbourhood is the northern limit in the British Isles for this species. It occurs on the coast of southern England, and is known in Ireland from the counties of Cork, Clare, and Galway, being abundant in the last-named at Dog's Bay. The pools of Clare Island, and the more open parts of Clew Bay, which are eminently suited for it, were carefully worked, yet not a single plant was observed.

Taonia atomaria J. Ag.

Dredged in Clew Bay, and washed ashore between Old Head and Leckanvy (1909, '10, '11). Frequent on the west coast and known as far north as Bundoran (Johnson); on the east coast it has been collected at Wicklow (Harvey).

Dictyopteris membranacea Batt. (= *Haliseris polypodioides* Ag.).

In contrast to Bifurcaria, an extension of distribution can be recorded for this southern species, Roundstone Bay having hitherto been its northern limit. Several specimens were dredged in Clew Bay by Mr. J. Adams, in August, 1909; but the plant was not seen again during the Survey. The specimens were large and strong; and the species is evidently quite at home as far north as Co. Mayo.

Erythrotrichia Bertholdii Batters.

Useful notes on the genus Erythrotrichia will be found in the paper by Batters, in which this species is described ('00, p. 374). The cylindrical filaments resemble those of *E. ciliaris* (Carm.) Batt. (non Thur.); but the plant is distinguished from that species by the absence of a basal disk.

Achill Sound, October, 1910, on old Zostera leaves.

E. investiens Born.

With slight hesitation I have referred a few odd filaments found at Old Head to this little-known species. The plants fit no other species of the

genus, and agree well with the description given by Zanardini. The filaments are bright rose in colour, rather thick (25–35 μ when sterile), and unbranched. There is no true basal disk; but a few horizontal cells are developed at the base, and the filaments occur in tufts, as shown in Zanardini's figure; lateral mamillose protuberances as described by him are also present. The specimens were found on Fucus (possibly attached to it), and agree well with Haucke and Richter's Exsicc., No. 655 (also on Fucus), which Batters suggests should be referred to *E. investiens* rather than *E. ciliaris* ('00, p. 374).

E. Welwitschii Batters.

This little-known and apparently very distinct species was found on limpet-shells encrusted with *Ralfsia verrucosa* near low-water mark, in October, 1910. The plant was originally described by Ruprecht as *Cruoria* (?) *Welwitschii*, and the same specimens were later referred to by J. Agardh as *Callithamnion lepadicola*. Batters ('02) removed the plant to its right genus, and made the new combination *Erythrotrichia Welwitschii*. A portion of the Lisbon gathering, collected by Welwitsch, exists at Kew, with which the Clare Island specimens agree well.

The species appears to be confined to the thalli of Ralfsiae, and is worthy of further study. Hitherto it has been recorded in the British Isles from Swanage only; but it is probably widely distributed. When wet it is inconspicuous; but when the limpet-shells are becoming nearly dry, it shows as a pale-pink felt.

Porphyra coccinea J. Ag.

Somewhat rare, and not previously recorded for Ireland. I noted it, however, in Co. Antrim in May, 1910; and a specimen collected by Miss Hutchins, from Bantry Bay, was found unnamed in the Kew collections.

P. umbilicalis Kütz.

Var. **umbilicalis** J. Ag.—The exposed Porphyra association, described on p. 28, consists entirely of this form.

Var. **laciniata** Thur.—Abundant throughout the area, being saxicolous or epiphytic, and occurring in the littoral and upper sub-littoral regions, and also in pools. It is the variety which forms the Porphyra association of sheltered localities.

Var. **linearis** Harv. (= *P. linearis* Grev. in Batters '02, p. 56; see Rosenvinge, '09, p. 61).—Unless the growth of the plants be watched from month to month, *P. linearis* Grev. would never be taken to be the same species as *P. umbilicalis* Kütz., especially as sporelings of the latter often

develop directly into broad frondose thalli. I fully agree, however, with Thuret and with Rosenvinge, who regard *P. linearis* as a young and winter form of *P. umbilicalis*. Observations made at Swanage, though not so extensive as those of Rosenvinge, led to that conclusion. On exposed coasts a very large proportion of the growth does not survive the spring. On the more sheltered shores of Clew Bay the plant doubtless develops, as it does at Swanage, into var. *laciniata*. A typical band of *P. linearis* was, however, only observed on the exposed parts of the Clare Island district.

CHANTRANSIA.

The species of this genus have been very erroneously named in the past; and it is highly satisfactory to have had the Survey material named by Dr. Rosenvinge. The following account is derived from his report:—

The epiphytic covering of Chantransia, which is conspicuous on many algae on Clare Island, appears to consist almost entirely of various varieties of *C. virgatula*. In sheltered localities (e.g. Clew Bay and Achill Sound) the same species is abundant; and *C. Thuretii* also is exceedingly common. It will be noted that in his work on the Danish species ('09) Rosenvinge places *C. secundata* and *C. luxurians* (which are given specific rank by Batters ('02)) as varieties of *C. virgatula*.

C. virgatula Thur.

Var. **luxurians** (J. Ag.) Rosenv.—Common and very conspicuous on Ceramium *spp.* in rock-pools at Kinnacorra and Portlea (Clare Island). On the mainland it was found on Gracilaria and Zostera dredged in shallow water. New to Ireland.

Var. **tetrica** Rosenv.—This variety, which is also new to Ireland, occurred on *Codium tomentosum* on Clare Island, and on Gracilaria at Old Head. It is distinguished by the presence of tetraspores on short opposite branches.

Var. **secundata** (Lyngb.) Rosenv.—Exceedingly abundant in all parts of the Survey area. On Clare Island it is the form which gives the pink colour to the growth of Porphyra on exposed rocks; and it is also found on the Rhodymenia and the *Laurencia pinnatifida* communities. The plant moreover covers Codium and Ceramium *spp.* in pools, and can endure a certain amount of fresh water, being found in the spray of the waterfall at Portlea. On the sheltered mainland it is common on many algae, both in the littoral and sub-littoral regions.

C. Thuretii (Born.) Kylin.

Though a new record for the British Isles, this species is common in Britain, and has doubtless been passed over as *C. Darvisii*. It is distinguished

from that plant by its more slender filaments, which are composed of very long cells, and by the occasional occurrence of sexual reproduction; but Rosenvinge remarks that he is not yet certain if the two are sufficiently distinct to be kept apart. *C. Thuretii* appears to be a species of quiet waters, being abundant in Clew Bay and Achill Sound, but only collected once on Clare Island and then in pools at Portlea. It is especially plentiful on Zostera, and is most conspicuous in late summer.

C. endozoica Darb.

A species of Alcyonidium washed ashore at Old Head was infected with a Chantransia apparently referable to this species. Dr. Rosenvinge writes that the parts are smaller, and that the fertile branches are less branched than in Darbishire's plant.

C. Alariae Jons.

Noted on several occasions on old fronds of Alaria which had been washed ashore. It extends at times over a very considerable area of the lamina.

Nemalion elminthoides (Velley) Batters.

Velley's figure (in Withering, "Bot. Arrang.," ed. 2, vol. iii, p. 255, pl. xvii, 1792) is unmistakable, and it is confirmed by his specimen in Herb. Kew; his name, therefore, is rightly adopted by Batters in favour of the more familiar *N. lubricum*, 1830. Velley's plants were collected at Portland Bill in (or previous to) 1792, and it was interesting to observe in July, 1911, that the plant still grows there in profusion.

A more difficult matter is the separation of this species from the well-known *N. multifidum*, described by Weber and Mohr in 1804. Ecological observations on Clare Island (p. 37) and elsewhere increase the suspicion that the two may be forms of one species; but the point requires detailed study. Interesting notes on the protonemoid stage of Nemalion and its biology are given by Chester (Bot. Gaz., xxi, p. 340) and by Rosenvinge ('09, p. 144).

Scinaia furcellata Bivona.

Found during the first year of the Survey only by J. Adams whilst dredging off Mulranny in about 7 fathoms (August, 1909). Distribution in Clew Bay probably local.

Gelidium aculeatum Batt. (= *G. corneum* var. *aculeatum* Grev.).

Having no personal knowledge of the value of characters in Gelidium, I follow Batters, who raises this plant to specific rank. It thus figures as an

addition to the Irish flora; but it is not unlikely that it has often been collected as a variety of *G. corneum*, though no record of the fact has been found.

Phyllophora Brodiaei J. Ag.

A boreal species. Not previously collected on the west coast, but known from the north of Ireland, Scotland, and northern England.

All the specimens labelled *P. Brodiaei* from the south of England in the Kew and British Museum herbaria are misnamed, being forms either of *P. palmettoides* or *P. rubens*, and there is little doubt that the same applies to other south coast records (cf. Batters, '02, p. 65).

Callymenia Larterae Holmes, Journ. Bot., '07, p. 86.

Several plants washed ashore on Clare Island in October, 1910, have been determined by Mr. Holmes as belonging to this species. The plant is characterized by the tapering base of the frond and its repeated proliferous branching. It has doubtless been overlooked in the past as a variety of *C. reniformis*.

Gracilaria confervoides var. **procerrima** (Turn.) Batt.

Amongst the many forms assumed by this species, this variety is one of the most distinct. It is doubtless the same as Harvey's variety *longissima*, of which he remarks: "Var. β is often 6 feet long, and quite simple, or with a few short lateral ramulae. Its peculiarities appear to result from its place of growth (Charlestown Harbour, Rhode Island), and intermediate forms connect it with the ordinary much-branched varieties." The Irish species confirm Harvey's opinion. They were dredged in Clew Bay, though some fine specimens 5 feet long were gathered by hand in the channels in Achill Sound. The amount of branching varies considerably; but the short subulate ramulae are almost constant. Probably common in Ireland, but no record found.

Nitophyllum uncinatum J. Ag.

This species is usually regarded as synonymous with *N. laceratum* var. *uncinatum*—an error which is due to the citation of a false synonym in the original description. The plant was described by J. Agardh in 1852. He states that it is not uncommon in the Mediterranean, and was characterized by the possession of acuminate fronds and of occasional uncinate branches; the sori were produced immediately behind the apex of special short branches. Unfortunately, Agardh quoted *N. laceratum* var. *uncinatum*, which is a

perfectly distinct plant, as a synonym. I have already pointed out this confusion (Kew Bull., 1909, p. 242); but the following notes, based on observations at Plymouth and in Clew Bay, deal with the subject in greater detail.

Taking first *N. laceratum*, we find that the variety *uncinatum* is directly connected with the ordinary forms of this common plant. *N. laceratum* is (with very rare exceptions) the only species found in rock-pools on open shores, and, though it exhibits great variety of form, there is usually no difficulty in the specific identity of the plant, the iridescent fronds of a pale brick-red or dull purplish-red colour being very characteristic. The uncinate form is not uncommon in pools, being found from early summer till autumn; it appears to be connected with a more or less vertical habit and contact with other algae, being usually found clinging to Corallina. The hooks may be few or numerous, and terminal or apparently lateral. The form of the frond is very variable, often lobed or bluntly pinnate, but never possessing the definitely acuminate branches of *N. uncinatum* (Plate X, fig. 11).

When *N. laceratum* occurs in the sub-littoral (1–7 fathoms), the form of the thallus differs somewhat, being longer and more or less regularly dichotomous; but the iridescence and characteristic dull colour are maintained. Uncinate specimens occasionally occur; but, except for increased length and greater regularity, they differ little from the rock-pool form. They are clearly connected with the normal plant. Tetrasporic sori are frequent; these are found, as is characteristic of the species, either in special proliferations or along the margins of the fronds.

N. uncinatum J. Ag. is, on the other hand, a plant confined to the sub-littoral region, and, though abundant in Clew Bay, is less generally distributed and apparently very local. It is found in late summer and autumn, being washed ashore in profusion in August, September, and October, in 1909, 1911, and 1910 respectively. It is distinguishable at once by its deep crimson or crimson-lake colour, and lack of iridescence. Most often it is attached to the stems of *Laminaria Cloustoni*; but it is found on various stiff algae such as Cystoseira, Gracilaria, etc., and by means of its hooked branches is entangled with loose weeds of all kinds. The acuminate character of the branches is always noticeable, but is most marked in young plants. The hooks are formed at the termination of the shoots, but not infrequently new branches grow out below the apex and take on the function of the main shoot so that the growth is sympodial (Plate X, fig. 10). The same course of development probably occurs in *N. laceratum* var. *uncinatum*; but if this be the case, the sympodial growth is more perfect, as the uncinate branches appear merely as small lateral hooks (Plate X, fig. 11). Cystocarps are unknown in *N. uncinatum*, but

tetrasporic sori are not infrequent, being produced in special short branches. The plant is very closely allied to *N. reptans* Crn.; and it is doubtful whether they are really distinct. I have not had the opportunity of examining a good series of the latter plant. For an account of the anatomy and physiology of algae with uncinate branches see Nordhausen ('99).

To sum up, the deep colour, lack of iridescence, and acuminate branches clearly mark this species, whilst its sub-littoral habit and obviously terminal hooks also aid in separating it from the uncinate form of *N. laceratum*. It is, however, allied to that species; and they have this feature in common, that they are both liable to be infected with the parasite Gonimophyllum.

Bonnemaisonia hamifera Hariot.

The discovery of *Bonnemaisonia hamifera* on the west of Ireland raises doubts as to whether this alga is not after all indigenous to Europe. Originally described from Japan, it has been usually regarded as a plant introduced to the south coast of England. It was collected by T. H. Buffham at Falmouth in 1895, and was subsequently found at Torquay and Shanklin (Isle of Wight). The Rev. H. Boyden tells me he has gathered it within the last few years at several widely separated localities in Cornwall (West Looe, Falmouth, and Penzance); and I have noted it for some five or six seasons in rock-pools at Weymouth. Chalon lists it from Cherbourg on the other side of the Channel, but it is not known elsewhere in Europe. It is locally frequent, but never abundant.

With regard to Clare Island it was with some astonishment that several fronds of the plant were emptied out of a tube of mixed algae collected at Kinnacorra in June, 1910. In October of the same year, and in April of the next, the locality was specially searched, but no further specimens were found. During August, 1911, however, one or more loose fronds were noted in Achill Sound, Roonah Point, and Clare Island, so that there is no doubt whatever that the species occurs in the district (see p. 165).

Laurencia hybrida Lenorm.

Although our three British species of Laurencia are perfectly distinct, considerable confusion exists with regard to the present species, which is usually found in herbaria, not only under the names of *L. hybrida* and *L. caespitosa*, but also on the same sheets as *L. pinnatifida* and *L. obtusa*. The plant is poorly described in most of our floras, and the confusion is increased by a difficulty as to names.

Nomenclature.—The name to be used is clearly *L. hybrida* (DC.) Lenorm. *Fucus hybridus* was described by De Candolle in 1805 ("Flore Française," ii.

p. 30).[1] It was transferred to Laurencia by Lenormand in 1830 (Duby, Bot. Gall., p. 951); and his name has been used by Kützing, J. Agardh, Le Jolis, and De Toni. Dawson Turner in 1808 named the plant *L. pinnatifida* var. *angusta*, giving a figure (Synopsis, Pl. 20, fig. *f*), and quoting *L. hybrida* as a doubtful synonym. Turner's name was adopted by Greville (who gives an excellent figure), Hooker (Brit. Flora), and Harvey (Manual Ed. I, p. 69, and Phyc. Brit., Pl. 55). The ideas of these writers as to the plant were not very exact, and they confused it with narrow forms of *L. pinnatifida*. A third name (and one which has been largely used in this country) is *L. caespitosa* Lamx., which dates from 1813. This, however, was a *nomen nudum*, and was moreover reduced to a synonym of *L. dasyphylla* by C. Agardh in 1822. But in 1840 it was taken up by Montagne (for a plant which he afterwards decided was a new species, *L. canariensis*, Pl. Crypt. Can., p. 154, and Kütz., Spec. Alg., p. 854), and was used by Harvey in the second edition of the Manual and also in Phyc. Brit. (Pl. 286). Our plant, therefore, figures in the latter work under two names; and Harvey himself admits doubts as to the species. J. Agardh, at a later date, examined some of Lamouroux's specimens, and redescribed what he considered the true *L. caespitosa* Lamx.; the identity of this plant is, however, doubtful. Though most of the older writers confused the species with narrow forms of *L. pinnatifida*, the plant they had in mind is perfectly clear, both from their descriptions and from specimens in herbaria. Some have used one name, some another. The name *hybrida* (1805) has priority over *caespitosa* (1813), which, as we have seen, was merely a *nomen nodum* till 1840. There is no question that the plant is distinct from *L. pinnatifida*.

Description and Habitat.—*L. hybrida* is abundant on the British shores and forms part of the Gigartina-Laurencia association of exposed coasts, but it is also frequent in rock-pools. It may always be distinguished from *L. pinnatifida* by the constantly cylindrical fronds and its pyramidal outline. The small size, greenish colour, and caespitose habit are also noteworthy, whilst its marked winter growth and absence in summer are quite characteristic. Small sporelings 2–3 mm. high are discernible in September; these develop during autumn and winter, and fruit in early spring. By May the plant begins to disappear, and is not seen again till September or October. When growing on bare rocks which are left dry by the tide, the plant is very compact, and seldom more than 1–2 inches high; but in shallow pools fully exposed to the light, it is more lax, and may attain a height of 4–5 inches. In autumn and winter *L. hybrida* is a dark greenish purple; but with the advance of spring the purple hue

[1] In some copies of this work the date is erroneously stated to be 1815.

disappears, and the plant assumes a green colour, pale when growing in sunny pools, but darker when on bare rocks or under the shade of other plants. It should be noted that *L. pinnatifida* also reaches its maximum development in spring; but it is present more or less throughout the summer, and appears to possess a persistent base (see p. 35).

L. hybrida has been also confused with *L. obtusa* with which it agrees in possessing cylindrical fronds. The colour and habit of the two are, however, very distinct. *L. obtusa* is a sub-littoral plant of dark red colour which becomes yellow with sunlight. It is also found in pools and shallow water, especially in winter and spring, and is almost always epiphytic. There is further an important morphological distinction to be noted in the structure of the antheridial conceptacles. The conceptacles of *L. hybrida* will be found to resemble those of *L. pinnatifida*, and to be quite distinct from *L. obtusa* (see Falkenberg, '01, pp. 242 and 249).

The distribution of the present species is more restricted than that of the other two. It is common in England, Scotland, and Ireland, and is found on the north and west coasts of France; but I have not seen undoubted specimens from other countries. The records from the Mediterranean, Ceylon, Japan, and the West Indies require verification. The antheridial character referred to above will possibly aid in the identification of this species, since in Laurencia exact similarity of form cannot be insisted upon when climatic conditions are different.

Polysiphonia macrocarpa Harv.

First described by Harvey in Mackay's "Flora Hibernica," part ii, p. 206. It was wrongly united in "Phyc. Brit." with *P. pulvinata*, but is rightly presented in Batters ('02). Amongst British species it is very distinct; but Bornet suggested that it might be a form of the Mediterranean *P. sertularioides*, though in his "Algues Schousboe" he preferred to keep them apart. *P. macrocarpa* usually grows in shallow crevices near low-water on exposed rocks, being not uncommon on Clare Island, and the only species of the genus noticed on The Bills.

P. fastigiata Grev.

Though usually confined to *Ascophyllum nodosum*, it is interesting to note that in exposed localities (where that plant is absent) *P. fastigiata* is frequently found on *Fucus spiralis*. In a general way *F. spiralis* on exposed rocks on Clare Island is free from the epiphyte; but at Alnahaskilla scores of infested plants may be counted. *P. fastigiata* was noted on the same host at other spots on the island, and in one case it occurred on *F. vesiculosus*.

P. subulifera Harv.

This rather rare species is apparently frequent in the west of Ireland, being found abundantly in Clew Bay, Achill Sound, and also in Roundstone Bay. Harvey notes its frequency on the Lithothamnium banks at Roundstone; and in September, 1911, it was the dominant species. It was also dredged on similar ground in Clew Bay, and appears to be one of the Florideae which can withstand considerable insolation in shallow water.

Dasya arbuscula Ag.

The frequency with which this plant is met with in Ireland at once strikes the collector as a great contrast to the south of England, where, though found from Land's End to the Isle of Wight, it is always rare. Harvey (Phyc. Brit.) notes its abundance at Bantry Bay, and on Clare Island it may be regarded as one of the most frequent and constant of the miscellaneous collection of Redweeds that occur near low-water mark on moderately exposed rocky shores (e.g. Kinnacorra). At certain seasons also it is washed ashore in plenty (July, August ?).

Ptilothamnion lucifugum sp. nov.[1] (Plate IX).

Plants gregarious, minute, 1–1·5 cm. high. Fronds decumbent at the base, then erect, producing branches and pinnae irregularly. Branches 3-6 mm. long, irregularly beset with pinnae; cells, 35–50 μ wide, by 3–4 times as long. Pinnae short, 2–3 mm. long, opposite, but more often irregular, usually naked below, but bearing above regularly opposite forked pinnulae; cells 25–30 μ wide by $1\frac{1}{2}$–2 times as long. Pinnulae bifid through the production of a lateral branch on the under side of the lowermost cell, rarely simple, very rarely trifid; cells 15–20 μ wide by $1\frac{1}{2}$–2 times as long. Decumbent portion of the frond irregularly attached to the substratum by rhizoidal pinnae, which occasionally terminate in a discoid expansion. Tetraspores and cystocarps unknown. Antheridia borne on the terminal cells of the pinnulae.

Habitat.—Attached to rocks in shallow pools in a dark cave, Portlea, Clare Island, August, 1911.

Closely allied to *P. micropterum* (Mont.) Bornet, but distinguished by its irregular branching, larger size, and peculiar habitat.

The present species was found as a dense mossy covering on the bottom

[1] Frondes caespitosae, 1–1·5 cm. altae, ramis primariis repentibus secundariis erectis. Pinnae 2–3 mm. longae, pinnulis omnibus furcatis aut rare simplicibus. Articuli ramorum 3–4plo pinnarum 1–2plo diametro longiores. Sporangia et cystocarpia ignota. Antheridia in articulo terminali pinnularum evoluta. Hab. In spelunca.

Species P. microptero proxima sed frondibus majoribus irregularibus differt.

of a dark cave-pool during the last day spent on the island; owing to its minute size, it was difficult to secure, the plants on detachment being easily lost in the water. No tetrasporic or cystocarpic plants were obtained, but sufficient material was collected to show general characters. The plant is closely allied to *P. micropterum*, which was described by Montagne from the Canary Islands. Sauvageau also collected it on Cystoseira at Gúethary, and in recording the same, adopted a suggestion by Bornet, and removed the plant from Callithamnion to Ptilothamnion (Sauv., '07, p. 206). Monsieur Hariot kindly allowed me to examine the Canary Islands type from the Paris Museum; and it was found to consist of a smaller and much more compact plant, probably of epiphytic habit. The Gúethary specimens appear to have been mislaid. Reinsch's *C. pinastroides* (suggested as a synonym in De Toni, Syll. Alg., iv) is certainly distinct; but Hauck's *C. pluma* from Trieste (Beiträge, vii, 1878, p. 131) proves, on examination of the specimens kindly lent me by Madame Weber, to be *P. micropteron*. No other record exists. As *P. micropteron* is so very little known, it is within the bounds of possibility that the Irish plant is an extreme form of that alga; but taking all things into consideration, it appears wiser to regard it as a distinct species.

Spermothamnion Turneri var. **subverticillatum** *comb. nov.*

Callithamnion Turneri var. *subverticillatum*, Lenorm. MS., in Herb.
C. subverticillatum, Zanard. in Kütz. Tab. Phyc., xi, tab. 81?

The specimens referred to this variety agree precisely with plants so named by Lenormand in the Kew Herbarium. *C. subverticillatum* Zanard. is most probably the same plant, but apparently Zanardini's specimens were not kept, as the plant is not listed in De Toni's catalogue of his herbarium. The variety differs from the ordinary form in the elongated slender shoots, and in the sub-verticillate branching. In Clew Bay it was found on several occasions, but always in a floating condition. As seen thus it is very distinct, and would appear to be a good species, as Zanardini believed; but whether the characteristic habit is due merely to growth subsequent to, and resulting from, detachment was not ascertained. Until this can be determined, and the question of Zanardini's plant inquired into, it appears best to regard the alga as a variety.

Griffithsia corallina Ag.

Occurs in the greatest profusion during spring in Clew Bay and Achill Sound. It is largely epiphytic and is found in channels and in shallow water.

Beautiful specimens, perfectly spherical in form and sometimes as much as 20 cm. in diameter, may be seen floating in with the tide during May. No plants were noted in the rock-pools on Clare Island.

Bornetia secundiflora Thur.

Bornetia is one of the most interesting additions to the Irish flora. It is abundant in the Mediterranean (south France), and common in the Biarritz neighbourhood. It extends up the Atlantic coast as far north as Normandy and Brittany, and is found as a very rare plant on the shores of Devon and Cornwall. Two fine plants were collected in a deep pool on Clare Island, in July, 1909, and though neither bore mature fruit, there can be no doubt as to their identity. The pool was searched on each subsequent visit; but, with the exception of a small frond found in August, 1911, no further specimens were observed.

Callithamnion byssoides Arn.

The specimens referred to this species agree well with those from Devonshire collected by Mrs. Griffiths, and with the plant as generally understood in this country. In general habit it bears a very close resemblance to *C. corymbosa*, and even with a lens it is not easy to separate the two. The distinctive feature is the irregular pinnate branching, which connects it in the other direction with *C. roseum*. From the latter it is marked off by the very much more slender growth, and by the tetraspores being usually single on the pinnae. The form of the cystocarp is also different.

C. byssoides is common in Clew Bay and Achill Sound (as a spring and early summer plant), occurring as an epiphyte on various algae in the low-littoral and sub-littoral region. It is very closely allied to, if not identical with, *C. Furcellariae* of the Swedish botanists.

C. scopulorum Ag.

I follow Börgesen in regarding this plant as a distinct species, which differs from *C. polyspermum* in its dwarf size, absence of cortication, and saxicolous habit. It is abundant on Clare Island, on moderately exposed rocks, but, owing to its minute size, is not conspicuous.

C. arbuscula Lyngb.

An alga belonging to the boreal group, but abundant on Clare Island. It apparently occurs on all the Irish coasts, but is quite absent on the south of England (see pp. 164 and 169).

Callithamnion corymbosum Lyngb.

Very abundant in spring and early summer, and found probably throughout the whole year. It was plentiful in October, 1910, at Achill Sound; and numerous young plants were dredged in Clew Bay the following February.

C. granulatum Ag.

When Harvey dealt with *C. spongiosum* in "Phyc. Brit.," he suggested the possibility of its being united with *C. granulatum* Ag. In 1851, J. Agardh carried out this prediction, and his view has been generally accepted. There are, however, two very distinct forms. One, which occurs in the *C. arbuscula* association, is compact, densely branched, and turns a pale greenish-yellow in summer; and the other, which hangs from vertical rocks in company with *Plumaria elegans*, is larger, less compact, and does not occur in sunny places. The former agrees in habit with the Mediterranean *C. granulatum*; and the latter is undoubtedly Harvey's *C. spongiosum*. The matter requires careful investigation, as it appears possible that Harvey's plant may after all be a good and distinct species. Both forms occur in Clare Island, and no intermediates were seen.

Ptilota plumosa Ag.

This species, which is said to occur all round the Irish coasts, is perhaps the most noteworthy of the boreal algae that are found on the west of Ireland (see pp. 165 and 169).

Antithamnion crispum Thur. in Le Jolis' "Liste," p. 112.

(*A. Plumula* var. *crispum* J. Ag., Batters, Cat., p. 89.)

This plant is distinguished from *A. Plumula* by its short recurved pinnae and thorn-like pinnulae. It is widely distributed, and often occurs where *A. Plumula* is absent (i.e. in the Adriatic; see Krasser in Zahlbruckner, Krypt. Exsicc., No. 648). Batters follows Agardh, who regards it as a variety; but the views of Thuret, Krasser, and others appear warranted. The true *A. Plumula* was not found in Clew Bay, and the Bantry Bay species in Herb. Kew are also referable to *A. crispum*.

Ceramium Boergesenii Petersen.

Dr. H. Petersen, who is at present investigating this genus, kindly undertook to examine my material. To him is due the discovery of this, and the following addition to the flora of our islands. *C. Boergesenii* has doubtless been passed over as a form of *C. decurrens*, to which it is very closely allied.

It is chiefly distinguished by the corticating cells which grow upwards as well as downwards from the nodes. Frequent in our district, being found especially on the receptacles of Himanthalia on Clare Island.

Distribution.—Iceland, Faeröes.

C. atlanticum Petersen.

A pretty little species, described by Petersen, from Iceland and the Faeröes. On Clare Island a few specimens only were found. It apparently enjoys open conditions, being collected on exposed rocks and on The Bills

C. rubrum Ag.

Dr. Petersen distinguishes the following forms in my material of this perplexing species :—

(*a*) *prolifera-secundata*, forms *typica*, *secundata*, and *irregularis*.

(*b*) *pedicellata-virgata*, f. *irregularis*.

(*c*) *subtypica-modificata*, forms *vera* and *irregularis*.

Abundant in great variety of form in all parts of our area.

Gloiosiphonia capillaris Carm.

Found in several spots on the island during the first year of the Survey only (July, 1909). Not present in the same spots in June, 1910, nor August, 1911.

Schizymenia Dubyi J. Ag.

This is a distinctly southern plant, being known in England from Devon and Cornwall only. In Ireland it has been recorded from Belfast Lough, but not from the west or south. Several specimens were noted on Clare Island in May, 1911.

Cruoria adhaerens J. Ag.

The distinctive features of *C. adhaerens* are not well known ; but relying on the slides in the Batters collection in the British Museum, I have regarded it as being characterized by the possession of short filaments which adhere closely together. The individual cells also are short, but the tetraspores very large.

Cruoriella Dubyi Schm.

C. Dubyi is the dominant species of incrusting algae in the shallow waters of Clew Bay. It occurs abundantly on shells and stones at all seasons ; and, in the inner parts of the bay, is found occasionally on the stipes of *Laminaria*

Cloustoni; tetrasporic fruits were collected in February. The flabellate arrangement of the cells on the under-surface of the thallus (a feature which Schmitz makes characteristic of the genus) distinguishes it at once, in our area, from allied plants.

Harvey records *C. Dubyi* (sub *Peyssonnelia Dubyi*) as occurring in great profusion in Birturbuy Bay, Roundstone ("Phyc. Brit."); but, as pointed out below, this was an error, since the specimens preserved are those of Peyssonnelia. It is remarkable that in Clew Bay Cruoriella should be dominant, and at Roundstone Peyssonnelia.

Peyssonnelia *sp.*

The species of Peyssonnelia occurring in west Ireland must for the present remain undetermined. It was recorded by Harvey as *P. Dubyi* (now *Cruoriella Dubyi*); and he states that it is abundant in Birturbuy Bay. Batters ('96, p. 11) showed that Harvey's material consisted of a genuine Peyssonnelia (the T.C.D., Kew, and Linn. Soc. material was examined), and he referred the plant to *P. rubra* Grev., a species originally described from the Ionian islands, and, as generally understood, common in the Mediterranean. Though the genus is correct, the specific identity appeared questionable. From Greville's description, his species is a plant with free-growing lobes, i.e. with the habit of *P. squamaria*; whereas the Clew Bay plant has an attached encrusting thallus, such as is found in *P. Harveyana*. In order to settle the point it was necessary to examine the type in Greville's herbarium at Edinburgh; and through the kindness of Professor Bayley Balfour, it was sent to Kew on loan. The specimens fully confirmed Greville's description and figure, and there is no doubt that the Irish species must be kept distinct. Madame Weber van Bosse, who is engaged in unravelling the tropical species of the genus, informs me that the form of the rhizoids, to which much value has been attached, is an unreliable character. The species of this, and allied genera, have in the past been so poorly described, that it is impossible to be certain if any of them are identical with the present plant. On this account it appears advisable to wait till a monographic work is available. The alga is rare in Clew Bay, and fruits in winter.

Porphyrodiscus simulans Batters.

On account of its characteristic nemathecia, the genus Porphyrodiscus was founded by Batters for the reception of this plant (Journ. Bot., 1897, p. 439). He detected it at Berwick in 1889, and apparently it has not been found elsewhere. The Clew Bay specimens were obtained at Annagh Island, on stones in muddy ground near low-water mark.

Rhododermis polystromatica Batters, *in obs.*, Journ. Bot., 1896, p. 389 (*R. elegans* var. *polystromatica* Batters).

The variety *polystromatica* is so distinct from Crouan's *P. elegans* that it certainly ought to be regarded as a distinct species. Batters himself proposed the combination in 1896 (l.c.); but in 1902 he (probably inadvertently) used the older designation.

Choreonema Thureti Schmitz.

A minute species, which requires to be carefully searched for. It has been stated to be common in Ireland, and to occur on all three species of Corallina; but this is probably an error. On Clare Island it was found only on *C. squamata* (its usual host), although a large amount of *C. officinalis* was carefully examined with a lens. The plant is also known to occur on *C. rubens.*

MELOBESIEAE.

The material of this group, as noted above, was examined by Dr. M. Lemoine, who kindly furnished critical observations on the specimens, and also prepared a complete list of the species obtained, together with notes on their distribution. In view of the confusion existing, the general distribution of each species as supplied by her is published in the present report. It will be noted that the nomenclature differs slightly from that employed by Batters.

Attention should also be drawn to the account given by Johnson and Hensman ('99), where analyses of the Knockboy and Bantry Bay sand, together with other details of local interest, are given. Since that date much critical work has been done, and hence seven of the plants listed there as distinct species are in the present report regarded as synonyms or varieties.

Melobesia farinosa Lamx.

Abundant on Zostera in Clew Bay, and found at all seasons.

Distribution.—General.

M. zonalis Fosl.

This minute species was dredged in Clew Bay (3–5 fathoms) in February, May, and August, 1911, and is evidently frequent. It occurs on glass, porcelain, and shells. *M. zonalis* belongs to the subgenus Pliostroma, the species of which are characteristic by being polystromatic.

Distribution.—England, Scotland, Ireland, N. France (Brest), Mediterranean (Banyuls).

Lithophyllum (Dermatolithon) pustulatum Fosl.

Common on Clare Island, especially on Gigartina and *Phyllophora rubens* in rock-pools, and near low-water mark. It was also found on *Cladophora rupestris.*

Var. **Corallinae** Foslie (*Melobesia Corallinae* Crouan, Batt. Cat., p. 96).—Common on *Corallina officinalis* in rock-pools on exposed shores.

Var. **Laminariae** Foslie (*M. Laminariae* Crouan, Batt. Cat., p. 97).—Not uncommon on stipes of *Laminaria Cloustoni.*

Distribution.—British Isles (common), Faeröes, Iceland, Norway, Sweden, W. Baltic, Denmark, N. and W. France, Mediterranean, Adriatic, Morocco, Canaries, Greenland, Atlantic coast of N. America. (Mass., Florida, Bermuda, W. Indies), Pacific (California).

L. (Dermatolithon) hapalidioides Fosl.

Dredged in Clew Bay on several occasions, and probably not uncommon, though often overlooked. The sub-littoral form is smooth, and very different in appearance from the variety *confinis.*

Var. **confinis** Foslie.—On Patella shells near low-water mark, not uncommon.

"La structure est la même dans le type et la variété, et c'est pourquoi Foslie (1909, p. 128) a réuni les deux espèces *L.* (*D.*) *hapalidioides* et *D. confinis.* Comme il le fait remarquer, le *L. confinis* correspondrait à la forme *squamulosa* du *L. Lenormandi*; on peut supposer que la var. *type* vit à une certaine profondeur sur les coquilles et au contraire que la var. *confinis* vit dans la limite des marées. La différence d'aspect résulterait d'une différence dans les conditions de vie." (M. Lemoine.)

Distribution.—British Isles, Faeröes, S. Norway, N. and W. France, N. Spain, Algeria, S. France (last three localities var. *confinis* only).

L. incrustans Philippi.

L. incrustans is the common incrusting alga of pools and rocks on exposed shores; and, with the exception of *Lithothamnium Lenormandi,* which forms a belt above it, it is the only species normally occuring in the littoral region (see p. 41). In the shallow waters of Clew Bay, a very smooth form in addition to the ordinary is frequently found.

Var. **subdichotomum** Heydr.—To this curious variety must the *L. dentatum* of the west of Ireland be referred. The record is due to Foslie, who dredged specimens in Roundstone Bay in 1899. He first regarded them as forms of *L. fasciculatum,* but later referred them to *L. dentatum.* The latter is a native of the Adriatic; but though recorded from Naples and Tangier, its

position in Ireland was very isolated, as it is entirely absent from the French coasts.

Specimens dredged by me in Clew Bay agreed well with Foslie's material in the Dublin Museum, and Dr. Lemoine, to whom a fragment was sent, at first passed it as that species. She, however, subsequently wrote that it bore a striking resemblance to certain curious forms of *L. incrustans*, which had been described from Guéthary (Basses Pyrénées) by Heydrich, and further examination showed that the structure agreed with *L. incrustans* rather than with *L. dentatum*. As it was advisable to have the point finally settled, further material was sent, including a specimen gathered by Foslie at Roundstone. Madame Lemoine kindly examined the samples anatomically, and reported as follows:—

"Je crois que tous ces échantillons représentent des formes de *L. incrustans*, mais ce sont des formes anormales et curieuses. Ce sont des échantillons âgés qui se sont séparés de leur substratum, et qui ont pris ce développement bizarre. Je me suis rendu compte aussi que l'algue était âgée, parce que, dans certains échantillons, en particulier dans celui de Clew Bay, le tissu se désagrège après décalcification, et il est impossible d'obtenir des coupes dans la partie centrale.

"Je ne suis pas arrivée à observer l'hypothalle, il aurait fallu abîmer les échantillons; les lamelles libres ne sont constituées que par le périthalle. J'ai étudié les deux échantillons de Roundstone dans lesquels les dimensions des cellules sont comparables à celles des cellules de *L. incrustans*.

"Les échantillons de Roundstone appartiennent à une forme décrite par Heydrich f. *subdichotoma* ['99, p. 225]. Ils seraient plus jeunes que celui de Clew Bay, qui, usé et roulé par les vagues, est tout à fait caractéristique de la f. *subdichotoma*."

A comparison of Heydrich's figures in the paper referred to (Berichte d. d. bot. Ges. xvii, p. 221) shows that the Irish specimens agree in form with the Mediterranean. The plant is rare, but one or more knolls were collected on each occasion that the Clew Bay or Roundstone "coral-banks" were dredged.

Distribution.—*L. incrustans*:—British Isles (abundant), Faeröes, N. and W. France, N. Spain, S. France, Italy, Dalmatia, Algeria, Morocco (Tangier and Atlantic Coast), Canaries, S. Africa, Sandwich Islands.

Var. *subdichotomum*.—Ireland (Clew Bay, Roundstone Bay), France (Guéthary, Banyuls).

L. lichenoides Philippi.

Lemoine ('11, p. 128) states that the anatomical structure of this species is clearly that of Lithophyllum, and she therefore restores it to that genus.

In England it is only known from the south coast; but it has been found in all the provinces of Ireland except Ulster, and is very common in the Clare Island district. It is usually attached to *Corallina officinalis*, and occurs in pools and in the low-littoral region.

Var. **agariciformis** Foslie.—Batters, following Foslie, regards *M. agariciformis* Harv. as a variety of this species; and Madame Lemoine, to whom I sent for anatomical examination a fragment of a Roundstone specimen (probably collected by McCalla), writes that there is no doubt whatever that Foslie was correct. The variety is evidently exceedingly rare, as no trace of such a form was found by me on any of the Lithothamnium banks of Clew Bay or Roundstone.

Distribution.—A southern species. S. and W. Ireland, S. England, N. and W. France, N. Spain, Mediterranean, Morocco.

Var. *agariciformis*. Roundstone Bay.

L. fasciculatum Fosl.

This species is known only from the west of Ireland, and is thus one of the most interesting algae of the Irish flora. It is known locally as "Wild Coral," and is plentiful in Clew Bay, occurring in patches mixed with *Lithothamnium calcareum*. It is also common at Roundstone (see p. 70).

Foslie distinguished several forms of the present species ('09). The plant was accidentally omitted (or rather unintentionally united with another species) in Batters' Catalogue, as explained by me last year (Journ. Bot., p. 115).

Distribution.—Clew Bay! Roundstone! Fahy Bay! Schull and Ballinacourty (*teste* Johnson).

Lithothamnium calcareum Aresch.

The dominant species of the fruticulose Lithothamnium association of Clew Bay and Roundstone (see p. 69). It occurs in great diversity of form, but it seems clear that varieties *compressa* McCalla, *squamulosa* Fosl., *crassa* Lem., *subvalida* Fosl., and *subsimplex* Batters, as described and figured by Lemoine ('10), are the most common in the district. Reference should be made to that paper for details as to biology and ecology. Mannin Bay, where *L. calcareum* occurs abundantly, is worthy of further investigation, and should be compared with Roscoff and Concarneau, which have been investigated by French botanists.

Distribution.—British Isles, N. and W. France, Norway, Denmark, Portugal, Morocco, Algeria, Mediterranean (Naples, Adriatic).

Lithothamnium norvegicum Kjellm.

L. norvegicum is an addition to the published list of our flora. It has been, however, sent out recently by Holmes in his "Algae Britannicae Rariores" (No. 264); he obtained specimens from Arran (Scotland). The species resembles in form a small, much-branched specimen of *L. calcareum*; but the branches are more slender and the whole plant more compact. The structure also is distinct (see Lemoine, '11, p. 108). It has doubtless been mistaken for *L. calcareum* in the past, and is probably not uncommon on our shores. In Clew Bay it occurred sparsely scattered amongst other species.

Distribution.—Clew Bay, Roundstone, W. Scotland (Arran); Norway, Denmark, America (N. Atlantic coast).

L. laevigatum Fosl.

(*Phymatolithon laevigatum* Fosl., Batt. Cat., p. 98).

A sub-littoral species, but found occasionally in caves. It was dredged off The Bills in about 15 fathoms, and was found on limpets in a cave on Clare Island.

Distribution.—England (Berwick), Ireland (Gola Island, Larne), Faeröes, S. Norway, Denmark, Atlantic coast of N. America (Rhode Island, Maine, Newfoundland).

L. polymorphum Aresch.

(*Phymatolithon polymorphum* Fosl., Batt. Cat., p. 98).

Common on exposed coasts in our area, and forming a band below *L. incrustans*, as explained on p. 41. For taxonomy see Lemoine ('11), p. 63.

Distribution.—British Isles (common), Norway, Sweden, Denmark, Faeröes, Iceland, Heligoland, N., W. and S. France, Tangier, Mediterranean, Adriatic.

L. compactum Kjellm.

(*L. circumscriptum* Strömfelt; *Clathromorphum circumscriptum* Fosl., Batt. Cat., p. 97).

Foslie at first regarded *L. compactum* and *L. circumscriptum* as distinct, but subsequently referred them to the same species. Kjellman's name antedates Strömfelt's by three years, and must be adopted (see Lemoine, '11, p. 98). The plant was dredged twice, in 5 fathoms between the outer islands of Clew Bay, and in 7 fathoms off Mulranny. It is listed by Johnson and Hensman ('99), but no locality is given, and it has not been found in England or Scotland.

Distribution.—Ireland (Mayo), Faeröes, Iceland, Norway, Spitzbergen, Nova Zembla, Greenland, Atlantic coast of N. America (Maine, Newfoundland, Nova Scotia), and Pacific Coast (Alaska).

L. Lenormandi Fosl.

Common in our area, forming an irregular band on damp and shady rocks above *L. incrustans* (see p. 41). It is also very common on stones in pools.

Var. **sublaevis** Foslie.—A sub-littoral form. Not uncommon in Clew Bay in 3–5 fathoms, on shells, especially Pecten.

Var. **squamulosa** Foslie.—Frequent on the sides of dark caves.

Distribution.—British Isles (common), Iceland, Faeröes, Norway, Sweden, Baltic Sea, Denmark, Heligoland, N., W., S. France, Mediterranean, Adriatic, Morocco, Canary Islands, N. America (Atlantic Coast).

L. Sonderi Hauck.

Beautiful specimens belonging to form *sublaevigata* Foslie were dredged from the "Helga" in Killary Bay. They formed a complete crust on the shells of mussels which occurred abundantly in muddy places. Superficially *L. Sonderi* strongly resembles *L. Lenormandi*; but the structure is quite distinct, the filaments in the former separating easily from each other, whilst in the latter the tissue is very compact (Foslie, '05, p. 24, Lemoine, '11, pp. 84 and 97). *L. Sonderi* has not been recorded from England, but specimens have been dredged by me at Plymouth in 1905 (*teste* Foslie).

Distribution.—British Isles, Norway, Sweden, Denmark, Heligoland, France.

Epilithon membranaceum Heydr.

(*L. membranaceum* Fosl., and *L. corticiforme* Fosl., Batt. in Cat., p. 97).

It is satisfactory to find that authorities agree in regarding the two species above cited as synonymous—a view held by several British algologists, though Batters in 1902 kept them distinct. Dr. Lemoine did not deal with the plant in her treatise on the Melobesieae ('11), but, in response to a special inquiry, she wrote the following note:—"J'ai étudié avec soin dans les Herbiers les *E. corticiforme* and *E. membranaceum*, je crois, comme d'ailleurs c'était l'opinion de Foslie (1909, p. 75), qu'ils doivent être reunis. Il est probable qu'on a désigné sous le nom de *corticiforme* les thalles portant des conceptacles à sporanges, et sous le nom de *membranaceum* ceux portant les conceptacles à cystocarpes. L'aspect des deux sortes de conceptacles est très différent: les conceptacles à sporanges mûrs forment des sortes de petits cratères qui laissent voir en leur centre le substratum; ces cratères, très nets sur l'échantillon de Clew Bay fixé sur Rhodymenia, sont souvent confluents et leur contour est ovale. Au contraire les conceptacles à cystocarpes sont d'abord hemisphériques; plus tard le toit tombe et il peut rester un petit trou

à sa place, mais le trou est circulaire. Si on conservait l'indépendance des deux espèces, il faudrait admettre que dans chacune on ne connait qu'une seule sorte de conceptacles. Dans l'Herbier Bornet ces deux espèces sont séparées; j'ai cherché en vain des conceptacles à cystocarpes pour le *E. corticiforme*. D'ailleurs d'après les descriptions de Rosanoff et de de Toni il est impossible de les distinguer. Hauck les a réunis."

It is clear that the present species cannot be retained in Lithothamnium; and Dr. Lemoine believes that Heydrich, who first clearly pointed out its peculiarities, was justified in forming a special genus for its reception, and that it is advisable to adopt his name. The nomenclature is, however, somewhat complicated by the question of the validity of Kützing's genus Hapalidium. *E. membranaceum* is common in the Survey area, being found most often on *Rhodymenia palmata* and *Furcellaria fastigiata*. In autumn it is not infrequent on *Cladophora rupestris* in shallow pools near high-water line, to which it gives a very curious appearance. It is also found occasionally on other algae and on shells (Trochus).

Distribution.—British Isles (frequent), Norway, Sweden, N. and W. France, N. Spain, Mediterranean, Crimea, Morocco (Atlantic coast), Ceylon, California.

Corallina squamata Ellis.

This species is probably much more common in the warmer parts of the British Isles than is generally supposed. On the exposed coasts of Clare Island it is, as explained on p. 40, probably more abundant than *C. officinalis*. In the south of England also, I have noted it very frequently in similar localities.

3. Economic Species.

Kelp.

Kelp-burning forms an important feature in the yearly routine of the islanders, as it does also on the exposed coasts of the mainland. During the last weeks of June and in the beginning of July dense clouds of heavy oily smoke may be seen along the coast-line, and the preparation for this general burning provides employment for many months. In a leaflet issued by the Congested Districts Board[1] practical advice is given, including notes as to the relative value of the different seaweeds, and instructions as to the best methods of burning. Each species is figured, and also certain weeds which should be avoided.

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[1] "The Kelp Industry. Hints for Kelp-burners with regard to Seaweed." Congested Districts Board Leaflet. 1898.

The "rods" (stipes) of the various Laminariae employed are collected as they are cast ashore in autumn, winter, and spring, and placed on the stone walls till burning time. In February and March the weed is also cut by hand during the lowest tides. From April 1st until June the "tops" or "leaves" (laminae) are collected in addition to the rods; and these are mixed with the latter when burning. It is during April and May that *L. Cloustoni* sheds its fronds, hence the term "May Weed." The name "Red Wrack" is given on account of its red-brown colour after exposure to weather.

Of the weeds employed, the bulk of the rods consist of *L. Cloustoni*, together with a slightly smaller amount of *L. digitata*. *L. saccharina* and *Sacchorhiza bulbosa* are also used and are equally valuable; but they are not washed ashore in anything like the same quantity. A storm or ground swell provides the islanders with several days' work, the "rods" being picked out for kelp, and the tops used (except in April and May, when part is set aside for burning) on the fields as manure. The foliage of *L. saccharina* bleaches at once with rain, and is then of no value for kelp; *L. digitata* bleaches less readily; and *L. Cloustoni*, as noted above, turns reddish-brown. *Alaria esculenta* and *Halidrys siliquosa* are recommended in the Leaflet, and are used in small quantities with the "tops." Ascophyllum and Fucus *spp.* yield but a very small amount of iodine, and are usually rejected. One of the most important papers on the commercial value of algae is that by Stanford ('84), which, though somewhat out of date, has not been superseded.

Manure.

Seaweed is extensively employed as manure all round the coast. In many spots the drift-weed washed ashore is sufficient for requirements; but in others the weed is cut by hand from the rocks, whilst in a few localities it is actually cultivated.

A good dressing of seaweed is always applied to potato beds previous to planting; in some cases so soon before that the sets are practically placed over a layer of fresh weed. It is usually put on stubble after cutting oats, and applied again to the land in spring. A dressing is also spread on meadow land; and in May the reddish fronds of the "May Weed" (= *L. Cloustoni*), and the streaks of white due to patches of bleached *L. digitata* and *L. saccharina*, give striking colour-effects on the green fields.

The species employed vary according to the nature of the shore. On exposed rocky coasts Laminaria is washed up; and where obtainable in plenty as in Clare Island, other weeds are despised. Laminaria is industriously collected during winter and spring, and carted or carried by panniered ponies

to the fields; on the mainland it is at times carted seven or eight miles inland. In other localities, such as Old Head and Bartraw, the farmers are content with drift-weed of a miscellaneous description. The drift is more valuable at some seasons than others. At times it is composed almost entirely of semi-decayed red weeds cast up from the shallow water, and at others there is a certain amount of Laminaria, and occasionally Fucus.

Black Wrack (*Fucus vesiculosus* and *Ascophyllum nodosum*) is systematically collected during February and March, where Laminaria is scarce. In the rocky parts of Clew Bay, and in many localities on the open coast, it grows freely on the rocks, though for a really large amount a flat shore is essential. This is supplied in abundance in the inner part of the bay, and in Achill Sound. Where rocks are present Fucus grows naturally, but where, as is usually the case, the shore is composed of sand, the farmers set to work to obtain a growth of Wrack by artificial means. Stones about a foot square are disposed in rows a yard apart, with paths left between for carting. Sporelings speedily appear on the stones, and during the course of a year develop into good-sized plants. The following season the Wrack is cut. This operation, which takes place in February and March, was observed by the Survey party of Easter, 1910. The weed on cutting is built up in stacks about six feet high, and after being tightened up with ropes is towed ashore on the flood-tide, and bleached at high-water level. Here it is unpacked and carted to the fields.

The botanical features of the Fucus-farms are dealt with on p. 53. Owing to the symmetrical arrangement of the stones, the artificial plots are at once distinguishable from natural vegetation; but when the weed is in its second season and the plants inclined to overlap, the distinction might not strike the eye of a casual observer. Plate V, fig. 2, gives a view of the plots at Darby's Point; similar farms occur in other parts of Achill Sound, and in Clew Bay they were noted at Murrisk.

The "coral-sand" described on p. 71 should be referred to here, as it is used for manuring in Connemara. Johnson and Hensman ('99) give the analysis of a Bantry Bay sample, which shows that the sand consists of about 80 per cent. of carbonate of lime. To this fact its efficacy as a fertilizer is attributed, and it is doubtless specially useful on the peaty shores of W. Ireland.

Recent Literature.

The Composition of Seaweed and its use as Manure. Journ. Bd. Agr. London, xvii, pp. 458–467 (September, 1910), p. 832 (January, 1911). Also abridged as Leaflet No. 254.

Seaweed as Manure. Journ. Dept. Agr. and Tech. Inst. for Ireland, xii, pp. 84-87. (October, 1911.) Also as Leaflet No. 99.

Sewage Commission Reports. The manurial value of Ulva and the significance of its nitrogen-content are dealt with in the reports referred to on p. 108.

Food-stuffs.

Three algae are collected for edible purposes in the Survey-area; but they are taken as relishes rather than as articles of food. During times of scarcity, however, Dillisk and Sloke form a useful addition to the daily *menu*. In Clare Island the only alga which is regularly sold as a commercial article is Carrageen Moss.

Dillisk and Crannogh.—The Irish Dillisk or Scotch Dulse is the common *Rhodymenia palmata*, the fronds of which are chewed in a fresh state or after having been dried. Crannogh is the small form of the same species found as a dense short growth on rocks in exposed places (p. 32). The flavour is peculiar somewhat pungent, but not unpleasant. On Clare Island, Dillisk and Crannogh are esteemed more highly than Sloke, probably owing to their being less abundant. On Achill Island, on the other hand, Crannogh is said to be the most plentiful.

Sloke (Slouk, Sloukaun, or Sloukaum).—Sloke, the Laver of the English, is the short crumpled form of *Porphyra umbilicalis*, which grows abundantly on exposed rocks (p. 28). The large flat form is not usually employed, except at Mulranny, where it is said to be collected and sold to tourists. Sloke is gathered in spring, and either stewed at once, or boiled into a jelly, and set aside for future use. When required, this jelly or "laver bread" is re-cooked, and then fried with butter. Used on Clare Island and on many parts of the mainland.

Carrageen or Iceland Moss.—The true Carrageen is *Chondrus crispus*, but certain forms of the allied plant *Gigartina mamillosa* are often included with it. Both are common on rocky shores; but they do not occur in such masses as either Dillisk or Sloke. It is still exported from several districts in Ireland, and is sold in at least two localities in our area. On Clare Island it is collected and sold to Dublin, and from thence to Liverpool, where it is said to be chiefly used for fattening calves. On the small island of Inishbiggle, four miles north of Achill Bridge, Mr. J. Tydd Frere has successfully encouraged the collecting of the weed by the peasants. The "Moss" is mainly bought by a Dublin agent, but smaller quantities are also sold to private persons in England and the colonies. As observed at Inishbiggle the weed is left to bleach on the grass, after which it is dried and stowed away in sacks. For culinary purposes it is boiled down to a jelly, and then

added to milk, or used as a substitute for isinglass. Carrageen is still employed in some quarters as an antidote for lung-troubles.

The following notes, though referring to a county outside our area, are of interest. They were supplied by Mr. Thomas Crehan, of Miltown Malbay, Co. Clare (sometime the home of W. H. Harvey), who, as agent for a firm of English ship-merchants, has dealt for many years in the sale of seaweeds:—

Crannogh.—Collected at Miltown Malbay all the year round, and sold to Blackburn at 1*s.* per stone.

Carrageen.—Sold to London, Scotland, Germany, Russia, and America, fetching £8 10*s.* a ton, or 1$ a lb. in America. The narrow form is used for edible purposes, and the wide form chiefly for dressing linen, manilla ropes, and other articles.

Sloukaen.—Sold to England for making "laver bread" at 2*s.* a stone.

4. The Flora of The Bills.

Though not so interesting as the terrestrial flora, the marine vegetation of these rocky islets is worthy of a special note. Nine miles from the mainland, and surrounded on all sides by deep water, they are subjected to the severest exposure.

Two algal communities were conspicuous:—the Prasiola association, covering the bird-cliffs and ascending on the shady side to 50 feet or more above sea-level, and the Laminaria band, which encircles the islets at low-water mark. The littoral region is for the most part compressed into its minimum horizontal range, being in many places nearly vertical. Several of the more accessible spots were examined. Alaria is more abundant than *L. digitata*; and Gigartina forms on almost vertical surfaces a band above. On the eastern side patches of the Porphyra and of the *Callithamnion arbuscula* communities were noted on the less precipitous rocks; but except for these, other associations appeared to be absent. The full list of species noted is appended:—

Plectonema tenebrans (in Balanus).
Prasiola stipitata.
P. crispa *var.* marina.
Enteromorpha compressa.
E. micrococca.
Chaetomorpha aerea.
Rhizoclonium riparium.
Cladophora prolifera.
C. rupestris.
Scytosiphon lomentarius.
Alaria esculenta.
Laminaria digitata.
Porphyra umbilicalis.
Gigartina mamillosa.
Chylocladia clavellosa.
Polysiphonia macrocarpa.
Callithamnion arbuscula.
Ceramium acanthonotum.
C. atlanticum.
Lithophyllum incrustans.

IV.—THE CHARACTER OF THE FLORA.

1. Notes on the Novelties and Additions.

As already mentioned, the systematic list contains the names of 437 species and 36 varieties. The revised census, as recorded by Mr. Adams' private annotated copy, gives the total number of species for Ireland as 464; so that making allowances for 12–15 species which are now regarded as synonyms or varieties, the Survey list is within fifteen species of that for the whole of Ireland.[1] As a local list, it must therefore be regarded as very complete, though amongst microscopic and sub-littoral species additions doubtless could be made by careful and continuous searching.

The list of additions to Ireland, which consists of ninety-two species and eleven varieties, is given below. It will be noted that it includes eighteen species and four varieties (marked †) new to the British Isles, of which the following five are new to science:—*Calothrix endophytica*, *Codium mucronatum* var. *atlanticum*, var. nov., *Ascocyclus Saccharinae*, *Fucus vesiculosus* var. *muscoides* var. nov., *Ptilothamnion lucifugum*.

Aphanocapsa pallida.
Dermocarpa violacea.
Pleurocapsa amethystina.
Spirulina subsalsa *var.** oceania.
Oscillaria margaritifera.
O. Corallinae.
O. laete-virens.
O. sancta.
Phormidium fragile.
†P. persicinum.
†P. subuliferum.
Lyngbya Meneghiniana.
†L. confervoides.
L. semiplena.
L. lutea.
†Symploca dubia.
Plectonema Nostocorum.
P. Battersii.
P. norvegicum.
Microcoleus chthonoplastes.
M. tenerrimus.
Calothrix consociata.
†C. endophytica *sp. nov.*
C. parasitica.
C. aeruginea.
Brachytrichia Balani.
Microchaete grisea.
Codiolum gregarium.
C. Petrocelidis.
Protoderma marinum.
Ulvella fucicola.
Monostroma orbiculatum.
Capsosiphon aureolus.
Enteromorpha prolifera.

[1] Some further species would have had to be added if Batters' Catalogue had been exactly followed; but in the systematic section several reductions have been made.

* In this list signifies that the variety only is new to Ireland.

E. minima.
Ulothrix consociata.
†U. pseudoflacca.
†U. subflaccida.
Phoeophila dendroides.
†Rhizoclonium Kerneri *f.* endozoica.
Cladophora Neesiorum.
Ostreobium Queketti.
Vaucheria coronata.
†Codium mucronatum *var.* atlanticum *var. nov.*
†Stictyosiphon adriaticus.
Phyllitis zosterifolia.
Streblonema sphaericum.
Ectocarpus clandestinus.
E. microspongium.
E. Battersii.
E. Holmesii.
E. Mitchellae.
Myriotrichia densa.
M. repens.
†Dichosporangium Chordariae.
Myriactis stellata.
M. Haydeni.
Leptonema fasciculatum.
Sphacelaria plumula.
Myrionema Corunnae.
M. papillosum.
M. aecidioides.
M. saxicola.
M. reptans.
Hecatonema reptans.
H. speciosum.
Microspongium globosum.
Chilionema ocellatum.
Ascocyclus foecundus.
†A. Saccharinae *sp. nov.*
Lithoderma fatiscens?
†Petroderma maculans.
Mesogloia lanosa.
†Acrothrix gracilis.
Fucus vesic. *var.* †muscoides *var. nov.*
Erythrotrichia investiens.
E. Welwitschii.
Porphyra coccinea.
Colaconema Bonnemaisonii.
Chantr. virgat. *var.* *luxurians.
var. †tetrica.
†C. Thuretii.
Harveyella mirabilis.
Gelidium aculeatum.
Callymenia Larterae.
Gracilaria conferv. *var.* *procerrima.
Nitophyllum Bonnemaisoni *var.* *crassinervum.
Rhodymenia palm. *var.* *sarniensis.
Bonnemaisonia hamifera.
Dasya corymbifera.
Spermothamnion Turneri *var.* †subverticillatum.
†Ptilothamnion lucifugum *sp. nov.*
Bornetia secundiflora.
Seirospora hormocarpa.
†Ceramium Boergesenii.
†C. atlanticum.
Petrocelis Hennedyi.
Porphyrodiscus simulans.
Rhododermis polystromatica.
Lithophyllum crustans *var.* †subdichotomum.
Lithothamnium norvegicum
L. Lenormandi *var.* *sublaevis.
L. „ *var.* *squamulosa.

*In this list signifies that the variety only is new to Ireland.

(*a*) *Additions to the British Isles.*—With regard to these, the following nine are inconspicuous species which are probably to be found in England and Scotland if carefully searched for:—

Phormidium persicinum.	Ulothrix pseudoflacca.
P. subuliferum.	Dichosporangium Chordariae.
Lyngbya confervoides.	Petroderma maculans.
Symploca dubia.	Chantransia Thuretii.
Ulothrix subflaccida.	

Of the remainder:—

Calothrix endophytica sp. nov., is conspicuous on salt-marshes, and should be searched for in Britain.

Rhizoclonium Kerneri forma *endozoica* forms green masses in the sponge Halichondria, and probably occurs in England.

Codium mucronatum var. *atlanticum.*—This species is new to Europe. It does not occur in the south of England, but is recorded in the present report from south-west Scotland, Isle of Man, and the Orkney Islands, in addition to the north, west, and south-west of Ireland.

Stictyosiphon adriaticus.—Rare, and only obtained by dredging. It should be found in quiet bays on the south coast of England.

Acrothrix gracilis. — Probably very rare. Perhaps overlooked as *Mesogloia Griffithsiana.*

Fucus vesiculosus var. *muscoides*, var. nov.—This variety has never been noted in England. It is probably confined to peaty shores.

Spermothamnion Turneri var. *subverticillatum.*—I have not observed var. *subverticillatum* in England; but it doubtless occurs in quiet bays on the south coast, since it is known from France. In Clew Bay it is frequent throughout spring and summer.

Ptilothamnion lucifugum.—Caves are frequently explored by algologists; but this beautiful microscopic species has hitherto escaped detection. It is allied to *Ptilothamnion micropterum*, which is only known from the Canary Islands and Guéthary (Basses Pyrénées). Probably a southern species.

Ceramium Boergesenii.—Doubtless common in England, but passed over as *C. decurrens.*

C. atlanticum.—This pretty and fairly well-marked species probably occurs in England and Scotland. A few specimens only were found on Clare Island.

Lithophyllum incrustans, var. *subdichotomum.*—Identified correctly for the first time by Dr. Lemoine, in the present report. Only known in the

British Isles from Clew Bay and Roundstone. It is doubtless dependent upon a very special type of ground.

(*b*) *Additions to Ireland.*—On examining the additions to the Irish flora we find that a large proportion are minute or critical species which require careful search and microscopic examination. In earlier days the west coast list was well up to date, but in recent years, when algology in our islands has been at a low ebb, the Irish seaweeds have been neglected, and the numerous microscopic species discovered in other countries have not been searched for in Ireland. Johnson added many to the Phoeophyceae some twelve to fifteen years ago; and Adams more recently has recorded additions to various groups. Batters' Lambay list ('07) furnished twenty species new to the Irish flora.

In the present account the Myrionemaceae are specially well represented, owing doubtless to a knowledge of their appearance in the field, gained during four to five years monographic work on the group. With the exception of the exceedingly rare *Ascocyclus hispanicus*, all the British species were found during the Survey. Several require particularly close observation, and have only been recorded once or twice previously for our islands.

Amongst the more interesting plants new to Ireland, we may mention, in addition to those already alluded to:—

Cladophora prolifera.—A very distinct species collected on The Bills. In the British Isles, known previously from Weymouth only.

Monostroma orbiculatum.—A salt-marsh species found in beautiful condition on Annagh Island.

Capsosiphon aureolus.—Found at the mouths of fresh-water streams. Hitherto known only from Scotland, but probably overlooked.

Vaucheria coronata.—Forming zones and broad associations, of a deep green velvet appearance. Exceedingly abundant in Clew Bay.

Ectocarpus clandestinus.—Probably rather rare. Fine material gathered on Clare Island in October, 1910.

E. Holmesii.—Under the bridge at Achill Sound and in caves. Found on several occasions with both kinds of fruit and in beautiful condition.

E. microspongium.—Very inconspicuous, forming minute cushions on crusts of Ralfsia.

Mesogloia lanosa.—Dredged in Clew Bay in 1909. A most distinct species, but rare and little known.

Porphyra coccinea.—Probably short-lived. Known from four localities only in the British Isles.

Gelidium aculeatum.—Formerly regarded as a form of *G. corneum.*

Bonnemaisonia hamifera.—Usually considered to be an alien species from Japan (see p. 136).

Dasya corymbifera.—A sub-littoral species. Known in England from Dorset and the Channel Islands only.

Bornetia secundiflora.—One of the most interesting additions. Head-quarters in the Mediterranean (see p. 141).

Seirospora hormocarpa.—Rare, but easily mistaken for other species; hence perhaps overlooked.

Lithothamnium norvegicum.—Probably not uncommon in Ireland, but regarded in the past as a variety of *L. calcareum.*

2. The Character of the Flora.

The flora of Clare Island and Clew Bay resembles that of the south-west of England, and is thus of a distinctly southern type. A number of species occur which have not been found in Scotland, the east and south-east of England, or Wales, though it must be remembered that much of the shore of our east coast is unsuitable for a littoral flora, and that Wales has been very little explored. Many species in the list are known only from the south and west coasts of Ireland, but here again further exploration would probably show a wider range.

Notes as to Absentees.

Before attempting to analyse the flora, a few remarks may be made on the larger algae which were to be expected, but which were not met with during the Survey. Of species known to occur in several parts of Ireland, the following may have been overlooked, since they are rare or only occur sparsely :—

Asperococcus compressus.	Helminthocladia purpurea.
Arthrocladia villosa.	Gigartina acicularis.
Achinetospora pusilla.	Daysa ocellata.
Porphyra miniata.	Pleonosporium Borreri.

Bryopsis hypnoides is a more noticeable absentee, as when present it is usually plentiful. The same may be said of *Nitophyllum Gmelini* and *N. Hilliae,* both of which are known from counties Cork, Kerry, and Clare, and also from Belfast Lough. Clew Bay would appear very suitable for their growth, and as their season is a fairly long one, we must conclude that if present they are very rare. In Plymouth Sound they are found in abundance. *Naccaria Wiggii* also was not seen in any of the dredgings.

At the same time it should be remembered that several large and conspicuous species were found only once.

Of southern algae, *Callithamnion tetricum* may be safely stated to be absent. This coarse, shaggy species is known from Munster and Leinster, and from the southern counties of England.[1] Its habitat—steep sides of rocks—was carefully searched on each visit, but without success. There appears to be no record north of Bantry. *Halopithys pinastroides* is certainly absent,[2] and probably *Pterosiphonia complanata.* With regard to northern species, *Odonthalia dentata* and *Rhodomela lycopodioides*[3] are wanting. They are found in Ulster, but do not extend far down the west coast. *Monostroma fuscum* was searched for in vain, probably for the same reason; it is abundant in Belfast Lough, and many parts of Clew Bay offer similar ground.

Of very rare species, *Stenogramme interrupta,* a singular plant found in many parts of the world, and which occurs in the south of England, and at Cork and Portaferry (Co. Down), was not found in any of the Clew Bay dredgings. By some it is regarded as an alien on our shores. A special search was made amongst the Fuci, but nothing approaching the curious *Fucus anceps* Harv. and Ward, of Kilkee was seen. *Spyridia filamentosa* should also be mentioned. This is locally abundant on the south coast of England, and in Wales reaches as far north as Holyhead; yet in Ireland it is unknown. A single specimen was found amongst dried material brought home from Achill in July, 1909; but as the plant was never observed during the Survey, there can be little doubt that it was an English specimen which was taken over to Achill with the drying paper.

Analysis of the Flora.

An attempt was made, but without much success, to classify the Clare Island flora after the method adopted by Börgesen and Jónsson ('05). These authors recognize five groups, arctic, sub-arctic, boreal-arctic, cold-boreal, warm-boreal, and have with much care classified the arctic and northernmost Atlantic floras according to this scheme. But the Clare Island investigations will probably tend to modify the views held in some cases; and in assigning plants to groups such as these, the personal factor cannot be eliminated. A great many Irish species do not fall into any of the five divisions, owing to the fact that the flora contains elements which belong to more southern regions. These species it is by no means easy to classify, chiefly on account of the

[1] The Cromer record in Batters ('02), is probably incorrect.

[2] The Irish records of this plant require confirmation.

[3] Adams gives a Munster record for *R. lycopodioides*; but the case should be re-investigated.

scarcity of records. The fact that the Survey has added about 250 species to Connaught, and over 100 species and varieties to Ireland, shows how little we really know of the distribution of algae. The south-east of Ireland needs special attention; also south-west Wales, north Cornwall, and the Scilly Isles. Börgesen has pointed out how badly the Shetland algae are in need of re-investigation ('05, p. 787; see also '03); and the same applies with equal force to north-west Scotland. For Donegal and the coast-line generally between Achill and Portrush there is hardly a record; and yet it is along this coast that the southern species disappear and the northern forms, such as *Odonthalia dentata, Porphyra miniata,* and *Monostroma fuscum,* begin to show. With regard to France and Spain, although we have good French handbooks, additions to the flora may still be made; and were it not for Sauvageau's two valuable lists ('97), which are admittedly preliminary, we should have practically no reliable data for the north of Spain.

For the above reasons I have not attempted to classify the whole flora into definite phytogeographic groups. We may, however, recognize certain well-marked elements, and by means of these attempt to analyse it.

(a) *Southern Element.*—Of the species which have a markedly southern distribution, the following are among the most noticeable :—

Cladophora prolifera.	Bostrychia scorpioides.
Codium adhaerens.	Chondria tenuissima.
Mesogloia lanosa.	Polysiphonia subulifera.
M. Griffithsiana.	P. furcellata.
Petrospongium Berkeleyi.	Dasya corymbosa.
Cutleria multifida.	Spondylothamnion multifidum.
Bifurcaria tuberculata.	Halurus equisetifolius.
Cystoseira ericoides.	Monospora pedicellata.
C. granulata.	Bornetia secundiflora.
Taonia atomaria.	Callithamnion granulatum.
Dictyopteris membranacea.	C. tripinnatum.
Nemalion elminthoides.	Compsothamnion thuyoides.
Callymenia reniformis.	Schizymenia Dubyi.
Bonnemaisonia hamifera.	Corallina squamata.

We may mention also eight species which were not found during the Survey, but are known to occur in S.W. Ireland :—

Asperococcus compressus.	Nitophyllum Gmelini.
Helminthocladia purpurea.	Pterosiphonia complanata.
Gigartina acicularis.	Dasya ocellata.
Nitophyllum Hilliae.	Callithamnion tetricum.

Nearly all the above species are confined in England to the southern counties. Several have been found only in south Devon and south Cornwall; others reach as far as the Isle of Wight; whilst a small number extend through the Straits of Dover as far north as Norfolk. All are known to occur in Normandy or Brittany, and with few exceptions they have been recorded by Sauvageau from the Bay of Biscay and north Spain. Though their head-quarters are in a southerly direction, a few extend up the Irish Channel to Anglesea and the Isle of Man; and several have been noted in the Clyde area and in the Orkney Islands. The Clyde has been thoroughly worked (see Batters, '91); hence numerous outliers have been detected. The Orkney records are distinctly interesting, and tend to show that some of the southern forms in the west Irish flora extend northwards by way of the Hebrides. For this the Gulf Stream drift is doubtless responsible.

The plants listed above grow luxuriantly in Ireland, and are evidently at home in their surroundings. The much-indented coast supplies great variety of conditions; and the lack of intense insolation in summer permits the presence of a better littoral and shallow sub-littoral vegetation than in the south of England. Several of the species are only found sparingly, as in other parts of our islands; but others occur in great profusion—e.g., *Petrospongium Berkeleyi, Dasya arbuscula, Polysiphonia subulifera* (local), and *Corallina squamata*; whilst *Codium adhaerens, Cutleria multifida,* Bifurcaria (at Roundstone), *Cystoseira fibrosa,* Halurus, *Monospora pedicellata* are very frequent. The abundance of *Dasya arbuscula* at low-water mark on Clare Island is very remarkable (see Phyc. Brit., tab. 274).

(b) *Northern element.*—With regard to northern forms we find that there occur in our area a large number of the species which Börgesen and Jónsson place in their sub-arctic and boreal-arctic groups. Many of these have, however, a very wide distribution, being abundant in all parts of the British Isles and extending to France and even Spain. Of the most noticeable boreal species (selecting from well-known plants only) we may pick out seven for notice. The first four are annuals,[1] and occur chiefly in spring; the last two are found all the year round, and are important constituents of the flora.

Stictyosiphon tortilis.—Very common in Clew Bay during spring, also in Scotland. It occurs in Northumberland, Cheshire, and Carnarvon. Batters gives a Cornwall record; but if it occurs on the south English coast, it must be extremely rare.

Desmotrichum undulatum.—Common in Clew Bay. Not known from England, but recorded from several localities in Scotland. It is rather small,

[1] The distribution of many of the smaller and inconspicuous species is so imperfectly known that they are best omitted.

so may have been overlooked; but most of the southern records of this plant prove to be errors for *Punctaria tenuissima.* It is also known from the Faeröes, Kiel, and W. Sweden.

Phyllophora Brodiaei.—See note on p. 134. The plant is known from Nova Zemblya, Spitzbergen, E. Greenland, Iceland, Norway, Sweden, Baltic, Scotland, N. England, and N. Ireland, and may therefore claim to be a distinctly boreal species. In Clew Bay it is scarce, but several colonies were noted at Mulranny.

Lithothamnium norvegicum.—Scattered amongst *L. calcareum* in Clew Bay and at Roundstone. Known from Scotland, Norway, Denmark, and the N. Atlantic coast of N. America. It has not been observed in the Lithothamnium banks of the English or French coasts.

Lithothamnium compactum.—Madame Lemoine remarks that this is a distinctly boreal species. It is known from Nova Zemblya, Spitzbergen, Iceland, Norway, Greenland, and the N. Pacific coast of N. America.

Callithamnion arbuscula.—The presence of this boreal species on the Irish west coast gives the appearance of a distinct overlapping in the flora. In the colder waters of the North Sea it is not known south of Yorkshire;[1] and on the west coast of Great Britain it descends to Ayrshire and the Isle of Man. On Clare Island it is abundant, and forms a conspicuous belt, just as it does in Scotland, Norway, and the Faeröes. It is recorded by Adams for Munster and Leinster, and probably extends right round the Irish coast.

Ptilota plumosa.—Another anomaly on the west coast. Listed by Börgesen as a sub-arctic species and general in Iceland, Nova Zemblya, and Spitzbergen, *P. plumosa* descends as far as Yorkshire on our east coast, and North Wales and the Isle of Man on the west. In Clare Island it is plentiful on the stipes of *Laminaria Cloustoni,* and is washed ashore in company with such southern plants as Taonia and *Callymenia reniformis.* Adams lists it from Munster and the south of Ireland; but as the older writers often confused the plant with *Plumaria elegans,* it would be advisable to confirm its presence in the southern provinces. In the London herbaria, there are no specimens south of Renvyle (Co. Galway).

(c) *Other interesting species.*—The most noteworthy alga in the list is undoubtedly *Codium mucronatum* var. *atlanticum.* This had either to be regarded as a new and endemic species, or to be linked with the Australasian *C. mucronatum.* The agreement in microscopic structure with the latter was found to be so close, that it was impossible to do otherwise than regard it as a form of that species. Its position on the west coasts of the British Isles is, however, remarkably isolated, as it is not known elsewhere in Europe, nor indeed

[1] Batters gives an Isle of Wight record; but this is almost certainly an error for *C. granulatum,* a compact form of which is not uncommon in that locality.

in the North Atlantic. It is almost impossible to believe that *C. mucronatum* can have been introduced, as at least one herbarium specimen shows that it has existed in S.W. Ireland for 100 years. At the same time, the preference of the plant for well-lighted pools, and the fact that it apparently disappears in autumn, might be taken as an indication that it is a native of a warmer region. That it was introduced from the British Isles to Australia and New Zealand is out of the question. For the present the plant must remain a remarkable case amongst algae of discontinuous distribution. Its precise range in the British Isles should be ascertained. When this is known we will be in a better position to pronounce as to the status of the plant, and to discover if it is spreading on our shores. From S. Devon and S. Cornwall it is (or was, a few years since) certainly absent, but the same cannot be said of Wales, as that coast has not been carefully worked. It is abundant in the Isle of Man; but no records are known from the east and south of Ireland.

The best-known case of an alien alga in the British Isles is that of *Colpomenia sinuosa*, which has been kept under observation in France and England (Sauvageau, '07, Cotton, '08, '11). It is a conspicuous plant, and was first observed both in France and England (Scilly Isles) in 1905. By 1909 it had spread as far as Hampshire, and it occurs now in great profusion in many parts of Cornwall, Devon, and Dorset. Colpomenia is specially adapted for floating; hence rapid colonization is comparatively easy. It affords an example of a Mediterranean species adapting itself to the conditions of a colder sea, and becoming naturalized at once. *Codium mucronatum*, on the other hand, does not readily float, and is probably much less hardy.

Bonnemaisonia hamifera provides another problem. It is known in Europe from several places in the English Channel, and has always been regarded as of Japanese origin. By means of its hooked branches it clings tenaciously to floating weed, and is thus no doubt capable of being transported for a considerable distance. Its occurrence on Clare Island was most unexpected, and raises a doubt as to whether the plant after all is not indigenous to our islands (see p. 136). On the other hand, there is the noteworthy fact that it was not noted by McCalla nor by any other west-coast collector, and that until 1895 it was unknown in Europe. If an introduction, it can hardly have come direct to the west of Ireland; but as nothing is known as to its presence or absence in the southern provinces, it is useless speculating as to the method of transport or port of entry.

Questions such as those raised above make us feel our lack of knowledge, and emphasize the need of further study of our own flora. The vitality and floating power of detached seaweed are likewise in need of investigation. A

mere list of species found floating, either of their own accord, or entangled with débris, would be of interest, and could be easily compiled by those who spend much time in dredging, tow-netting, etc. The algal growths on the bottoms of both large and small vessels present, moreover, an almost unworked field.

3. Comparison with other Areas.

East Ireland.—A comparison of the floristic features of the east and west of Ireland does not reveal so great a contrast as was expected. No special account of the east-coast flora has been published, nor have I personally examined any part of the shore, except the extreme north. Adams ('08, annotated copy) lists most of the Clare Island austral species for Leinster, and a considerable number for Ulster also. There are, however, ten well-known and conspicuous algae which have not yet been recorded for the east coast, but most of these would probably be found in Leinster if carefully searched for. S.E. Leinster is similar, as to its flora, to Munster; and Ulster has a surprising number of southern species, Belfast and Larne Loughs being at one time famous for Nitophylla and other seaweeds which occur chiefly in the southern counties. At the same time, it would be advisable to confirm such records as Bifucaria, *Callithamnion tetricum*, and *Schizymenia Dubyi*. The real difference between the east and west coast lies doubtless in the proportion of southern vegetation present; plants which are common or frequent in Mayo and Galway being probably rare or very rare in Co. Dublin. The luxuriant growth displayed by such species as *Lomentaria clavellosa* and *Dasya arbuscula* is also a characteristic feature of the west-coast vegetation.

England and Scotland.—With regard to England, as already shown, the Clare Island flora resembles that of Devon and Cornwall, but in England the boreal element (represented by *Callithamnion arbuscula*, and *Ptilota plumosa*) is wanting, as are also several other northern species. *Codium mucronatum* is likewise entirely absent. Such plants as Acrothrix and *Stictyosiphon adriaticus*, known at present in the British Isles only from Ireland, will probably be found in England when our south-coast bays have been more thoroughly explored by dredging. On the other hand, a few well-known and conspicuous species, more or less frequent in Devon and Cornwall, have not been found in Ireland. The most noteworthy amongst these are *Punctaria crispata*, *Gracilaria compressa*, *Grateloupia filicina*, *G. dichotoma*, and *Spyridia filamentosa*, the last-named being locally abundant in Great Britain, and extending from Sussex to Anglesea. There are also other species, but these are of very rare occurrence. The east coast of England is comparatively poor; more than two-thirds of the species listed on p. 162 are entirely absent; the remainder have been reported

to occur more or less frequently as far north as Norfolk. When Yorkshire is reached, the four boreal species, Odonthalia, *Rhodomela lycopodioides, Ptilota plumosa*, and *Callithamnion arbuscula*, become noticeable and are abundant from this county northwards. The east of Scotland possesses a similar type of flora, and additional northern forms appear (e.g. Stictyosiphon, Euthora). The Orkney Islands, on the other hand, show a southern element, which is doubtless present also in the Hebrides. Details as to the flora of the Hebrides and the connexion with S.E. Scotland, N.W. and N.E. Ireland would be of great interest.

Faeröes.—The British and Faeröese floras have already been elaborately compared by Börgesen ('05, pp. 784–788); and the Clare Island investigations do not materially modify his statements. Börgesen naturally was most concerned with the flora of Scotland and the Shetlands; and in conclusion he states that "the Faeröese algal flora must be regarded as a rather poor selection of the algae of Scotland and the adjacent islands, as almost all the Faeröese algae are found on the coasts of Scotland; whereas Scotland, on the other hand, has a very great number of species which are wanting at the Faeröes. The greatest resemblance is between the Faeröese flora and that of the Shetland Islands; the Faeröes have a few, perhaps no more than six, specially northern species, which will probably not be found in the Shetland Islands." The six species referred to are *Alaria Pylaii, Rhodophyllis dichotoma, Halosaccion ramentaceum, Ptilota pectinata, Rhodochorton penicilliforme*, and *Lithothamnium laeve*. Of these the Rhodochorton has since been recorded as British (Batters, Journ. Bot., '06, p. 3); and a somewhat doubtful record of *L. laeve* exists for Ireland. The first four, however, could not easily be overlooked; and it is very unlikely that they extend as far south as the British Isles. With regard to Ireland, other species might be added to Börgesen's list, as several which he assumes may be found in the north of Scotland will hardly descend to Ulster; and *Fucus inflatus, Euthora cristata*, and *Antithamnion floccosum*, known on the east of Scotland or Shetland, have never been found in Ireland. The curious overlapping of north and south in the algal flora of the west of Ireland consists, as one would expect, in a continuous southern extension in the range of certain boreal species rather than in the presence of isolated patches.

France and Spain.—The flora of France and the Bay of Biscay is of special interest, and may be outlined here. The species found in Normandy and Brittany are practically the same as those of Devon and Cornwall, though doubtless in Brittany the southern element is present in greater quantity. South of the Loire the flora undergoes a change; and in the Biarritz and Guéthary neighbourhood it possesses a decidedly southern facies. Fucus and

Ascophyllum are practically absent from Biarritz, and such plants as *Spathoglossum Solierii* and *Liagora viscida* are of frequent occurrence. On the north coast of Spain these southern species cease to flourish; and a vegetation of the Brittany type re-appears. At Cape Ortegal the flora changes again; and, by the advent of such algae as *Phyllaria purpurascens* and *Laminaria pallida*, it receives a stamp which is characteristic of Cadiz and Morocco (see Sauvageau, '97). There appears to be no element in the Irish flora which is specially characteristic of the Spanish peninsula. Many species are common to both countries; but these for the most part extend right up the coast of France, and are also to be met with on both sides of the English Channel. The Biarritz neighbourhood is peculiar in possessing a flora of particularly austral type.

Neither is there any evidence of a S.W. France or Mediterranean element, such as is represented amongst flowering-plants by Dabeocia and *Erica mediterranea*. The two Mediterranean algae for which the west of Ireland was specially noted were both wrongly named; and a third less familiar species, with the same geographical distribution, has had to be struck off the list. The record of *Codium elongatum* (a native of the South of France and North Africa) was an error for *C. mucronatum*; *Lithophyllum dentatum* (a species not known outside the Mediterranean) must be replaced by *L. incrustans* var. *subdichotomum* (*teste* Lemoine, p. 146); and *Peyssonnelia rubra*, though still a puzzle, was certainly an erroneous determination. The last-named has been recorded from many warm-temperate and tropical regions, often incorrectly. It was originally described from the Ionian Islands, and in the British Isles was supposed to occur at Roundstone and Plymouth. The species of the genus are singularly difficult to differentiate; but whatever the Irish plant may be, it is clear from an examination of the type specimens that it is not *P. rubra*. On the other hand, *Bornetia secundiflora*, which is abundant in the Mediterranean, and found sparingly in Brittany, Devon, and Cornwall, and more frequently in west France, may be added as a rare plant to the west-coast list. The majority of the southern species listed for Clare Island appear to have their headquarters in S.W. England, W. France, and N. Spain, rather than in southern Europe.

4. Origin of the Flora.

The origin of the algal flora at present found in the Survey area is a subject as to which we have very little to guide us. The source of the Clare Island flora as distinct from the mainland presents, of course, no difficulty, whatever view be taken as to the date and manner of the formation of the island. But any theory as to the origin of the marine flora of the west of

Ireland must be highly speculative, since our knowledge of the rapidity with which algae extend their range is very meagre, and fossil evidence (with regard to our area) is absolutely wanting. For this reason the most important data are those furnished by the study of the general distribution of the species, and by a recognition, if possible, of the presence of any definite phytogeographic groups. Börgesen ('05, p. 805) has summarized the views propounded by Kjellmann and Reinke as to the origin of the North Atlantic algal flora, which, in a word, is said to consist of a mixture of old atlantic and arctic elements. The question of the survival of plant-life in Ireland during the Ice Age, as to which there is so much difference of opinion, I leave to others, and will confine my remarks to phytogeographic observations, and to features in the Clare Island flora which appear to be of interest. Such may be of service to those engaged in the study of the antecedents of the present Irish fauna and flora.

Although the flora contains a decidedly larger proportion of southern forms than corresponding areas in England and Wales, there appears to be no element, such as is found amongst Phanerogams, which is strikingly austral. The southern species extend, probably without exception, along the south Irish coast, and are found in Devon, Cornwall, and Brittany; many also occur in the Bay of Biscay and on the north coast of Spain. Their range being continuous is, therefore, not remarkable. No notably Spanish or Mediterranean species are found. A boreal element of a special character is, on the other hand, recognizable, the abundance of *Callithamnion arbuscula* and *Ptilota plumosa* being very striking in an area where the general facies is of a much more southern type. Neither of these species occurs in the south of England, nor have they been recorded south of Yorkshire and Anglesea. Their position on the Irish west coast is, however, not isolated, but is merely a continuous southern extension of their range. But, as a result, there is in the marine flora, as in the terrestrial, a distinct mingling of north and south. Other boreal algae might be mentioned; but these are not so abundant, nor has their distribution been so carefully ascertained.

The presence on the west coast of Ireland of a boreal element which is absent from the south of England, is a familiar problem to the Irish botanist. In the case of the algae cited above, the question of a land-connexion between England and Ireland need not be discussed, since the plants already occur in the northern part of Great Britain. It would appear, therefore, that the climatic or other conditions of the southern counties are unfavourable for the growth of these species. With regard to climatic factors, it is well known that extremes are more important than the mean; and from this we might conclude that, in the equable climate of Ireland, the maximum temperature

which the plants can endure is not reached during summer, but that in the south of England this point is exceeded. The meteorological office reports show, however, that though the atmospheric temperature in S.W. England exceeds in summer that of S.W. Ireland, the sea-temperature is practically the same.[1] The temperature factor then may explain the absence of the littoral *C. arbuscula*, but hardly that of the sub-littoral Ptilota. The physical nature of the coast has also to be considered. Both the algae mentioned require rocky ground. Ptilota grows on the stipes of *Laminaria Cloustoni* (a stout species demanding a very firm bottom); and *C. arbuscula* is found only on exposed rocks in the littoral region: from shores of sand, shingle, or soft rock they would therefore be absent. On the east of England, stretches of hard rock in the four counties immediately south of Yorkshire are very scarce; and it is most probable that both plants would extend much further south were such rocks available. For Wales and S.W. England, however, this difficulty does not exist.

Another theory that presents itself is the possibility that, owing to more recent geographical changes in the English coast-line, *C. arbuscula* and *P. plumosa* are still advancing in the Irish and North Seas, and that they have not yet reached their southern limit. The conditions (e.g., currents, nature of coast, etc.) may have been less favourable to their progress than in Ireland. This, however, is improbable, as the dispersal of marine algae by spores appears to be an easy and comparatively rapid process. Ptilota, moreover, is readily transported, being found washed ashore in abundance, and often in a bleached state. Such specimens (which are possibly of distant origin) frequently possess cystocarps containing presumably healthy spores. Currents do not appear to offer any resistance to the southern advance of algae in the Irish Channel.

From these considerations it is probable that the geographical theory does not meet the case, and that ecological factors are more likely to explain it. If this be so, the scarcity of hard rocks may have limited the range of these boreal species in the North Sea; and a high summer temperature may have prevented *Callithamnion arbuscula* from settling down on our south-west coast. Ptilota remains a puzzle. Numerous points present themselves which would be worthy of inquiry; but with its precise distribution in Wales and Ireland uncertain, these must be left for future consideration.

The only geographic types recognized worthy of discussion here are the

[1] The average sea-temperatures for the past five years for Seafield (Co. Clare) and Plymouth during the summer months are almost identical. But during 1911 the Plymouth average from July 15 to September 9 was distinctly higher. The more eastern counties (Kent, Sussex) possess a much higher sea-temperature in summer than Devon and Cornwall.

austral and southern elements dealt with above; but a further word may be said as to the comparison between the east and west coasts of Ireland. As far as can be seen from records, and from a study of herbarium material, the east-coast flora is characterized not so much by a poverty of species as by a smaller proportion of the austral element, and by a lack of the special luxuriance characteristic of the west. It appears useless at present to attempt to pronounce an opinion as to the origin of the species on either coast. The fact that *Colpomenia sinuosa* can suddenly appear in Brittany and Cornwall, and in the course of a few years be completely naturalized over a very large area on both sides of the English Channel, proves how quickly changes may take place, and how easily we may err in discussing the age and history of a flora.

There remain two isolated species to be noted. *Bonnemaisonia hamifera*, a fairly conspicuous and unmistakable alga, is elsewhere in Europe known only from a few stations on either side of the English Channel. It occurs in the North Pacific (Japan and California), and has usually been regarded as an alien in this country. The plant is dealt with on p. 136; but nothing can be stated as to origin in Clare Island, owing to our complete ignorance of its range in Ireland. *Codium mucronatum* var. *atlanticum* is even more noteworthy. So closely allied to the New Zealand form of the species as to be almost inseparable from it, and yet unknown in the northern hemisphere except in the British Isles, its distribution is certainly remarkable. As far as is known, it does not occur in England, but has existed in Scotland for at least seventy years, and in Ireland for upwards of a hundred. Its precise range has not yet been ascertained. Until each species of our flora is recognized, and until its range is accurately determined, plenty of work remains for the systematic algologist. Common species need not be despised. On Clare Island some of the most abundant and conspicuous algae have proved the most interesting; and yet, owing to lack of data concerning their distribution, we are hampered in drawing theoretical conclusions.

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DESCRIPTION OF PLATES.

Plate I.

Porphyra umbilicalis association on south shore of Clare Island in July (1910). The Porphyra belt at this spot takes the place of *Fucus spiralis*, and occurs between the bands of Pelvetia and *F. vesiculosus*, var. *evesiculosus*. It is thus somewhat higher than usual. The shore is exposed and rather steep.

Plate II.

Boulder-beach between Portlea and the lighthouse, showing broken character of zones and associations. The Pelvetia belt is practically absent, and the zones of *Fucus spiralis* and *F. vesiculosus* which follow are interrupted and discontinuous. In the foreground Himanthalia with the usual undergrowth of *Laurencia pinnatifida* is seen, and also the beginning of the *F. serratus* vegetation. Gigartina joins the Laurencia band in the lower levels, and *Rhodymenia palmata* hangs from the shady sides of boulders.

Plate III.

Shallow rock-pool on south shore, half-tide level. Showing more or less continuous covering of *Lithophyllum incrustans* with characteristic lip-like protuberances (centre). Several tufts of *Polysiphonia fruticulosa* occur, and in the upper left-hand corner *Corallina officinalis* and the more southern *C. squamata* are seen together. To the extreme right is *Polysiphonia Brodiaei* (upper corner). In pools of this kind small plants of *Codium mucronatum* var. *atlanticum* are frequent.

Plate IV.

"Coral beaches" in Mannin Bay, Co. Galway. The white sand of the beach is composed of finely broken fronds of *Lithothamnium calcareum*, which are washed ashore from the Lithothamnium association in the Bay. In some beaches a few rocks are present, but these are largely devoid of algae (fig. 2). The weed washed ashore in foreground is Zostera. Photographed at low-water by Dr. G. H. Pethybridge, October, 1911.

Plate V.

Fig. 1.—Lithothamnium sand from Mannin Bay. Medium-grained sand from the middle part of the beach (nat. size). At high-water mark the sand is very coarse, and contains shells and *Lithothamnium* knolls; at low-water it is extremely fine, and its origin is hardly discernible without a microscope.

FIG. 2.—"Fucus farm" in Achill Sound. Photograph of Blind Sound (near Darby's Point) at low-water, showing stones with growth of Fucus. The stones are set out (often in regular rows) by the cottagers, and become rapidly colonized by *Fucus vesiculosus*, which, at the end of the second season, is cut for use as manure.

PLATE VI.

Fucus vesiculosus var. *muscoides* var. nov.

FIG. 1.—Dried specimens of individual plants (slightly less than natural size). The specimens in the two upper rows are from the dense mossy growth seen in fig. 2; those from the lower are from the margins of such growth, where increased space and moisture allow of better development. In the lowermost specimen to the right two male receptacles are recognisable.

FIG 2.—Small piece cut out from var. *muscoides* sward in Achill Sound. The sward forms a narrow irregular zone in several parts of the Sound. It is more or less mixed with *Statice maritima*, *Glyceria maritima*, Salicornia *spp.*, etc., and in the month of May is particularly attractive, owing to the bright pink flowers of the first-named. Photo by Mr. G. Massee of tuft brought back to Kew (slightly reduced).

PLATE VII.

Codium mucronatum var. *atlanticum* var. nov., with a fragment of *C. tomentosum* (nat. size). The drawings are made from dried specimens; but the thick branches and robust habit of *C. mucronatum* are noticeable. In the living state the plants can readily be distinguished by this character; but in dried specimens it is necessary to examine the utricles.

PLATE VIII.

Utricles of *Codium mucronatum* and *C. tomentosum*.

1-2. *C. tomentosum*. Showing short utricles with the cell-wall thickened at the apex. (Clare Island, Oct., 1910.)

3. *C. mucronatum* var. *atlanticum* var. nov. Showing utricles double the length of those of *C. tomentosum*, and considerably wider; apex even or mucronate; not thickened as in *C. tomentosum*. (Giant's Causeway, May, 1910.)

4. *C. mucronatum* var. *atlanticum* var. nov. Note drumstick utricle specially frequent in old plants. (Clare Island, April, 1909.)

5. *C. mucronatum* var. *atlanticum* var. nov., with gametangia (♀). (Roonah Quay, June, 1910.)

6. *C. mucronatum* var. *Novae Zelandiae.* Note similarity of utricles to those of the Irish plant. (New Zealand, Herb. Kew.)
7. *C. mucronatum* var. *tasmanicum.* Apex of utricle very pointed. (Tasmania, Herb. Kew.)
8. *C. mucronatum* var. *californicum.* Mucro long, blunt; often apparently articulate. (California, Herb. Kew.)

PLATE IX.

Ptilothamnion lucifugum sp. nov.

1. Decumbent and upright fronds, showing irregularly produced branches and pinnae. (× c. 15.)
2. Part of a branch showing pinnae and forked pinnulae. The pinnae are occasionally opposite; but usually the opposite pinna remains practically undeveloped. (× 80.)
3. End of pinna. (× 140.)
4. Pinnulae with antheridia. (× 140.)

5-6. Part of decumbent branch showing rhizoidal pinnae, which occasionally terminate in a more or less discoid expansion. (× 140.)

PLATE X.

1–2. *Calothrix endophytica* sp. nov.

1. Portion of Enteromorpha frond showing Calothrix filaments within the cavity. (× 400.) 2. Cluster of short filaments, with the basal heterocysts (normal). (× 500.) 3. Longer filaments, with basal and intercalary heterocysts. (× 500.)

4-9. *Ascocyclus Saccharinae* sp. nov.

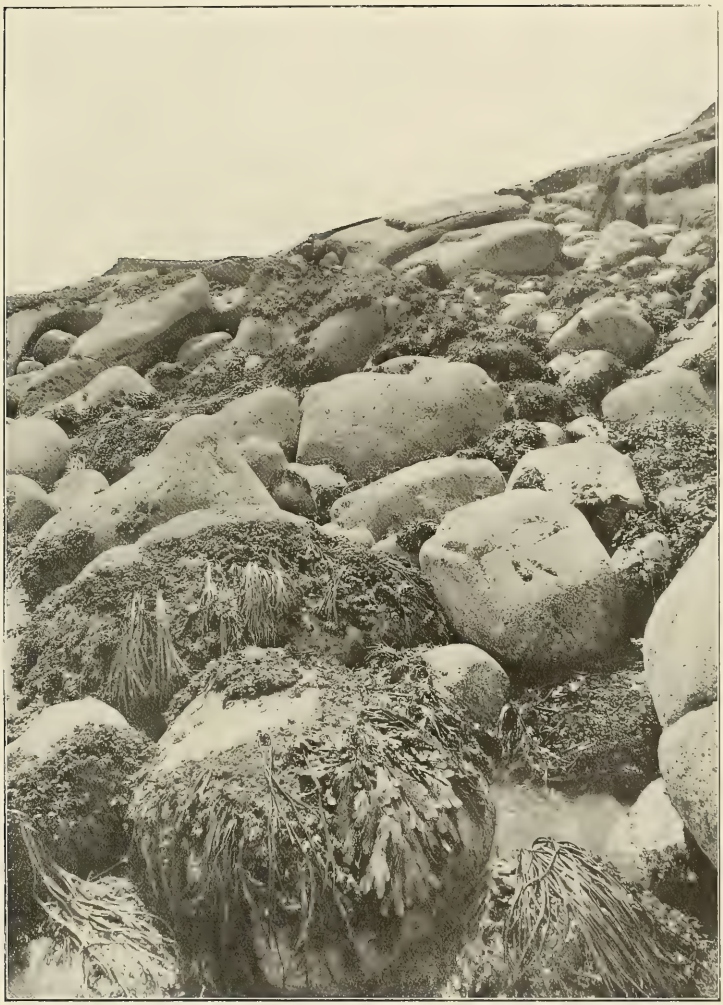
4. Discoid thallus, easily separable into filaments. 5. Assimilating filaments and young ascocysts. 6. Assimilating filaments and young sporangia. 7. Sporangia and hairs, with basal sheath. 8. Sporangia, and two empty ascocysts. 9. Two ascocysts with contracted contents. (× 400.)
10. *Nitophyllum uncinatum* J. Ag., showing irregular fronds and acuminate branches. (Dried specimen, nat. size.)
11. *N. laceratum* var. *uncinatum* Grev. Quite distinct from the last, being merely a variety with uncinate branches of the common *N. laceratum* (nat. size).

PLATE XI.

Map of the Clare Island District.

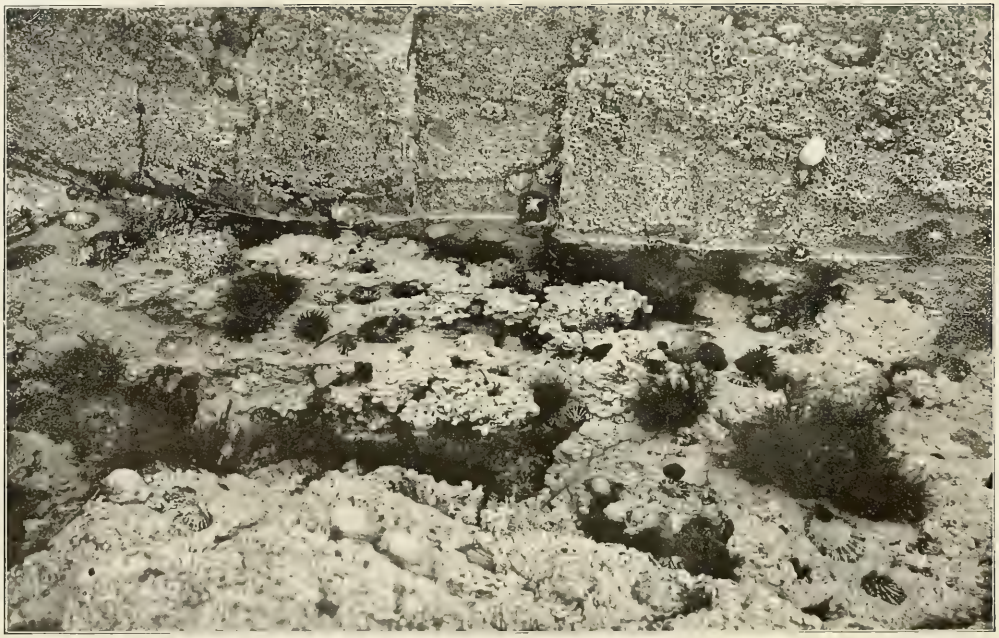
The Porphyra association of exposed shores, Clare Island. R. Welch, *photo.*

CLARE ISLAND SURVEY.—COTTON: MARINE ALGAE.



Boulder Beach at Portlea, showing discontinuous zonation. R. Welch, *photo.*

CLARE ISLAND SURVEY.—COTTON: MARINE ALGAE.



Shallow rock-pool with covering of *Lithophyllum incrustans*. R. Welch, *photo.*

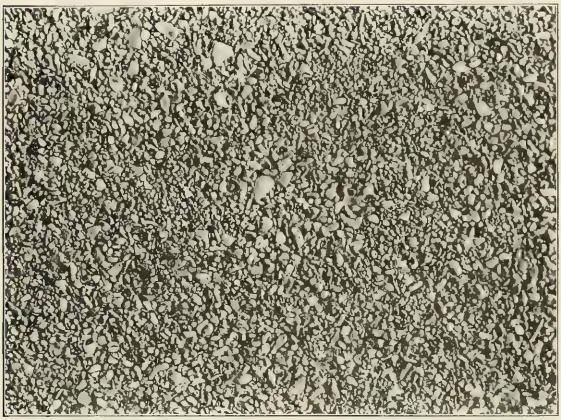
Clare Island Survey.—Cotton: Marine Algae.

FIG. 1.

FIG. 2. G. H. Pethybridge, *photo*

"Coral Beaches" in Mannin Bay. Sand composed of broken fronds of *Lithothamnium calcareum*.

CLARE ISLAND SURVEY.—COTTON: MARINE ALGAE.



G. H. Pethybridge, *photo.*

FIG. 1.—Lithothamnium sand from beach in Mannin Bay.

T. J. Westropp, *photo.*

FIG. 2.—Fucus farms in Achill Sound.

CLARE IRELAND SURVEY.—COTTON: MARINE ALGAE.

FIG. 1.

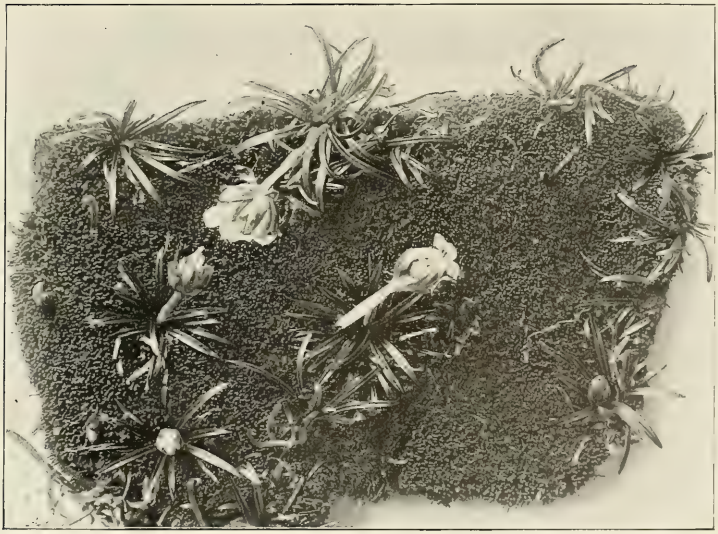
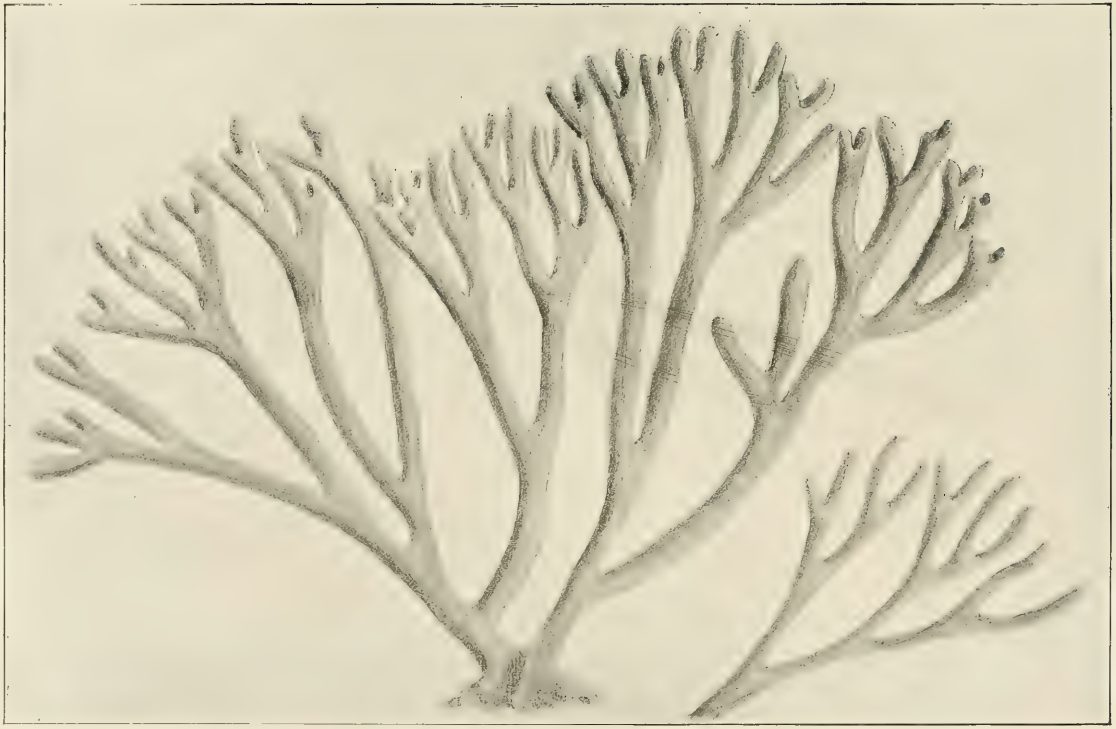


FIG. 2. G. Massee, *photo.*

Fucus vesiculosus var. *muscoides* var. nov.

Fig. 1.—Individual plants. Fig. 2.—Sward formed by the same, with scattered plants of *Statice maritima.*

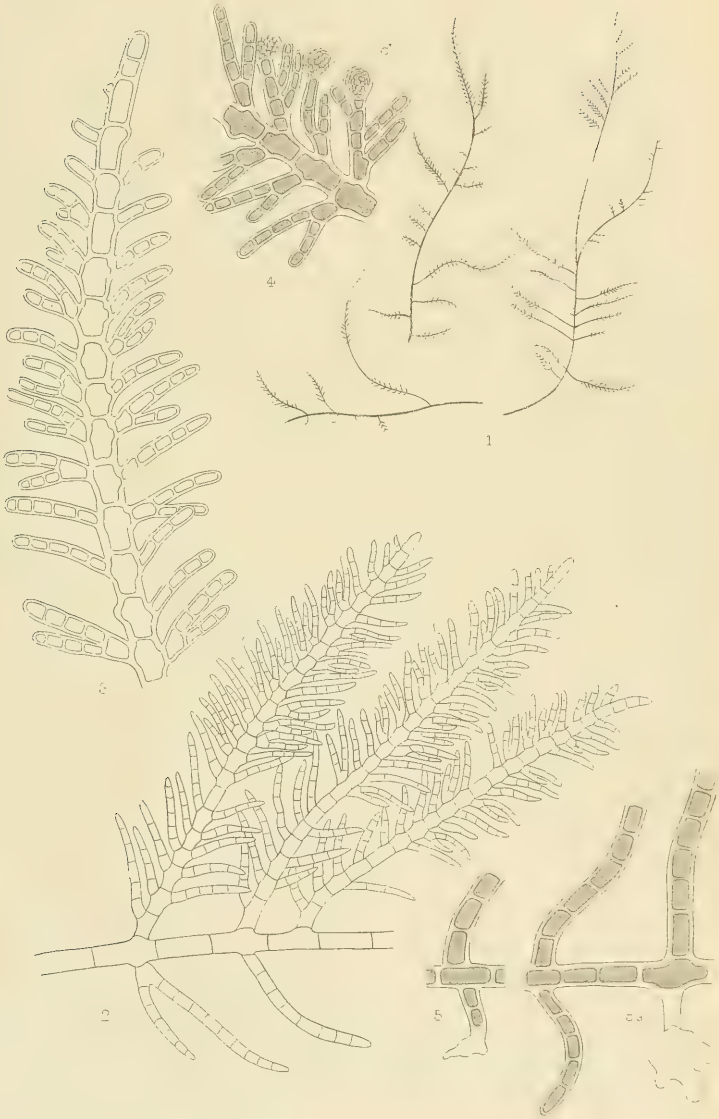
CLARE ISLAND SURVEY.—COTTON: MARINE ALGAE.



Codium mucronatum var. *atlanticum* var. nov. (whole plant).
C. tomentosum Stackh. (fragment to right).
Clare Island Survey.—Cotton: Marine Algae.

1, 2 *Codium tomentosum.*
3–5 *C. mucronatum* var. *atlanticum.*
6 ,, ,, ,, *Novae Zelandiae.*
7 ,, ,, ,, *tasmanicum.*
8 ,, ,, ,, *californicum.*

CLARE ISLAND SURVEY.—COTTON: MARINE ALGAE.



Del. A.D.C. West, Newman

Ptilothamnion lucifugum, *sp. nov.*

CLARE ISLAND SURVEY,- COTTON: MARINE ALGAE.

Del. A.D.C. West, Newman lith.

1-3. Calothrix endophytica, *sp. nov.* 4-9. Ascocyclus Saccharinae, *sp. nov.*
10. Nitophyllum uncinatum, *J. Ag.* 11. N. laceratum *var.* uncinatum *Grev.*

Map of the Clare Island District.

Clare Island Survey.—Cotton: Marine Algae.

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FRESH-WATER ALGAE,

WITH A SUPPLEMENT OF MARINE DIATOMS.

By WILLIAM WEST, F.L.S.

Plates I.–II.

Read April 22. Published July 6, 1912.

I made two special visits to the district dealt with by this Survey at Whitsuntide, 1910, and Whitsuntide, 1911, and collected a great deal of material. The hundreds of gatherings were made from as varied habitats as possible, and have since been worked out microscopically. Collecting was carried on over the whole of the district, from Achill Island round by Curraun and Westport to Louisburgh and Mweelrea; inland as far as Castlebar; and on Clare Island itself. I have also utilized much other material that I had collected from the district on several previous visits; and I have to thank the following gentlemen for the opportunity of examining material collected by them:—Messrs. Lancelot Bayly, A. D. Cotton, J. W. H. Johnson, R. Ll. Praeger, L. B. Smyth, and G. H. Wailes. Mr. Wailes collected the material from Inishturk, Inishbofin, and Caher Island; these collections were all from additional localities of much interest, and consequently have greatly enriched this paper. The list of halophilous Diatoms has been very considerably enhanced by means of the excellent material collected by Messrs. Smyth and Cotton; my own collections of marine material were limited and were not made for the purpose of this Survey, as I was then unaware that I was to be asked to examine and enumerate the marine Diatoms as well as the fresh-water ones.

Previous work in the district of this Survey has not been very considerable. Archer's records are the earliest, but those from Mayo are few when compared with his numerous observations from such counties as Dublin and Wicklow. With regard to Diatoms, O'Meara did excellent work at the greater part of Ireland; but I am not aware of any detailed work by anyone at the district under consideration. In a Paper[1] I published twenty years ago,

[1] W. West: A Contribution to the Fresh-water Algae of W. Ireland. Journ. Linn. Soc., Bot., xxix, 1892.

a number of records of Algae in general from near Westport were enumerated. In 1906 I published a Paper[1] in conjunction with my son, Prof. G. S. West, in which some records were given for the plankton occurring in Lough Keel and Lough Acorrymore, Achill Island. A fair number of other records of Desmids have been published in "British Desmidiaceae"[2] for near Westport, Castlebar, and Achill Island. From Clare Island itself and the Louisburgh district I do not know of any previous records.

The district is very rich in Algae; 887 species, 254 varieties, and 46 forms have been collected,[3] and the investigation has resulted in extending the known distribution of a large number of species, in adding 157 species to the number of those already known for Ireland, in adding 19 species to those already known for the British Isles, as well as adding to science 6 new species, 27 varieties, and 7 forms. The new species are as follows:—

Hormospora ellipsoidea	Synechococcus minutus
Ankistrodesmus Selenastrum	Microcystis minutissima
Reinschiella curvata	Lyngbya cliarense

As an example of a remarkable extension of range, one genus with its single species was known previously only from one locality in Colorado. As was anticipated for this class of plants, the species occurring on the island are very much the same as those occurring in similar localities on the adjacent mainland, the conditions being similar. The Algae are, as usual, much scarcer on the Carboniferous limestone of the mainland than on other rocks, from the natural comparative scarcity of wet places there, as well as from the calciphobic character of many species.

A few associations, out of many lists that were made, are enumerated; these may be of some interest in these days of ecology-worship. It will be noticed that the lists of species enumerated vary very considerably though obtained from similar pools with similar surrounding influences.

In all the bogs of this district, the gigantic thiobacterium *Hillhousia mirabilis* was abundant. Another smaller species of this genus was also frequent and is being investigated by the authors of the larger species; the smaller species has been found in England also.

Although the list which follows is a fairly long one, with many localities,

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[1] W. and G. S. West: A comparative study of the Plankton of some Irish Lakes. Trans. Royal Irish Academy, vol. xxxiii, Sect. B, Part II, 1906.

[2] W. and G. S. West: British Desmidiaceae, vols. i, ii, iii, and iv. Ray Society, 1904, 1905, 1908, 1911.

[3] Made up as follows:—Fresh-water Algae, 769 species, 230 varieties, 40 forms; Marine Diatoms, 118 species, 24 varieties, 6 forms.

the microscopical examination of the material having occupied considerably more than a thousand hours, the district cannot be said to be exhausted by any means.

When measurements are given, they apply only to the specimens actually measured; hundreds of specimens of many species were observed, but comparatively few were measured.

At first I made lists from the different divisions of Clare Island; but as I found they were increasing in similarity as work proceeded, I thought it best to merge them into one.

Many other Algae were collected, which, on account of their barren condition, or by reason of the few specimens seen, could not be determined with certainty, such as species of Oedogonium, Zygnema, Spirogyra, Mougeotia, &c.

It is possible that a few brackish-water forms, and even a few marine ones, may occur in the list of fresh-water Diatoms, this being due to the fact that some of the fresh-water lakes and pools are close to the sea and often frequented by gulls, and sprinkled with storm-spray from the sea during gales; I have noticed this commingling from the Outer Hebrides and similar places. As far as I know, I have not repeated a name in the list of marine Diatoms which had already occurred in the list of those from fresh water.

To show how marine and fresh-water species get mixed in such places as tidal rivers, I give a list of ten species out of many others from the mouth of the Bunowen River, Louisburgh, at about the limit of high tide; the first five are fresh-water forms, the others marine ones:—*Ceratoneis Arcus, Melosira varians, Surirella ovalis, Gomphonema constrictum, Synedra Acus, Hantzschia virgata, Rhabdonema adriaticum, Amphora salina, Navicula palpebralis,* and *N. digitoradiata.*

As other reports of the series (see Report 10, Phanerogamia) have dealt or will deal with questions of soil, &c., it is only necessary for me to say that the prevalent soil where most of the collections were made is peaty, that the rainfall is heavy—about 60 inches—and that the climate is mild even in winter.

I must here express my great indebtedness to Mr. J. Adams, M.A., for the trouble he has taken in kindly adding up the number of species, &c., and analyzing the new records for tabulation.

Species now for the first time recorded for Ireland are distinguished by an asterisk; those new to the British Isles by two asterisks; while species, varieties, and forms new to science are printed in capital letters.

CONTRACTIONS USED FOR LOCALITIES.

Ac = Lough Acorrymore, Achill Island.
AS = Near Achill Sound.
B = Church Lake, Inishbofin.
C = Clare Island.
CP = Croaghpatrick.
Cr = Near Castlebar.
CI = Caher Island.
Cn = Croaghaun, Achill Island.
D = Near Dugort, Achill Island.
DL = Doo Lough.
I = Inishbofin.
IT = Lake on Inishturk.
K = Keel Lough, Achill Island.
L = Near Louisburgh.
LG = Lough Gall, Achill Island.
M = Near Mulranny.
Mw = Mweelaun.
RL = Roonah Lough.
S = Slievemore, Achill Island.
SL = Sraheens Lough, Achill Island.
VL = Valley Lough, Achill Island.
W = Near Westport.

LIST OF SPECIES.

Class RHODOPHYCEAE.

Order NEMALIONACEAE.

Fam. **Helminthocladieae.**

Batrachospermum vagum Ag.—C, AS, I, D, Cn.

Fam. **Lemaneaceae.**

Sacheria mamillosa Sirod.—C.

Class CHARACEAE.

The following localities are taken mostly from papers on the botany of the district between Mulranny and Castlebar by Rev. E. G. Marshall,[1] and of Clare Island, Achill, and Inishturk, by R. Ll. Praeger[2]; the balance are from MS. notes by the latter. All Mr. Praeger's specimens were verified by H. and J. Groves. I did not collect Characeae during my two visits.

Chara fragilis Desv.—Newport; Castlebar; Clare I.; Achill I.; Inishturk.
var. **barbata** Gant.—Clare I.
var. **delicatula** Braun.—Clare I.
C. aspera Willd.—Newport; Castlebar; Achill.
var. **subinermis** Kuetz.—Achill.

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[1] Journ. Bot., xxxviii, 184. 1900.
[2] Irish Nat., xii, 277, 1903; xiii, 265, 1904; xvi, 113, 1907.

C. polyacantha Braun.—Castlebar.
C. vulgaris L.—Mulranny; Achill.
Nitella translucens Ag.—Newport; Clare I.
N. opaca Ag.—Newport; Castlebar; Achill; Clare I.

Class CHLOROPHYCEAE.

Order OEDOGONIALES.

Fam. **Oedogoniaceae.**

*__Bulbochaete Brebissonii__ Kütz.—I.
gigantea Pringsh.—W.
insignis Pringsh.—LG.
mirabilis Wittr.—C.
Oedogonium Braunii Kütz.—C.
crispum (Hass.) Wittr.—C, vegetative cells 10–13μ broad, 4 to 6 times longer, oogonia (average) 40μ wide, 36μ high.
cryptoporum Wittr.—C, veg. cells 44 × 7–7·5μ, oogonia 27μ broad 21μ long.
var. **vulgare** Wittr.—C.
*__giganteum__ Kütz.—L.
Itzigsohnii De Bary, var. **minus** West.—D, lat. cell 5·8–7μ, lat. oogonia 25 – 26μ.
macrandrum Wittr.—VL.
platygynum Wittr.—C.
__pusillum__ Kirchn.—C, vegetative cells 3·3 × 12μ (average), oogonia 12μ broad, 14μ long.
__propinquum__ Wittr.—VL.
punctato-striatum De Bary.—LG.
Rothii (Le Cl.) Pringsh.—VL, D.
undulatum (Bréb.).—A, Br, C, I.
*__urbicum__ Wittr.—B.
Several other sterile species from many localities.

Order CHAETOPHORALES.

Fam. **Herposteiraceae.**

Herposteiron confervicola Näg.—C, K.

Fam. **Ulotrichaceae.**

*__Ulothrix aequalis__ Kütz.—L; W, up to 18–20μ broad, 26–30μ long; C, B.
var. **catenaeformis** (Kütz.) Rabenh.—IT.

Ulothrix moniliformis Kütz.—I.

subtilis Kütz.—S, cell 8μ lat., 5μ long.; C.

var. **variabilis** (Kütz.) Kirchn.—L, C, Ac, I, CI, B, W, CP.

var. **tenerrima** (Kütz.) Kirchn.—W, Mw.

tenuis Kütz.—C; D, 15–17μ broad, 4μ long, from several places.

zonata (Web. et Mohr) Kütz.—C, L, VL, CI, Ac.

Hormospora ELLIPSOIDEA sp. nov.—H. lobulis subangustis, solitariis, et subflexuosis; cellulis approximatis sed demum subdistantibus, diametro circiter 1½–plo longioribus, polis rotundatis, 10·5–11·6μ long, 7·5–8·3μ lat., tubul. 15·5–16·5μ lat. D.

***Binuclearia tatrana** Wittr.—C, in many places, usually from 7–9μ broad; S; CP, up to 11μ broad; Cn.

Fam. **Chaetophoraceae.**

Chaetophora pisiformis (Roth) Ag.—C.

elegans (Roth) Ag.—C.

Myxonema amoenum (Kütz.) Hazen.—D.

protensum (Dillw.) Hazen.—SL.

nanum (Dillw.)—C.

fastigiatum (Kütz.) Hazen.—C, SL, LG, Ac.

tenue (Ag.) Hazen.—S, CP.

Fam. **Microthamniaceae.**

Microthamnion Kuetzingianum Näg.—C; D, 3–3·5μ broad, 14–17μ long.

Fam. **Trentepohliaceae.**

Trentepohlia Iolithus Wallr.—Cliffs of Croaghmore.

aurea (L.) Mart.—W, C, D, Cliffs of Croaghmore.

lichenicola (Ag.).—L, up to 10–12μ broad, zoosporangia 16–20μ.

Order ULVALES.

Fam. **Ulvaceae.**

Enteromorpha intestinalis (L.) Link.—C, frequent in quite fresh water.

Order SCHIZOGONIALES.

Fam. **Prasiolaceae.**

Prasiola parietina (Vauch.) Wille.—L, W, C.

Order MICROSPORALES.

Fam. **Microsporaceae.**

Microspora abbreviata (Rabenh.) Lagerh.—C, cells 11–12μ broad, 1½ times longer than broad, average size; Cn, breadth 10–11μ.

Microspora amoena (Kütz.) Lagerh.—L; C, 20–25μ broad; M, I.
var. **crassior** Hansg.—W, lat. 23–25μ; D.
var. **irregularius** W. & G. S. West.—Ac, K; C, in several places, 21–24μ broad.
floccosa (Vauch.) Thur.—W, C, D, Cr, Ac.
***fugacissima** (Roth) Rabenh.—W, D, L, C.
pachyderma (Wille) Lagerh.—C, in several places, average 13·3μ broad.
****stagnorum** (Kütz.)Lagerh.—W, 8·5–10μ lat.

Order CLADOPHORALES.

Fam. **Cladophoraceae.**

Cladophora crispata (Roth) Kütz.—L, W, C, DL.
flavescens Ag.—W, L, C, Cr.
glomerata (L.) Kütz.—Cliffs of Croaghmore, width 53–82μ, of branches towards the tips 24μ.
***Chaetomorpha sutoria** (Berk.) Rabenh.—C.
Rhizoclonium hieroglyphicum Kütz.—C; W, 13–15·5μ in diameter, 56 64μ long.

Order SIPHONEAE.

Fam. **Vaucheriaceae.**

Vaucheria spp.—Several, in different localities, but sterile. One from Clare Island averaged 61μ in thickness, another from Westport was from 100–110μ in diameter.

Order CONJUGATAE.

Fam. **Zygnemaceae.**

Sub-fam. Mesocarpeae.

Mougeotia viridis (Kütz.)—C, 8μ broad, 10 to 13 times as long, zygospore 30μ across the angles, 26μ across the middle.
gracillima (Hass.) Wittr.—C, lat. cell. 5·5–6μ, up to 136μ long: examples from other pools, 5–5·5 × 55–83μ; D, 6μ broad, spores 20μ across middle, 24μ across the angles.
elegantula Wittr.—D, 40–48μ long, 3·5–4μ broad.
parvula (Hass.) Wittr.—D, 8μ broad, zygospores 19μ, spherical.
spp., several others from many different localities, sterile.

Sub-fam. Zygnemeae.

***Zygnema anomalum** (Hass.) Cooke.—C, I, Cl, Cr.
cruciatum Ag.—Cr.
ericetorum (Kütz.) Hansg.—L, C, D.

Zygnema pectinatum Ag.—C, vegetative cells 35μ broad, 92μ long.

leiospermum De Bary.—C, breadth 18–19μ, 2–3 times longer, zygosp. 25 × 30 (–33)μ; S. W. of Dugort, 16–20μ broad, 32–48 (rarely 52)μ long, zygospores mostly spherical (sometimes ellipsoid), 24–27μ, mixed among sterile Spirogyra. (Plate I, fig. 3; Plate II, fig. 23.)

***Vaucherii** Ag.—AS.

var. **subtile** Rabenh.—D, cell. 13–15μ lat., 3–4-plo longioribus, The zygospores were as broad as the cells and sometimes a little broader, distending them laterally, usually 1½ times as long as broad.

***parvulum** (Kütz.) Cooke.—C.

Spirogyra condensata (Vauch.) Kütz.—C, lat. fil. 35–40μ, lat. zygosp. 31–37μ; W, lat. fil. 31·5–33·5μ, 48–64μ long, zygosp. 31–32 × 42–46μ; S, a form with sub-spherical zygospores, lat. fil. 34–41·5μ, zygosp. 36–39μ lat.

***flavescens** (Hass.) Rabenh.—C, VL.

***insignis** (Hass.) Kütz.—C, lat. cell. 24–32μ, 3–6-plo longioribus, zygosp. 31–32μ × 86–90μ.

longata (Vauch.) Kütz.—L; W, lat. cell. 23–27, circa 3-plo longioribus, zygosp. 28–32μ, lat. usque 56μ long.

porticalis (Vauch.) Cleve.—C, lat. cell. 36–43μ; W, lat. cell. 42–52·5μ, 2–3-plo longioribus, zygosp. 35–42 × 52–59μ.

***quadrata** (Hass.) Petit.—C, lat. fil. 19–22μ, saepe 12–16-plo longioribus, zygosp. 33–35 × 60–85μ; L, lat. cell. usque 31μ; CP, D.

***Weberi** Kütz.—VL.

tenuissima Hass.—D; C, sterile cells 8·5–11μ broad, 10 to 13 times as long.

nitida (Dillw.) Link.—D, cells average 108μ long × 72μ broad.

varians (Hass.) Kütz.—D, cells usually 1½ to 2 times longer than broad, 28–32μ wide, inflated on conjugating side, zygospores broadly elliptic to roundish, 28–31μ broad.

Fam. **Desmidiaceae.**

***Gonatozygon Brebissonii** De Bary.—W; L, forma 83 × 8·5–μ.

var. **laeve** W. & G. S. West.—C, 128–9 × 8·5–9μ, faintly punctate under high power.

var. **minutum** W. & G. S. West.—M, 65 × 5·8μ; Cr, 95 × 5·6μ.

Kinahani (Arch.) Rabenh.—S, 343 × 14μ; D, 250–256 × 152μ; near Slievemore, a small form, 152 × 10μ.

monotaenium De Bary.—W, Ac; C, small forms, 132 × 8·5μ.

Spirotaenia minuta Thur.—SW of D, 24 × 6·5μ.

obscura Ralfs.—D, 55 × 16·4μ.

bispiralis West.—W.

condensata Bréb.—C, 165 × 25μ; D, 212 × 20μ, a long narrow form, smaller forms down to 122 × 19μ with six turns of the spiral.

Mesotaenium chlamydosporum De Bary.—W; D, 29·7 × 11μ: in another place 23 × 11μ, 24 × 11·5μ, 25 × 12μ.

f. **minor**, W. & G. S. West.—W; D, 20 × 9μ.

De Greyi Turn.—L, 67–103 × 23–24μ; D; C, a short form intermediate between type and var. *breve*, 70 × 21μ.

var. **tenuis** W. & G. S. West.—D, an elongated form, 105 × 15μ.

endlicherianum Näg.—S, 25 × 7·5μ; C, 29·7 × 9·2μ, another gathering 25·3 × 7·7μ; D, 25 × 8·3μ; Cr, 33 × 10μ.

var. **grande** Nordst.—M, 53–54 × 13·3μ.

macrococcum (Kütz.) Roy. & Biss.—L, 37 × 15μ; C, 37·15 × 5·4μ; VL; CP, 35–35·5 × 14–14·5μ.

var. **micrococcum** (Kütz.) W. & G. S. West.—S, 19 × 8·3μ; C.

Cylindrocystis Brebissonii Menegh.—C, AS, S; SL, 58 × 18μ; CP, L, B, W, M; D, up to 61 × 18·5μ.

var. **minor** W. & G. S. West.—M; D, 25 × 11·6μ, short forms, in another locality 41 × 12·5μ, some thick forms 29 × 14μ.

crassa De Bary.—IT, SL, L, C, CP; D, 47 × 23·4μ, in one place thick specimens 47·5–48·3 × 25 (–28)μ, also narrower forms 36·5 × 19·2μ.

diplospora Lund.—C, 68 × 29μ, also from another place small forms 50 × 21μ; SL, CI; CP, average size of some 65 × 28·7μ, others 64 × 24μ; D, 59 × 24μ, also 66 × 26μ.

Netrium Digitus (Ehrenb.) Itzig. & Rothe.—C, up to 360 × 98μ; D, M; IT, up to 90μ lat.; LG, I, SL, B, W, CP.

interruptum (Bréb.) Lutkem.—W, C.

var. **sectum** W. & G. S. West.—W.

Naegelii (Bréb.) W. & G. S. West.—L.

oblongum (De Bary) Lutk.—C.

var. **ANGUSTATUM** var. nov.—Var. cellulis distincte angustioribus quam in forma typica, 123 × 23μ. C, in sphagnum pool.

var. **BREVIUS**, var. nov.—Var. cellulis diametro $3\frac{1}{2}$-plo longioribus. C, 86 × 25μ, also 86 × 25μ in another locality.

var. **cylindricum** W. & G. S. West.—D, 89–108 × 22·5 23μ, a large form; near L. Keel, Achill, 63–70 × 18·3μ; C, 79 × 18μ.

Penium cruciferum (De Bary) Wittr.—M, 15 × 8·4μ: in a different gathering in the same district up to 27 × 12·5μ; W, 17 × 9·8μ.

Penium curtum Bréb., f. **intermedia** Wille.—C, 39·5–40·5 × 15·4–16·5μ.

cucurbitinum Biss.—M, L; D, 60 × 26·6μ.

f. **minor** W. & G. S. West.—C, SL, M, D.

Cylindrus (Ehrenb.) Bréb.—C, 44 × 11–11·5μ, common among *Utricularia minor*; D; W, 35 × 11μ, the forms seemed to have smaller granules than usual, the newly formed cell-walls were colourless, another gathering measured 29–42 × 10·6–12μ.

didymocarpum Lund.—C, 38–39 × 13–13·5μ, also 35 × 14·3μ.

exiguum West.—Cr, 17 × 6μ.

f. **major** W. & G. S. West.—S, 44–44·5 × 10·5–10·8μ.

inconspicuum West.—C.

Jenneri Ralfs.—D.

margaritaceum Ralfs.—C.

mooreanum Arch.—W.

minutum (Ralfs) Cleve.—W; S, 133 × 13·3μ; D, 132 × 14μ, 152 × 13·2μ, 119 × 14μ.

var. **tumidum** Wille.—D, 100 × 16μ.

Navicula Bréb.—M, W; C, 48 × 14μ, a rather long form occurred in one place, 74 × 15μ; L, 46 × 12·5μ; D, 49 × 12·6μ.

phymatospermum Nordst.—D, 33 × 15μ; M, 30 × 14·2μ; CP; C, 35·5 × 17·5μ.

polymorphum Perty.—S, 55 × 24·2μ; D, 50 × 24μ, 60 × 25μ.

spinospermum Josh.—C, 31 × 14μ, 28·4 × 12·5μ; S, 34 × 15μ, also 26·7 × 13·4μ; D, 27–32 × 13–14μ.

spirostriolatum Bark.—W, LG; D, in several places, a short form 117 × 23·3μ, others averaging 140 × 25μ.

truncatum Bréb.—W; S W of D, 39 × 12·5μ.

Roya Pseudoclosterium (Roy.) W. & G. S. West.—D, 86–118 × 2·5–3μ.

Closterium abruptum West.—C, M; L, 155 × 15·8μ; Cr, 158 × 15μ, a little more curved than type. Some forms from Clare Island were a little longer than the type with narrower apices, average size 184 × 15μ.

acerosum (Schrank) Ehrenb.—L, 320–323 × 33–34μ, 21° of arc; S.W. of D, 507 × 44μ, 24° of arc, also 490 × 43·8μ, 27° of arc.

aciculare T. West, var. **subpronum** W. & G. S. West.—W, 498 × 6μ.

acutum Bréb.—W; C, from several places.

var. **linea** (Perty) W. & G. S. West.—W; D, average size 134 × 3·7μ.

angustatum Kütz.—W, 386 × 20μ.

var. **ASPERUM**, var. nov.—Var. costis omnibus granulatis, granulis subdistantibus, apicibus cellularum laevissime subrecurvatis. W, 457 × 22μ. (Pl. I, fig. 5.)

Closterium Archerianum Cleve.—L, I, W; C, a form 285 × 21μ, not more than 110° of arc.

attenuatum Ehrenb.—W, 597 × 40μ; M.

calosporum Wittr.—C, CI; L, 148 × 11·6μ, 114° of arc.

Cornu Ehrenb.—C, LG, W; L, 148 × 6·3μ.

var. **ARCUM** var. nov.—Var. cellulis curvatioribus usque 85° arci, subparallelibus solum circa medium, 138 × 8·5. LG.

costatum Corda.—C, average size 355 × 52μ, 80° of arc: in one place the examples were rather narrow, 340 × 40μ; IT, CI, W.

Cynthia De Not.—W, 156 × 16μ average, 124° of arc; M.

Dianae Ehrenb.—C; M, 250 × 26·5μ, 128° of arc; IT, L, LG, AS; CI, 285 × 29·1μ; D, VL, Cr; I, some minor forms also from this locality, 163 × 14·5μ.

var. **arcuatum** (Bréb.) Rabenh.—C, between apices 128 × 16·5μ, others 162–166 × 18, 133° of arc, a form approaching type, but shorter: another gathering, 201–224 × 19–21μ; CI, 168 × 21·6μ, 134° of arc; W, 137 × 18·3μ; L, 120 × 16·6μ, 150° of arc.

didymotocum Corda.—C; M, 422·5 × 47·5μ, 425 × 48μ, 428 × 46μ, 345 × 42·5μ, 375 × 45μ, breadth near apices 16–20μ, breadth at 20μ from apex 25–28μ, 30–37° of arc; W.

***eboracense** Turn., var. **ACHILLENSE** nov. var.—Var. cellulis semper majoribus quam in forma typica, margine ventrali leviter sed distincte tumido ad partem mediam. D; S, 262 × 61μ (the last measurement was the most constant, 270 × 69μ, 257 × 61μ, 255 × 57·5μ, 290 × 63μ, 287 × 64μ). (Pl. 1, fig. 13, Pl. 2. fig. 16 (poles).)

Ehrenbergii Menegh.—D, 353 × 56μ; C, 348 × 73μ; from a pool on Croaghmore a large number of examples were measured: they varied as follows:—353–743μ long by 56–106μ wide; S, IT, I, AS, W; L, short forms, 254 × 66μ.

gracile Bréb.—L, W; C, average size 172 × 6·6μ.

var. **tenue** (Lemm.) W. & G. S. West.—W; M, 74 × 3·3; S. W. of D, 82 × 4μ.

incurvum Bréb.—CI, 52 × 10μ, 185° of arc; L, 49 × 9·7μ, 61 × 9·6μ, 50 × 10μ.

intermedium Ralfs.—C, 260 × 22·5μ, 224 × 22μ, 294 × 21·5μ, 33–36° of arc: from another place, 250–260 × 17·5 – 20μ, 33° of arc; M, L, W; D, 224 × 16μ; Cn, some peculiar small forms, 188–228 × 19–19·5μ.

var. **hibernicum** West.—W.

Closterium Jenneri Ralfs.—C, M, VL, CI, W; Cr, 84×11–12μ.

var. **HIBERNICUM**, var. nov.—Var. cellulis longioribus angustioribusque quam in forma typica, et minus curvatis. Long. inter apices 116μ, lat. 11μ, lat. prope apices, 4–5μ, 120° of arc. W.

juncidum Ralfs.—W, 110×9μ, 206×10μ, and 165×8μ from different gatherings; D, 268×8μ.

var. **elongatum** Roy & Biss.—A little shorter than R. & B.'s variety, 342×12μ.

var. **brevior** Roy.—194×14μ.

Kuetzingii Bréb.—L, abundant in several places, 347×17μ; SL, abundant in the plankton, average size 417×17μ.

Leibleinii Kütz.—C, W; L, 157×23μ, 135° of arc; D. In one pool in Clare Island among *Utricularia minor* and *Batrachospermum vagum*, a small very arcuate form occurred without ventral inflation, 101×17·5μ, 170° of arc.

var. **OCCIDENTALE** var. nov.—Var. cum parte mediana marginis interioris subrecta, id est, cellula sine inflatione centrali, 146–158×20·6–21·7μ. L; DL, 153–158×25μ, 175° of arc; W, 172×22μ, 140° of arc, a form with middle of inner margin distinctly, though very slightly, concave; W, 137×18·3μ, 138° of arc; D.

***Libellula** Focke.—W.

var. **interruptum** W. & G. S. West.—M.

lineatum Ehrenb.—C, a small form, 356×18·7μ, 40° of arc: from another place, large forms, 573×30μ, 34° of arc; M, 45–47° of arc; W, a small form 334×16μ, 40° of arc.

Forma brevior, striis delicatissimis. A shorter form with pale yellowish-brown cell-wall. I; M, 435×32μ, 45–47° of arc.

Lunula (Müll.) Nitzsch.—C, B, L, I, W; D, 657×116·6μ; SL, 557×85μ. (Pl. 2, fig. 15 (form of poles)).

moniliferum (Bory) Ehrenb.—W; L, 269×43μ, 84° of arc; C, large much curved forms, 378–390×63–66μ, 140° of arc.

parvulum Näg.—C, in one locality small forms 90×12μ, 132° of arc: in another place, 132×11μ, 120° of arc; M, IT; L, 125×13·6μ; W, D; I, various forms, some 141–145×12·5μ, 122° of arc, near apices 4–5μ; K.

var. **angustum** W. & G. S. West.—C, 91–101×7–8μ, 125° of arc; I, 120° of arc; C.

praelongum Bréb., f. **brevior** West.—C, 360×16μ: from another locality 220×13μ: none of the examples had as long a recurved apex as is usually figured.

Closterium pronum Bréb.—W; C, 348–380 × 10·5–11μ.

f. **BREVIUS** f. nova.—Cellulis semper distincte brevioribus, 222–250 × 8·4–9μ. C.

pritchardianum Arch.—D, 462 × 30μ, 358 × 30·5μ, 343 × 30μ; C, large forms, 495 × 51μ.

Pseudodianae Roy.—M; C, 203 × 14μ; CI, 193 × 12·5μ; W, 164 × 12μ, 98° of arc: also a smaller form 155 × 11μ, 84° of arc. A small form was seen from Clare Island, 130 × 9·6μ.

Ralfsii Bréb.—L, 382–384 × 38–39μ; C, 251 × 42μ, a short form.

var. **hybridum** Rabenh.—W, 316–384μ, average breadth 32μ: Cr, 390 × 28μ.

rostratum Ehrenb.—L, AS, M, D; C, 330 × 25μ, 343 × 26·5μ.

var. **brevirostratum** West.—M, L; C, 248 × 20μ average.

setaceum Ehrenb.—I, CI; B, 11–12μ broad; Cr, 320 × 8·5μ.

striolatum Ehrenb.—W, 253 × 40μ, 38° of arc; L, very variable, short forms 228 × 38μ.

subulatum (Kütz.) Bréb.—C, 215 × 10μ.

***tumidum** Johnson.—C, 106 × 17·6μ, a form with the ventral margin almost straight in the middle part.

Toxon West.—C; W, 206 × 10μ.

var. **VALIDUM** var. nov.—Var. cellulis duplo crassioribus quam in forma typica, 250–260 × 17·5–20μ. C. (Pl. 1, fig. 6.)

turgidum Ehrenb.—C, W.

Ulna Focke.—D, 410 × 15μ, breadth near apices 11μ; C, various lengths, 225, 275, 285, 300, 310, 432·5, by 15–16·5μ in breadth; CP, 295 × 22μ.

Venus Kütz.—C, B; W, 55 × 6·6μ, 165° of arc; M, 80 × 9·8μ, 138° of arc.

Docidium baculum Bréb.—C, W.

Pleurotaenium coronatum (Bréb.) Rabenh.—IT; C, up to 464μ long and 38μ wide.

var. **fluctuatum** West.—SL, 575 × 54μ, apex 50μ.

Ehrenbergii (Bréb.) De Bary.—M, average size 448 × 24μ at middle; VL, IT, L, W, CI; C, 319 × 27·5μ (just above the base of semicell); Cr, 393 × 40μ, specimens up to 455μ long.

var. **granulatum** Ralfs.—Cr, 240 × 17μ.

Trabecula (Ehrenb.) Näg.—W.

f. **clavata** (Kütz.) W. & G. S. West.—W; C, 353 × 33·5μ.

var. **rectissimum** W. & G. S. West.—C, in Creggan Lough, a form with practically parallel sides, 418 × 20μ.

Pleurotaenium truncatum (Bréb.) Näg.—L; Cr. 412×42μ; W; C, 425×56μ.
var. **Farquharsonii** (Roy and Biss.) W. & G. S. West.—L, 252×37·5μ.

Tetmemorus Brebissonii (Menegh.) Ralfs.—S, 145×32μ; M, I, C; D, 151×33μ; CP; W, 100×26μ. (Plate I, fig. 8.)
var. **minor** De Bary.—C; D, 70×20μ, 62×16μ, 67×18μ.

granulatus (Bréb.) Ralfs.—C; D, 160 × 30μ; IT, SL, L, CI, W, B, CP.

laevis (Kütz.) Ralfs.—AS, CP; D, 72×18μ; C, 82×21μ, 75×20·7μ; CI, W. VL; S, 80×19μ. This was with zygospore S. of Dugort. ends retuse, sides almost straight (slightly convex), greatest length and breadth 71×47μ. (Pl. 1, fig. 10.)

minutus De Bary.—W, LG; L, average size 57 × 17·5μ; D, 58×19μ, also 62–65×18·3μ from another gathering.

Euastrum ampullaceum Ralfs.—C.

affine Ralfs.—W.

ansatum Ralfs.—C, M, IT, L, W, VL, Cr; D, 76×39μ, 78×35μ.

bidentatum Näg.—IT, L; D, 52·5–58×35–36μ, frequent; W, frequent; B, VL, S; C, common in many places, 50×36μ, also 55×37·5μ; CP; M, 46 × 34μ; Cr.

binale (Turp.) Ehrenb.—C, 18–20×14–16μ, also 14·3×11μ; W, Cr, C, P, D.
f. **secta** Turn.—D, a small form, 16×11μ.
f. **Gutwinski** Schmidle.—C, 23·4×17μ (average size); W, CP, Cn; D, 26·6–29 × 20–21μ.
var. **subelobatum** West.—C.
var. **retusum** West.—C.
f. **hians** West.—IT, B, I, LG, M.
f. **minor** West.—C, 10–12μ long, 9–11μ wide; D, 11–11·5μ broad, 11–12μ long.

crassicolle Lund.—C.

crassum (Bréb.) Kütz.—M, LG, W; D, 165 × 78–81μ.

crispulum (Nordst.) W. & G. S. West.—C.

cuneatum Jenner.—D, 138 × 65μ, isthmus 18μ, a large form.

denticulatum (Kirchn.) Gay.—C, 24 × 18·6μ; M, IT, L, W, S, Cn.

Didelta (Turp.) Ralfs.—C, W; CP, 154 × 86μ.

dubium Näg.—C, up to 36 × 21·6μ; L.

elegans (Bréb.) Kütz.—C, 27·5 × 18μ; IT, SL, LG, I, B, W, D, VL; Cr, 30 × 19μ; M, 29 × 17·5μ.

erosum Lund.—C.

gemmatum Bréb.—W.

Euastrum insulare Wittr.—W, 17·5 × 11·5μ; M, LG; SW of D, 29 × 19μ, in one place a short wide form occurred 16 × 14μ.

var. **PARVUM**, var. nov.—Var. cellulis similibus ad formam typicam sed parvioribus et relative brevioribus, lobulis lateralibus minus retusis, 12·5 × 10μ. D; Cr, 14–17 × 12–13μ.

montanum W. & G. S. West.—C; LG, in this locality the examples had more pyramidal semicells than in the type, causing the apices to be relatively narrower; D, 27·5 × 20·5μ, width of apex 12·5μ.

oblongum (Grev.) Ralfs.—C, IT, W; M, 174 × 89μ; Cr, 166 × 83μ; D. (Plate I, fig. 1.)

var. **cephalophorum** West.—Cr, 158 × 93μ.

pectinatum Bréb.—C, W, M, VL, IT, LG, D.

var. **inevolutum** W. & G. S. West.—C.

pulchellum Bréb.—C, 38 × 33–36μ; M, 37 × 28μ.

var. **retusum** W. & G. S. West.—C.

rostratum Ralfs.—C; L, 52 × 30μ; W.

sublobatum Bréb.—IT.

Turnerii West.—SL; Cr, 36–37·5 × 28·3μ.

***validum** W. & G. S. West.—M, 26·6 × 23.

ventricosum Lund.—M, W.

verrucosum Ehrenb.—W, D.

var. **reductum** Nordst.—K; LG.

Micrasterias apiculata (Ehrenb.) Menegh., var. **fimbriata** (Ralfs) Nordst.—C, W.

Crux-melitensis Ralfs.—W; Cr, 106 × 93μ, width of polar lobe 24·5μ.

denticulata Bréb.—C, 224 × 194μ, 222 × 192μ, 220 × 196μ; W; CP, the following are measurements of some of the specimens in μ:—232 × 224, 238 × 212, 220 × 189, 224 × 224 (an example as broad as long), 220 × 200, 216 × 182, 240 × 196, 228 × 208, 208 × 186. (Pl. 1, fig. 14, various forms of polar lobes; Plate II, figs. 17, 18).

var. **angulosa** (Hantzsch) W. & G. S. West.—C, 275 × 215μ.

Jenneri Ralfs.—W; D, 171 × 123μ.

var. **simplex** West.—D, 170 × 117μ.

oscitans Ralfs, var. **mucronata** (Dixon) Wille.—W; D, 171 × 123μ, rare.

pinnatifida (Kütz.) Ralfs.—W.

papillifera Bréb.—SL, W.

rotata (Grev.) Ralfs.—W.

Sol (Ehrenb.) Kütz. (*M. radiosa* Ralfs).—W.

thomasiana Arch.—AS; D, 226–230 × 175–160μ.

truncata (Corda) Bréb.—C, 106 × 103μ, 114 × 106μ; M, I, W; CP, 132 × 110μ and 145 × 121μ; D.

Cosmarium abbreviatum Racib.—VL.

var. **planctonicum** W. & G. S. West—Plankton of LG.

f. **minor** W. & G. S. West.—W.

amoenum Bréb.—W; From several places in C, from 50×27 up to $59 \times 31\mu$; D, $43{\cdot}5 \times 26\mu$, $48 \times 31\mu$, $46{\cdot}6 \times 30\mu$, $52{\cdot}6 \times 28\mu$.

anceps Lund. var. **crispulum** Nordst.—L, $18{\cdot}3 \times 11{\cdot}6\mu$.

var. **TATRICOIDES** var. nov.—Var. cellulis relative latioribus, cum isthmo ancipitis sed forma tatrici, cytiodermate glabra. C, $33 \times 21\mu$.

angulosum Bréb. var. **concinnum** (Rabenh.) W. & G. S. West.—W., CP, D, L; C, $12 \times 10{\cdot}3\mu$, in several places. In one of the collections from Clare I. a large form was seen $21 \times 18{\cdot}2\mu$.

***binum** Nordst.—W.

bioculatum Bréb.—W.

f. **depressa** Schaarschm.—S.W. of D, a small form 10μ long, 11μ wide.

bipapillatum W. & G. S. West—W.

bipunctatum Borg.—W.

Blyttii Wille.—SL, W; C, $16 \times 14\mu$.

Boeckii Wille.—L, D, VL, M, SL; C, $38 \times 34\mu$.

Botrytis (Bory) Menegh.—C, L, CI; W, $55 \times 50\mu$; DL, SL, LG, VL, Cr; CP, rather large and wide examples, $80 \times 68\mu$.

var. **mediolaeve** West.—C, 65–67×51–53μ, also in another locality $59 \times 49\mu$; W.

Brebissonii Menegh.—C, $106 \times 76\mu$; M; W, $100 \times 68\mu$.

Broomei Thw.—W.

caelatum Ralfs.—C, $48 \times 44\mu$; W.

var. **spectabile** (De Not.) Nordst.—D, $46 \times 40{\cdot}5\mu$.

circulare Reinsch.—W.

f. **minor** W. & G. S. West.—W.

conspersum Ralfs.—W.

var. **latum** (Bréb.) W. & G. S. West.—Cr, $80 \times 71\mu$.

contractum Kirchn.—M, a form between the type and var. *ellipsoideum* (Elfv.) W. & G. S. West.

corriense Bissett.—Cr, $39 \times 29\mu$.

crenatum Ralfs.—L; D, $21{\cdot}5 \times 19\mu$.

Cucumis Corda.—W; M, rather broad forms, $65 \times 43\mu$; I, B, L; C, from one locality on dripping rocks among Vaucheria a broad form occurred $62 \times 45\mu$: from L. Creggan $65 \times 37{\cdot}5\mu$, isthmus $20{\cdot}8\mu$; D, a small form $52{\cdot}6 \times 28{\cdot}3\mu$.

Cosmarium Cucurbita Bréb.—A, S; D, 43 × 21μ; M, IT, C, LG; SL, 46 × 21·7μ; CP, Cn; L, 46 × 22μ.

Debaryi Arch.—W.

depressum (Näg.) Lund. (*C. Scenedesmus* Delp.).—C, IT, VL, SL, W.

var. **reniforme** W. & G. S. West.—W.

var. **MINOR** var. nov.—Var. cellulis minoribus, long. 25μ, lat. 26μ, also 24·1 × 25μ. Cr; C, a wider form 23·3μ long, 31μ wide.

***decedens** (Reinsch.) Racib.—SL.

difficile Lutk.—VL; M, 31 × 19·5μ; W.

var. **sublaeve** Lutk.—C, 35 × 20·8μ; W, L; M, 32 × 20μ.

elegantissimum Lund. var. **minor** West.—D.

exiguum Arch.—C, 26–26·5 × 12μ; W, 27–28 × 15–16μ.

var. **subrectangulum** W. & G. S. West.—Cr, 11·7 × 9μ, a small form.

formosulum Hoffm.—L, plankton of Lough Roonah near L; CI, D, VL; C, 47 × 40–43μ, also from another place 43–44 × 37–40μ; some examples were near the variety *Nathorstii*; W, up to 52·5 × 48μ; K.

furcatospermum W. & G. S. West.—C, 21 × 19μ, forma cum sinu angustiori.

galeritum Nordst.—M, W; C, 52·5 × 40μ.

globosum Buln.—W.

granatum Bréb.—L, W, VL; C, 29 × 18–20μ; Cr, 33 × 21–22μ.

var. **subgranatum** Nordst.—L, W.

humile (Gay) Nordst.—W, 14 × 12μ; D, Cn, VL, Cr.

var. **substriatum** (Nordst.) Schmidle.—C, 17·5 × 15μ; L, K, SL, I, LG, C, I, W, D.

var. **glabrum** Gutw.—W.

var. **striatum** (Boldt.) Schmidle.—W.

holmiense Lund., var. **integrum** Lund.—D.

Hammeri Reinsch.—M, W, C.

var. **homalodermum** (Nordst.) W. & G. S. West.—W.

isthmium West.—W.

impressulum Elf.—C, VL, L; W, 28 × 20μ, also 24 × 17·5μ; DL, D; CP. 21·6 × 15·8; Cr, 21 × 15μ.

latum Bréb.—Cr, 63·5 × 75μ.

laeve Rabenh.—C, M, L, VL, D.

var. **octangulare** (Wille) W. & G. S. West.—L, CI, Cr, W; C, 22·5 × 16·6–17μ; K.

var. **septentrionale** Wille.—C, L, D.

var. **cymatium** W. & G. S. West.—C.

margaritiferum (Turp.) Menegh.—C, 43·5 × 38μ; M, SL, W, CP.

Cosmarium Meneghinii Bréb.—C, 15·5–16 × 13–13·4μ; CI, W; D, 16 × 12·6μ; VL; DL, 16·6 × 13·3μ.

var. **nanum** Wille.—C, 16·6 × 13·5μ, a small form.

moniliforme (Turp.) Ralfs.—C, SL, W.

f. **panduriformis** Heimerl.—D, W.

monomazum Lund. var. **polymazum** Nordst.—Cr.

nitidulum De Not.—S.W. of D, a small form, 27 × 21·6μ.

notabile Bréb.—L.

f. **minor** Wille.—W.

nymannianum Grun.—C, among *Sphagnum cuspidatum*, 46·6 × 37·5μ, also among Hypnum, 44–47·3 × 35–38·5μ.

obliquum Nordst.—W; D, 15 × 11·6μ.

ochthodes Nordst.—C, 70 × 55μ, also in another place 84 × 62–64μ, also 91 × 63μ, 68·5 × 52·5μ, 72·5 × 56μ; D.

ornatum Ralfs.—C, L, W.

pachydermum Lund.—C, 81 × 66μ; B.

perforatum Lund.—W.

perpusillum West.—CI.

Phaseolus Bréb.—W.

var. **elevatum** Nord.—Cn, at above 2100 feet, average size 27 × 26μ.

plicatum Reinsch.—D, 48·5 × 26·6μ.

var. **hibernicum** West.—SL.

portianum Arch.—W, CP.

var. **nephroideum** Wittr.—W.

praemorsum Bréb.—W.

pseudoconnatum Nordst.—W.

pseudoexiguum Racib.—C, 25–26 × 12–13μ, also 23 × 10·5μ from another place among *Utricularia minor*; D, 24 × 11μ, 25·5 × 11μ, 25 × 12μ.

pseudopyramidatum Lund.—M, W.

pseudonitidulum Nordst.—SL, C.

var. **validum** W. & G. S. West.—D, a small form, 51 × 42μ; C, 52·5 × 40μ.

punctulatum Bréb.—L, M, IT, I, CI, W, VL.

var. **subpunctulatum** (Nordst.) W. & G. S. West.—DL, L, M; C, form *a* W. & G. S. West frequent, 28–31 × 26–30μ; W, D; Cr, 28·3 × 26μ.

pygmaeum Arch.—C, IT, L, SL, DL, D, W.

pyramidatum Bréb.—M, SL, I; C, a small form, 57 × 42μ; W, LG; D, small forms 68·5 × 45μ average; Cr.

Cosmarium quadratum Ralfs.—W, D; Cr, 57·5 × 33·5μ, also 60 × 31μ.

quadrifarium Lund.—W, 51–55 × 48–50μ.

quadrum Lund.—Cr, 72 × 70μ, 66 × 66μ, 63 × 68 (broad)μ, 78 × 60μ.

***Quassilus** Lund.—W.

quinarium Lund.—Cr, 37·5 × 31μ.

Ralfsii Bréb.—W, SL.

var. **ROTUNDATUM** var. nov.—Var. lateribus semicellularum rotundatis, angulis basalibus interdum levissime productis, sinu subclauso, 110 × 100μ, isthmus 24μ. W. (Pl. II, fig. 19.)

var. **montanum** Racib.—D, 126 × 98·5μ, a form with the sinus open to its apex. D. (Pl. II, fig. 20.)

rectangulare Grun.—C, common among *Utricularia minor*, 31–36·5 × 26–30μ; IT, LG, I, CP, D.

radiosum Wolle.—W.

Regnellii Wille.—C, 4·6μ long, 13·4μ wide: from another place 17 × 14·5μ, 18 × 14·7μ, 15·5 × 13μ; L, CI, B, DL, D.

Regnesi Reinsch.—I, W; C, 8 × 8μ; D, 8·2 × 8·2μ.

var. **tritum** West.—W.

reniforme (Ralfs) Arch.—C, 48 × 44μ, isthmus 13·5μ; L, LG, W; Cr, 50 × 48μ; M; K, 52·5 × 47·5μ.

***sexangulare** Lund. f. **minima** Nordst.—C, CI, IT.

speciosum Lund.—C.

var. **biforme** Nordst.—D.

sphagnicolum W. & G. S. West.—C, 9μ long, 11μ wide; DL, Cr; D, 10μ long, 12·5μ wide.

sphalerostichum Nordst.—C, M, W, D, B, W, SL.

subcostatum Nordst.—C, 25 × 23μ, the smaller forms approaching f. *minor*.

f. **minor** W. & G. S. West.—K, 24 × 22·4μ.

subcrenatum Hantsch.—C, from several places, the small forms 26 × 22μ, the largest examples measured 33·5 × 30μ; D, 25·5 × 22μ.

var. **divaricatum** Wille.—W.

***subcucumis** Schmidle.—CI; B, 70 × 45μ.

subspeciosum Nordst.—W.

subundulatum Wille.—W.

subtumidum Nordst.—C, L, LG, W, D.

var. **MINOR** var. nov.—Var. cellulis minoribus quam in forma typica, 26 × 20μ. C.

subprotumidum Nordst.—C.

var. **Gregorii** (Roy and Bissett) W. & G. S. West.—Plankton of RL; L, CI, W, SL; plankton of LG, 31 × 29μ.

Ionactinum nucleum West.—D. W.

cyathiformium West.—SL.

saxicum Reinh.—Cr., very rare. 49 × 27μ., width of apex 19μ.

secundiphilum (Kütz.) Menegh.—C. 90 × 65μ.; D., W., SL.; W., up to 106 × 72μ. M. W. a form of this occurred near Westport with the upper two-thirds of the sporocell almost semicircular. Cr. a short broad form, 80 × 58·5μ.

Thwaitesii Ralfs.—Cr. 61 × 26·5μ.

tuscum Ralfs.—C. M. D. W.

uncinatum (Perty) Rabenh.—W.

undulatum Lund.—C. 87·5 × 38μ.; W.

Turpinii Bréb.—Plankton of L. Ennell near L. W. small pool connected with a spring, 77·5 × 56μ.

var. minutum W. & G. S. West.—W.

*undulatum Link.—L. 30 × 15·5μ.

undulatum Corda.—D.; W., 57 × 38μ.

var. minutum Wittr.—C. 21 × 19μ.; W.

vivide (Corda) Rabenh.—C. 12·5 × 17·5, very rare among Tetraedron minor.

vulgatum (Bréb.) Arch.—C., W., Cr.

Kallstroemia anomalopsis (Bréb.) Klitz.—L. 48 × W. 7μ. long, 5μ. broad without spines, 8μ. with spines; Cr.

var. degalperianum W. & G. S. West.—Plankton of SL.

armatum (Bréb.) Rabenh.—C. M.; SL., a form from this locality with three-lobed processes approached var. *fusum* Nordst.

sonnatum Arch. var. minimum West.—W.

armatum Bréb.—C. W.

fascicularum Lemm.—C. W.

fusum Arch.—C. 24–29 × 13·5–16μ. common among Tetraedron minor.

D.

variabile Moore.—W. & G. S. West.—C. very frequent; L. SL. W. Cr.; D. 24 long × 23μ. broad without spines, spines 2–3μ.

rhombomorphum Arch.—L. 17 × 16μ. without spines; D. 19·5 × 21·7μ. without spines.

Ankistrodesmus convolutus Corda.—L. D. SL. W. 45μ. long, 4·5μ. broad without spines, 6μ. broad with spines; Cr. M. 5μ. long, 6μ. broad with spines, 4·5μ. without spines.

falcatus Bréb. var. acicularis West.—D.

minutissimus G. S. West.—W. D. C. length 11·5μ., breadth with spines 14·5μ.

Arthrodesmus Incus (Bréb.) Hass.—C. H. M. W. VL.

var. **indentatus** W. & G. S. West.—C. W.

var. **Baldii** (West) W. & G. S. West.—D. LG.; C. some forms with markedly divergent spines.

f. **latiscula** W. & G. S. West.—D. length 16·5μ, breadth with spines 27μ, isthmus 5μ.

f. **minor** W. & G. S. West.—C. L. W. M. The average length of examples in the boggy pools of Clare Island was 14μ. D. some very small examples, 11 × 11μ without spines, breadth with spines 16μ, isthmus 4·5μ.

octocornis Ehrenb.—C. LG. W. Cr.

f. **impar** Jacobsen.—C.

Staurastrum anatinum Cooke & Wille.—SL. W.

aculiferum (West) Anders.—C. 25–29μ long, 25–33μ broad with processes; D.

aculeatum (Ehrenb.) Menegh.—C. W.

alternans Bréb.—W. M. VL; Cr, 21·5μ long, 25μ wide.

apiculatum Bréb.—L. C; Cr, 19 × 20μ.

Arctiscon Lund.—W.

arcuatum Nordst.—W.

asperum Bréb.—C.

Avicula Bréb.—C. the cell walls were delicately and regularly punctate. 36–37μ long, 26·5–27μ wide without processes, 37μ wide with processes; W.

var. **subarcuatum** (Wolle) West.—C. L. LG. VL. W. D.

bieniauum Rabenh.—W.

var. **ellipticum** Wille.—W.

brevispinum Bréb.—W; SL, 46·6 × 40·8, a rather long form.

Brebissonii Arch.—L. VL.

***cosmarioides** Nordst.—C. D. New to Ireland, very rare in Great Britain.

controversum Bréb.—C.

crenulatum (Näg.) Delp.—C.

cuspidatum Bréb.—L. VL. W; C, 26–31μ long × 23–29μ wide; D.

var. **maximum** West.—Plankton of LG. and of SL; K.

curvatum West.—C.

cyrtocerum Bréb.—H. W.

dejectum Bréb.—C. K. L. SL. W. D. LG.

denticulatum (Näg.) Arch.—Plankton of LG.

Dickiei Ralfs.—W.

f. **punctata** West.—W.

Staurastrum dilatatum Ehrenb.—C, average size 20·8μ long, 21·5μ broad; D, W, DL, LG; Cr, 23μ long, 24μ broad.

*disputatum W. & G. S. West.—W.

*erasum Bréb.—Plankton of LG, SL, and of RL.

furcatum Bréb.—W.

var. **reductum** W. & G. S. West.—C.

furcigerum Bréb.—L, W.

gracile Ralfs.—C, L, Ac, K, W, CP, Cr.

var. **nanum** Wille.—W.

var. **cyathiforme** W. & G. S. West.—Plankton of LG, breadth with processes 69μ, length 40μ; C; SL, up to 88μ wide.

hexacerum (Ehrenb.) Wittr.—C, L, DL, D, Cr, W.

hirsutum (Ehrenb.) Bréb.—SL, M, L; D, 31·6 × 25–26μ; C, average size 44 × 44μ; CP, 46μ long.

inconspicuum Nordst.—C.

inflexum Bréb.—C, small forms 25·5μ long; IT, L, VL, Cr; LG, 29–30μ broad with processes, 21μ long, a small form.

jaculiferum West.—K, D.

f. **biradiata** West.—Plankton of LG and of SL.

laeve Ralfs var. **Clevei** Wittr.—D.

longispinum Bailey.—SL, length 98μ, breadth with spines 117μ.

Manfeldtii Delp.—Ac.

margaritaceum (Ehrenb.) Menegh.—C, 26–27 × 19–20μ, mostly tetraradiate; LG, both tri- and tetra-radiate; W, SL, M, CP; D, 31 × 21·5–25μ.

Meriani Reinsch.—C, 34 × 25μ, a short form with dilated apices.

monticulosum Bréb.—C.

muticum Bréb.—C, W, D; Cr. 41·5 × 33·5μ.

f. **minor** Rabenh.—C, 15μ long, 15·8μ broad; among *Utricularia minor*: in another locality among submerged Hypnum, the average size was 16μ long and 15·5μ broad; D, very small forms in several places, not more than 14·3 × 12·5μ, in another gathering 18 × 16μ.

muricatum Bréb.—IT, C; W, 50 × 37μ without spines.

O'Mearii Arch.—D, C.

orbiculare (Ehrenb.) Ralfs, var. **hibernicum** (West) W. & G. S. West—W.

var. **Ralfsii** W. & G. S. West.—IT, L; W, up to 42 × 33μ; C, 33 × 29μ, another gathering average size 29·5 long, 26·5 broad; D, 30·8 × 27·5μ, and 31 × 27μ; Cr, 38 × 31μ.

var. **depressum** Roy & Bissett.—IT, SL, W; D, 28 × 26·6μ.

var. **extensum** Nordst.—D, 36·6 × 28μ; Cr, 37·5 × 29μ.

Staurastrum oxyacanthum Arch.—C.

paradoxum Meyen.—C, K, Ac, D, Cr, Cn.

var. **longipes** Nordst.—DL, 20μ long, 44μ wide (with processes), isthmus 6·7μ; VL, D.

pelagicum W. & G. S. West.—Plankton of LG, and of VL.

pilosum (Näg.) Arch.—AS, C, L, W; D, 34 × 33μ.

pileolatum Bréb.—S.W. of D, rare, 41–43 × 20–21μ, also 39 × 23μ, other specimens from another gathering, 40μ long × 23·3μ broad across apex, 18·3μ across base, 12·5μ at isthmus.

polymorphum Bréb.—C, L, W; D, 23·4μ broad, 5-rayed.

var. **PUSILLUM** var. nov.—Var. multe parvior, processubus gracilioribus et subinflexis, forma corporis ut in forma typica. C, 18–18·5μ long.

polytrichum Perty.—C, M; S.W. of D, not more than 47μ wide, spines 6–7μ long.

punctulatum Bréb.—C; L, average dimensions 33–34μ long × 32μ wide; IT, LG; W, 39 × 35μ; M, D, C, P.

var. **coronatum** (Schmidle) W. & G. S. West.—D.

var. **pygmaeum** (Bréb.) W. & G. S. West.—C, 38 × 35μ; L, 36 × 29μ, breadth of isthmus 13·3μ, 31·6 × 30·8μ; W; D, 31·5 × 28μ; M, 39 × 32·5μ.

pungens Bréb.—C, rare, south side in small pond.

Reinschii Roy.—D, 21·6 × 22μ; C, 21 × 23μ; W, SL.

scabrum Bréb.—AS, M, CI; C, 33–35μ broad, 36–37μ long, isthmus 13·5μ broad.

Sebaldi Reinsch.—L, SL, Cr.

sexcostatum Bréb.—C, 42μ long, 40μ wide with processes; SL.

spongiosum Bréb.—S.W. of D, rare.

striolatum (Näg.) Arch.—D, L, W, C.

teliferum Ralfs.—C; W, 36 × 31·5μ; LG.

tetracerum Ralfs.—C, M, VL, DL, W; Cr; LG, 21μ broad with processes; D, Cn.

f. **trigona** W. & G. S. West.—D, W.

tumidum Bréb.—W, M.

vestitum Ralfs.—W.

Spondylosium pulchellum Arch.—C, in many places; LG, CP; D, frequent, average size 17 × 13·6μ.

Sphaerozosma aubertianum West.—Ac.

excavatum Ralfs.—W.

secedens De Bary.—D, 9·6μ long, 11μ wide.

Desmidium Swartzii Ag.—C, 41–43μ broad, 20·5–21μ long; W; Cr, 38·3μ broad, 14·5 long.

cylindricum Grev.—C, M; D, average of many specimens 12μ long, 49μ wide.

Gymnozyga moniliformis Ehrenb.—C, W; SL, 24 × 20·8μ, another gathering 36–40 × 20–23·3μ; D, 25–31 × 16·5–20–21μ.

Hyalotheca dissiliens (Sm.) Bréb.—C, AS, I, VL, W, B, Cr; D, diameter of zyospores 26μ; C, cells 16·3μ long, 29μ broad, 65μ with hyaline sheath; CP; M, 26–28μ broad.

f. **punctata** Jacobsen.—C; CP, 24–25·2 broad.

undulata Nordst.—L. Creggan, C.

Order PROTOCOCCOIDEAE.

Fam. **Chaetopeltideae.**

Chaetosphaeridium globosum (Nordst.) Klebahn.—C, cells 13·3–15μ broad; I, cells 9–10μ broad; W.

var. **depressum** W. & G. S. West.—C, 10–12μ broad.

Fam. **Volvocaceae.**

Sub-fam. Volvoceae.

Volvox aureus Ehrenb.—C, frequent, average diameter of cells 350μ.

Eudorina elegans Ehrenb.—C, SL, I, CI; D, a number of examples were measured from here, the colonies reached up to 220μ, and as the cells began dividing to form new colonies they varied from 26 to 32μ in diameter as incipient colonies.

Gonium pectorale Müller.—C, W.

Pandorina morum (Müller) Bory.—C, SL, LG, I, CI, W, D; Cr, cells 8–10μ broad, coenobia 30–45μ broad; M, cells 10–12μ broad.

Sub-fam. Chlamydomonadeae.

***Carteria multifilis** (Fresen.) Dill.—L, up to 16μ broad.

Chlamydomonas Pulvisculus (Müll.) Ehrenb.—C, W.

***Kleinii** Schmidle.—D.

Sphaerella lacustris (Girod.) Wittr.—C, L, W.

Fam. **Endosphaeraceae.**

***Phyllobium sphagnicola** G. S. West.—D, on *Sphagnum cuspidatum.*

***Chlorochytrium Knyanum** Szymanski.—C.

Fam. **Characieae.**

Characium debaryanum (Reinsch.) De Toni.—Ac, K.

***Pringsheimii** A. Br.—L; C, epiphytic on Oedogonium.

subulatum A. Br.—VL.

Fam. **Pleurococcaceae.**

Pleurococcus angulosus Menegh.—W.

vulgaris Menegh.—C, L; W, and on mainland everywhere.

Trochiscia reticularis (Reinsch.) Hansg.—C.

Fam. **Hydrodyctyaceae.**

Sub-fam. Pediastreae.

Pediastrum boryanum (Turp.) Menegh.—C, L, K, RL, I, LG, CI, VL, W, DL, L, SL.

var. **PRODUCTUM** var. nov.—Var. processibus cellularum externarum perlongis, multe longioribus quam latitudo cellulae et non capitatis. C.

duplex Meyen.—VL, W; D, average breadth of colonies of 16 cells 56μ, of 8 cells 43μ.

tetras (Ehrenb.) Ralfs.—C, L, LG, CI, W, DL, D, Cr. Colonies of four were mostly seen. In one gathering from Clare Island, all seen were in fours, the colonies were very small and measured usually 9–10μ across, rarely 11μ; the notch was sublinear, and the two outer sides of each cell were always retuse.

***glanduliferum** Benn.—Plankton of RL, LG, VL, L.

***gracile** A. Br.—VL, C.

Fam. **Protococcaceae.**

Sub-fam. Coelastreae.

Sorastrum spinulosum Näg.—C; plankton of LG.

Coelastrum sphaericum Näg.—C, very frequent: I, L, CI; W, diameters of colonies 34–36μ, of cells 8·5–9μ; VL.

cambricum Arch.—C.

microporum Näg.—C.

Sub-fam. Crucigenieae.

Crucigenia quadrata Morren.—C, VL.

Tetrapedia (Kirchn.) W. & G. S. West.—VL, C.

rectangularis (Näg.) Gay.—C, in several places, 4–4·5 × 5·5–6·5μ.

***Tetrastrum staurogeniaeforme** (Schröd.) Chodat.—VL, DL.

Sub-fam. Selenastreae.

Scenedesmus antennatus Bréb.—W.

acutiformis Schröder.—C, W, DL, D, VL; Cr, some of the forms from here were rather broad, 14 × 5·5μ.

bijugatus (Turp.) Kütz.—C, I, LG, W; Cr, cells 10–11 × 4·5–5μ.

denticulatus Lagerh.—S.W. of D

Scenedesmus obliquus (Turp.) Kütz.—CI, VL, W, Cn; C, in one place small forms with cells 7·2 × 2·5μ.

var. **dimorphus** (Turp.) Rabenh.—K, VL, DL, D; Cr, length of cells 24–26μ, width of colony of 4 cells with processes 26–30μ, width of colony of 4 cells at middle 21μ; W; C, length of cells 20·8–21·5μ, width of colony of 4 cells with processes 23·3μ, width of colony of 4 cells at middle 15·5μ.

quadricauda (Turp.) Bréb.—C, RL, I, LG, L, CI, VL, DL, WD, Cr.

var. **horridus** Kirchn.—Mw, C.

Dimorphococcus lunatus A. Br.—M, C.

Selenastrum gracile Reinsch.—D, Cr, W.

Ankistrodesmus falcatus (Corda) Ralfs.—C, L, DL, SL, CI, W, B, Cr, K.

var. **tumidus** G. S. West.—C, in several places up to 6μ broad; Cr, up to 7·5μ broad.

var. **acicularis** (A. Br.) G. S. West.—C, I, Sl, CL.

var. **mirabilis** (W. & G. S. West) G. S. West.—W, 91 × 3μ, slightly curved, chloroplast interrupted; C, 133 × 3·5μ, almost straight.

Pfitzeri (Schröd.) G. S. West.—C, Mw, CI.

***Braunii** (Näg.) W. & G. S. West.—Cr.

convolutus Corda var. **minutum** (Näg.).—Cr, C.

SELENASTRUM sp. nov.—Cellulae semilunatae, apicibus acutis, inter apices 18–18·3μ, lat. ad medium 7·5μ. Inter algis variis (Cosmariis, &c.). Cr.

Closteriopsis longissima Lemm.—I, CI, LG, D.

Reinschiella CURVATA sp. nov.—R. cellulis solitariis, libere natantibus, late lunatis, margine interiori concavo, apicibus acutis, spina brevi extrorsum curvata praeditis, long. sine spin., 38μ, lat. 20μ, long. spin. 5–6μ. C. (Pl. I, fig. 2.)

Kirchneriella obesa (West) Schmidle.—K; plankton of RL, VL, L, Cr.

Sub-fam. Oocystideae.

***Oocystis crassa** Wittr.—B, Cr, SL, D.

gigas Arch.—I.

lacustris Chod.—Plankton of LG.

solitaria Wittr.—C, 19 × 10μ, also in other places 34 × 20μ, 33 × 21·5; D, up to 33·5 × 21·5μ; M, I, B, M; CP, 35 × 20μ (average): this often occurred in fair abundance of constantly small dimensions often 8–9μ broad and 14–16μ long; some examples from neighbouring pools were larger, extra broad, 30–31 × 22·5μ; Cr, 23–28 × 145–17μ.

Oocystis elliptica West.—C, I.

Nephrocytium Naegelii Grun.—C; plankton of LG.

lunatum West.—C, L, Cr, W.

agardhianum Näg.—L, I.

***obesum** West.—C, M, CI; Cr, size of cells in colonies of 25–27 × 15–16μ, colonies 60 × 48μ.

Eremosphaera viridis De Bary.—C, up to 151μ broad; M, average 139μ broad; IT, W, D.

***Palmellococcus miniatus** (Kütz.) Chodat.—C, mostly 3μ broad.

***Chlorella vulgaris** Beyer.—C, L, D, W.

Sub-fam. Tetraedrieae.

Tetraedron caudatum (Corda) Hansg.—L, VL, DL, W, C.

***limneticum** Borge.—VL, DL; plankton of LG.

regulare Kütz.—C, W.

enorme (Ralfs) Hansg.—C, W; Cr, 35μ wide.

Cerasterias longispina (Perty) W. & G. S. West.—D.

var. **HEXACTINUM** var. nov.—Var. processibus radiantibus sex ex centro commune. D.

Sub-fam. Phythelieae.

Chodatella breviseta W. & G. S. West.—C, D.

***Lagerheimia genevensis** Chodat.—D, from several localities; C, AS.

subglobosa Lemm.—D.

Sub-fam. Dictyosphaerieae.

Dictyosphaerium pulchellum Wood.—L, K; plankton of RL, abundant; plankton of LG; W.

ehrenbergianum Näg.—L, LG, W.

***Tetracoccus botryoides** West.—I; C, 4·5–5·5 in diameter, in another place not more than 4μ.

Botryococcus Braunii Kütz.—C, L, SL, C, I, Cr. In some of the many places in which it was seen, as in Clare Island, the peculiar state described as *Ineffigiata neglecta* was the only state observed.

***protuberans** W. & G. S. West.—C; Cr, cells 7–8·5μ broad mostly.

Fam. **Palmellaceae.**

Sub-fam. Palmelleae.

Palmodactylon varium Näg.—C, width of cells 6·3–7·5μ.

Palmella mucosa Kütz.—M; W, 8·8–11μ in diameter.

***miniata** (Leibl.) Chod.—Mw.

*Schizochlamys delicatula West.—C, most abundant in many places.

gelatinosa A. Br.—C, 10–11·7μ broad, among *Batrachospermum vagum*; D, 10–11μ broad.

Sphaerocystis Schroeteri Chod.—K, SL; plankton of LG; VL; D, cells 8μ broad.

Sub-fam. Tetrasporeae.

Tetraspora gelatinosa (Vauch.) Desv.—C, in several places, cells 8–15μ broad; CP.

Apiocystis brauniana Näg.—C, W; L, on *Cladophora crispata.*

Sub-fam. Gloeocystideae.

Gloeocystis gigas (Kütz.) Lagerh.—C, 17–20μ, in another place 11–15μ, another gathering averaged 22μ; L, M, SL, VL; W, 11·6–15μ mostly; D, 16–17μ; Cr, 10–11μ.

vesiculosa Näg.—C, from 7·5 up to 11μ broad; M, SL, L, LG, CI, W, B, D.

rupestris Lyngb.—C.

*Asterococcus superbus (Cienk.) Scherffel (=*Gl. infusionum* (Schrenk) W. & G. S. West).—C, IT, I, L, CI, M, D, SL.

*Dactylothece Braunii Lagerh.—LG.

*Palmodictyon viride Kütz.—C.

*Coccomyxa subellipsoidea Acton.—C, forming jelly-like incrustations on mosses.

Class HETEROKONTAE.

Order CONFERVALES.

Fam. Tribonemaceae.

Ophiocytium cochleare (Eich.) A. Br.—C, L, W, D.

bicuspidatum (Borge) Lemm. f. longispina Lemm.—C, in several places, 26–29 × 5·5–6·5μ without spines.

majus Näg.—C, IT, VL, CI, W.

parvulum (Perty) A. Br.—Cr, C.

Arbuscula (A. Br.) Rabenh.—CI, W.

*Bumilleria pumila W. & G. S. West.—C.

*Tribonema affine (Kütz.) G. S. West.—C, I.

bombycinum (Ag.) Derb. & Sol.—C, 12–13·3 broad; B, SL, L, CI, W, CP.

f. minor (Wille) G. S. West.—W, C.

Chlorobotrys regularis (West) Bohlin.—C, very common with *Utricularia minor*; M, Cn, C, D, CP, IT, I, CI, W, B, LG, DL, SL, Cr. This was so variable in size and abundant in one place in Clare Island, growing with *Batrachospermum vagum*, that I measured a number of examples; they varied from 11·6 to 25·5μ in diameter; it was on account of the very large size of some of them that they were measured.

Class BACILLARIEAE (= Diatomaceae).

(I have here adopted Van Heurck's arrangement of the Diatoms for convenience.)

Div. I. RAPHIDIEAE.

Tribe **Cymbelleae.**

Amphora ovalis Kütz.—C, 52 × 33·5μ; IT, L, D; W, 50 × 30μ, valve-view.
var. **affinis** Kütz.—D, 26·6–36 × 14·1–18μ.
var. **Pediculus** (Kütz.) V. H. (*A. minutissima* W. Sm.).—B, L.
f. **minor** V. H.—W, 31 × 17·6μ, 29 × 15·5μ.

Cocconema affine (Kütz.) W. & G. S. West.—M, D, L; CP, average length 22μ.
caespitosum (Kütz.) G. S. West.—W, M, L, K.
var. **lata** V. H.—C.
var. **Auerswaldii** (Rabenh.) V. H.—C, W, CP.
Cistula Ehrenb.—C, IT, W, M.
cuspidatum (Kütz.) G. S. West.—C, L, D; W, 74 × 24μ; SL.
var. **naviculiformis** (Auersw.) W. West.—L; D, in several places; W, average size 33 × 7·3μ.
cymbiforme Ehrenb.—W, M; C, 56 × 10·3μ; Croaghmore cliffs; K.
var. **parva** (W. Sm.) W. West.—L, W, CP.
***delicatulum** (Kütz.) W. & G. S. West.—C, SL; D, 30 × 5μ, valve-view; LG, Cr; W, 36·5 × 4·8μ.
Ehrenbergii (Kütz.) G. S. West.—C, large forms up to 125 × 30μ, 136 × 32·5μ, valve-view; L, I, W.
gastroides (Kütz.) W. & G. S. West.—D; C, 115μ long, also 98 × 22μ, valve-view; M, from 104 up to 180μ long; W, 131 × 26·6μ, in another place 124 × 25μ; Croaghmore cliffs.
var. **minor** (V. H.) W. West.—C.
gracile (Rabenh.) G. S. West.—W, CP, Ac.
f. **minor** (V. H.) W. West.—M, L, SL, W, B.
helveticum (Kütz.) W. & G. S. West.—C, 61 × 9μ.

***Cocconema laevis** (Näg.) W. West.—C, B; W, 24 × 5·6μ.
lanceolatum Ehrenb.—C, 79 × 13·3μ; W.
***leptoceras** (Kütz.) W. West var. **elongata** (V. H.) W. West.—C.
***microcephala** (Grun.) W. West.—C, D.
***obtusum** (Greg.) W. & G. S. West.—M, C.
tumidum Bréb.—C.
turgidum (Greg.) W. West.—W.
ventricosum (Ag.) W. & G. S. West.—IT; C, up to 33 × 8·3μ, valve-view; SL; near LG; CP, 28·3 × 7·5, valve-view; D, 20 × 7·5μ; Croaghmore cliffs.

Tribe **Naviculeae.**

Mastogloia Smithii Thw.—C, 48·5 × 12μ, in several places; W.
var. **amphicephala** Grün.—C, SL; near LG.
Stauroneis anceps Ehrenb.—C, 40 × 8·6μ; L; W, 49 × 13·3μ, a broad form; D, Croaghmore cliffs.
var. **LATA**, var. nov.—Var. cellulis diametro 3-plo longioribus, 60 × 20μ. A marked variety, as the type is 4½ times as long as broad. C.
var. **linearis** (Kütz.) V.H.—L; W, 46 × 12μ.
var. **amphicephala** (Kütz.) V.H.—W, 45 × 9μ; C, 51 × 10μ.
Phoenicenteron (Nitzsch.) Ehrenb.—C, up to 152 × 28·4μ; L; W, 121 × 28μ, in one locality all small forms 86–95 × 20μ; M, 180–183μ × 31–33μ.
f. **PRODUCTA**, f. nova.—F. cellulis minoribus et apicibus distincte productis, 81 × 18·2μ average size, some only 73 × 15μ. C.
gracilis Ehrenb.—W.
acuta W. Sm.—M, I, C; D, small forms 80–90μ × 13–14μ; W, average size 110 × 17·5μ.
Legumen Ehrenb.—W.
Navicula acuminata W. Sm.—W.
***affinis** Ehrenb.—IT.
alpina (W. Sm.) Ralfs.—CP, SL.
ambigua Ehrenb.—W, 59 × 13μ.
amphirhyncus Ehrenb.—W.
amphisbaena Bory.—C, W; D, 55–62 × 21–23·4μ.
***anglica** Ralfs.—D, C, W.
***appendiculata** Kütz.—L; W, 41 × 6·6μ; M.
****atomoides** Grun.—B.

***Navicula atomus** Näg.—D.

Bacillum Ehrenb.—L.

Brebissonii Kütz.—C, IT, I, B, L; W, 52·5 × 11μ, valve-view; M, LG, SL; D, 45 × 10·5, valve-view; Cn, Croaghmore cliffs.

var. **subproducta** V.A.—S.W. of D, 34 × 11μ.

bicapitata Lagerstedt.—C, L, SL; S.W. of D, 56 × 12μ, valve-view; W, 61 × 12μ, valve-view.

cryptocephala Kütz.—L, W, Cr; C, up to 43 × 10·5μ; D.

var. **exilis** V.H.—C.

cuspidata Kütz.—M, C, W.

crucicula (W. Sm.) V.H. var. **protracta** Grun.—D, 20 × 6μ.

dicephala W. Sm.—C, M, W, L; D, 29·5 × 95μ.

elliptica Kütz.—C, 31 × 14·3μ, valve-view; IT, L, I, AS, B; D, 24-25 × 14·2-15μ; W.

var. **ovalis** Hilse.—CP; W, 26·6 × 11μ, a rather narrow form; D, 21·6 × 11·6μ.

var. **oblongella** Näg.—C, I, B, M, L; W, large forms averaging 29 × 11μ.

var. **minima** V. H.—L; W, up to 18 × 9μ.

exilis (Kütz.) Grun.—C, 23·3 × 6μ; M, IT, SL, L, B, CI, W, D, CP.

Gastrum (Ehrenb.) Donk. var. **placentula** (Ehrenb.) V. H.—C, D, L; in all three localities it occurred in fresh water, but near the sea; in the last locality it was among Spirogyra.

gibba (Ehrenb.) Kütz.—C, 67 × 11μ up to 86 × 14μ; M; W, 50·5 × 8μ.

gibberula W. Sm.—W.

***gracillima** Greg. — C, a variety with very faintly subundulate margins.

***gregaria** Donk.—C, a large form up to 46 × 12μ.

gracilis Kütz.—D; C, 51 × 10 valve-view; Croaghmore cliffs.

***hilseana** Janisch.—CP, C.

Iridis Ehrenb.—C, IT.

var. **Amphirhyncus** (Ehrenb.) De Toni.—C, D, L.

var. **producta** (W. Sm.) V. H.—D, W, C, SL.

lanceolata Kütz.—C, L; D, 51 × 10μ.

var. **phyllepta** (Kütz.) V. H.—C; W, small forms 23 × 6μ.

limosa Kütz.—M, L, D; C, 53 × 9μ, a narrow form; W, 66 × 17·5μ, 54 × 14·3μ, 56 × 13·3μ.

var. **gibberula** (Kütz.) V. H.—IT, L.

Legumen Ehrenb.—SL, Cr; C, 76 × 15·3μ; W, 75·5 × 14·6.

var. **decrescens** Grun.—D, 70 × 13·4μ, a narrow form.

Navicula major Kütz.—W, M, IT, D, CI, L, SL; C, 171 × 26μ (girdle-view). In one gathering S. of Dugort, a small form occurred averaging 135 × 24μ, girdle-view.

mesolepta Ehrenb.—C; M, 56 × 11μ; IT, L, W; D, 58·5 × 12·5μ.

var. **Termes** (Ehrenb.) V. H.—C, 47 × 9μ valve-view; Cr; D, 27 × 6μ, valve-view, up to 47 × 11·6μ; L.

var. **PROTENSA** var. nov.—Var. cellulis multe angustioribus quam in forma typica, lateribus regulariter triundulatis, average size 63 × 8·8μ. W.

****minima** Grun.—B.

nobilis (Ehrenb.) Kütz.—W, 330 × 53μ; C, L, CI, D; M, 278 × 49μ (valve-view), others 225 × 60μ (girdle-view).

var. **Dactylus** (Ehrenb.) (V. H.)—C, 200 × 34μ, valve-view; M, one form was relatively narrow, 260μ long, 35μ wide, another 184 × 22·7μ.

oblonga Kütz.—L.

peregrina Kütz.—C, L, SL, W, D, VL.

var. **PRODUCTA** var. nov.—Var. polis distincte productis, cellulis latioribus quam in forma typica. Formae majores 118–119 × 37·5μ, formae minores 71 × 29μ. C. (Pl. II, fig. 22.)

Pupula Kütz.—D, 30 × 9μ, among *Hippuris vulgaris.*

pusilla W. Sm.—D, in fresh water 200 yards from the sea; C, a narrow form in fresh water 39·5 × 15·4μ; W, 29 × 13·3μ.

var. **PUSILLISSIMA** var .nov.—Var. cellulis multe parvioribus, 24 × 12·6μ. D.

radiosa Kütz.—C, 55 × 10μ; K; L, a narrow form, average size 70 × 9·5–10μ; IT, I, VL, CI, M; W, 60 × 11·6μ; D, LG.

var. **acuta** W. Sm.—C, 92 × 12·5μ, 83 × 9·3μ, valve-view; L, D, W, Cr.

Rabenhorstii Ralfs.—W.

rhyncocephala Kütz.—C, M, L; D, 51 × 10·8μ; SL; W, a narrow form 48 × 10μ, as well as typical forms.

var. **amphiceros** V. H.—D, 44 × 13·3.

f. **robusta** Rabenh.—W.

****seminulum** Grun.—C.

serians (Bréb.) Kütz.—C, SL, L, CI, W, SL.

var. **brachysira** (Bréb.) V. H.—M.

var. **thermalis** Grun.—B.

sphaerophora Kütz.—C, 60 × 20μ.

***sublinearis** Grun.—M, I.

Navicula stauroptera Grun.—L; Cr, 92 × 15μ, valve-view.

Tabellaria Ehrenb.—W, 113 × 15μ, another gathering 112 × 15·5μ, 103 × 13·3μ; C, 114 × 16μ; M, 120 × 19μ, also small narrow forms, 83 × 10μ; S, 108 × 12μ; L.

var. **acrosphenia** Rabenh.—W.

***vulpina** Kütz.—W, 84–90 × 12·5–14·3μ; M, 88 × 14·3μ.

viridula Kütz.—C, L, SL, Cr; W, 72·6 × 16·5–17μ; M, 70 × 16·5μ.

f. **minor** V. H.—W, 44 × 10μ; C, 50 × 10μ, valve-view.

var. **slesvicensis** (Grun.) V. H.—D, 41 × 11μ, 51 × 13μ; W, 54 × 12·5μ.

var. **avenacea** (Bréb.) V. H.—L, 46 × 8·5μ, valve-view.

viridis Kütz.—C, M, IT, I, L, CI, B; W, 91 × 15·3, girdle-view; SL, CP; D, 102 × 22μ, valve-view; Cn; Croaghmore cliffs.

var. **commutata** Grun.—C.

var. **ANGUSTATUM** var. nov.—Var. cellula angusta, diametro 7-plo longiori, apicibus non attenuatis. D, 87 × 12·5μ.

Vanheurckia rhomboides (Ehrenb.) Bréb.—W; M, up to 94 × 20μ; L, D; C, 84 × 16μ.

var. **saxonica** (Rabenh.) W. & G. S. West.—C, 51–63 × 13·3–15·4μ; L, As, M, CP, SL, IT, DL, S, I, W, B, CI, D, Cn.

viridula Kütz.—C, L, SL, Cr, W; CP, 108 × 21μ, also from another place 73 × 13μ.

vulgaris (Theo.) V. H.—C.

Amphipleura pellucida Kütz.—L, W, SL.

***Gyrosigma acuminatum** (Kütz.) O.K.—L, 126 × 14μ, smaller forms 101 × 13·5μ; W, 122 × 13·5μ.

attenuatum (Kütz.) Rabenh.—L; W, 227–235 × 27·5–29μ; VL.

var. **scalprum** (Grun.) O.K.—C; W, 127 × 21·3μ.

Spencerii (Quekett) O.K.—W, C.

var. **nodifera** (Grun.) O.K.—Croaghmore cliffs.

****curvulum** (Ehrenb.) Rabenh. f. **longior** (V.H.)—C, 155 × 14·5μ.

Tribe **Gomphonemeae.**

Gomphonema acuminatum Ehrenb.—C, W, IT, L, I, CI, D; Cn, 64–69 × 11·5–14μ, valve-view.

constrictum Ehrenb.—L, 37·5 × 11·5μ, valve-view; W, D, VL; CP, 34–42μ long, 15–18μ broad, breadth of stalk 4μ.

var. **capitatum** (Ehrenb.) V.H.—L, D, CP.

Gomphonema gracile Ehrenb.—C.

var. **dichotomum** (Kütz.) V.H.—B, W, D; Cr, 44 × 6·5μ, valve-view; Croaghmore cliffs, K.

intricatum Kütz.—C, I, B, W, LG.

var. **Vibrio** (Ehrenb.) V.H.—B, D, LG.

var. **pumila** Grun.—B.

***montanum** Schumann var. **subclavatum** Grun.—C.

var. **commutatum** Grun.—C, 41μ long, 9μ greatest breadth in valve-view; W, 44 × 8·4μ, also in another place 44 × 9·5μ.

olivaceum (Lyngb.) Kütz.—C, L, I, VI, D, CP.

parvulum Kütz.—C, LG, M.

Rhoicosphaenia curvata (Kütz.) Grun.—L, on *Cladophora crispata*; C, on *C. flavescens* and *Rhizoclonium hieroglyphicum*.

Tribe **Achnantheae.**

Achnanthidium flexellum Breb.—W; C, 31·5 × 15·8μ, valve-view, 35–38 × 14·6–16μ.

Achnanthes exilis Kütz.—C; W, 24μ long, average size; S, IT, L, I, B, D, LG; CP, 16–20μ long; Cr; K, 20μ long.

linearis (W. Sm.) Grun.—C, L.

biasolettiana Grun.—C, IT, B, L, W, Cr.

***minutissima** Kütz.—C, 22–24 × 4·5μ, valve-view.

microcephala (Kütz.) Grun.—C, CP.

Tribe **Cocconeideae.**

Cocconeis Pediculus Ehrenb.—C, IT, D, W, L, on *Cladophora crispata*.

Placentula Ehrenb.—C, 18–36 × 12·5–23μ; L, I, D, W.

var. **lineata** V. H.—C.

DIVISION II. PSEUDRAPHIDIEAE.

Tribe **Epithemieae.**

Epithemia Argus (Ehrenb.) Kütz.—C, 41–44 × 10μ valve-view, girdle-view 18μ; L, B.

var. **amphicephala** Grun.—C, 41·6 × 9·1μ average; W.

turgida (Ehrenb.) Kütz.—C, average size 79·5–92·5μ long, 16·5–17μ broad, valve-view; IT, L, W.

var. **Westermanni** Kütz.—L, W.

gibberula (Ehrenb.) Kütz. var. **producta** Grun.—Cr; D, 26–34μ long; M length 37·5μ; C, length 36–37μ, in another place 30μ long; B, I, CI.

Epithemia zebra (Ehrenb.) Kütz.—C, 49 × 10μ, valve-view; I, D, L, Croaghmore cliffs.

var. **proboscidea** Grun.—C, 55 × 8·5μ valve-view; D, Croaghmore cliffs.

Hyndmanni W. Sm.—C, 166 × 30μ; Croaghmore cliffs (a small form). A very rare diatom.

Sorex Kütz.—IT; LW, 40μ long, 12μ across, girdle-view.

Rhopalodia gibba (Kütz.) Otto Müll.—C, 128–143μ long × 12·8–13μ, girdle-view; L, I, B, D; W, 118–140μ long; VL.

var. **ventricosa** (Kütz.) Otto Müll.—C.

Eunotia Arcus Ehrenb.—M, W.

var. **bidens** V. H.—W, M; C, 31·6 × 4μ, valve-view; L; D, 32 × 5·2μ, valve-view.

var. **minor** V. H.—C, CI, M, B, SL, CP; D, 26–27 × 4μ; Croaghmore cliffs.

var. **uncinata** V. H.—B, M.

var. **hybrida** Grun.—I.

var. **tenella** Grun.—C.

monodon Ehrenb.—CP.

diodon Ehrenb.—SL, C, PC.

***triodon** Ehrenb.—M.

flexuosa Kütz. var. **bicapitata** Grun.—W.

***exigua** (Bréb.) Rabenh.—C, D, CP, L.

var. **nymanniana** Grun.—W.

Faba (Ehrenb.) Grun.—D; W, 19·3 × 5·6μ.

gracilis (Ehrenb.) Rabenh.—C, M, L, I, SL; D, short forms 53 × 3·4μ also in another gathering 136 × 3μ; W.

****impressa** (Ehrenb.) var. **angusta** Grun.—D, 20–25 × 3–3·3μ.

lunaris (Ehrenb.) Grun.—C, L; W, many were measured from 23 to 98μ long from the same gathering, usually 3·2–4μ wide; Ac, M, VL, AS, I, CI, D, B, SL, CP, Cn.

var. **bilunaris** (Ehrenb.) Grun.—L, D; W, 28·5 × 5·5μ.

var. **excisa** Grun.—Variable in length, 14–31 × 5–6μ.

var. **subarcuata** (Näg.) Grun.—D, L.

var. **EMARGINATOVALIDA** nov. var.—Var. cellulis emarginatis ad latus ventrale, crassioribus brevioribusque quam in formas ceteras. D, among *Hippuris vulgaris*. This variety has twice the breadth of Van Heurck's figure of *E. lunaris* var. *excisa* Grun. (=*Synedra falcata* Bréb.). His figure measures 30 × 4·6μ; the Irish specimens are 24 × 7·2μ. (Plate II, fig. 21.)

Eunotia major (W. Sm.) Rabenh.—C, L; W, 122μ long; D, 152μ long.
var. **bidens** V. H.—SL.
**minor (Kütz.) Rabenh.—W, 31 × 6μ, valve-view.
pectinalis (Dillw.) Rabenh.—C, K, Ac, M, W; S.W. of D, 95 × 31μ, girdle-view.
var. **undulata** Ralfs.—D, 60–65 × 5–5·3μ.
var. **Soleirolii** Kütz.—W.
var. **ventricosa** Grun.—CP.
var. **stricta** Rabenh.—D, 40μ long.
f. **elongata** V. H.—B, W.
f. **curta** V. H.—D; W, 25 × 7μ valve-view.
praerupta Ehrenb.—L; W, 35 × 7μ; C, 55 × 9·5μ.
var. **bidens** (Ehrenb.) Grun.—C; D, 43μ long.
var. **inflata** Grun.—L.
var. **curta** V. H.—L; W, 34 × 6·3μ.
robusta Ralfs var. **tetraodon** V. H.—M.
Ceratoneis Arcus Ehrenb.) Kütz.—C, L; CP, 40–45 × 5–6μ, a constantly short form; W, 36·6 × 4μ.

Tribe **Synedreae.**

Synedra Acus Kütz.) Grun.—C, W; L, 132 × 6·6μ, valve-view; I, B, D, Croaghmore cliffs, K.
var. **delicatissima** W. Sm.—W; C, 88μ long; CP, 112 × 4μ, valve-view.
amphicephala Kütz.—LG, L; W, 35 × 3·2μ.
famelica Kütz.—C, L, I, B, D, LG, CP.
pulchella Kütz.—C, W; L, 53·5 × 6μ, valve-view; CP, 114–132μ long, 7·2μ broad at middle, 4·9μ at apices.
var. **Smithii** Ralfs.—VL; D, 121 × 5μ, valve-view.
f. **major** V. H.—C, 133–136 × 7–7·6μ.
radians (Kütz.) Grun.—VL, C, CI, M, W, B; L, 61 × 1·6μ, valve-view.
Ulna (Nitzsch.) Ehrenb.—L, C, K, I, VL, CI, D; W, average length 220μ, up to 260μ; CP, Croaghmore cliffs.
var. **amphirhynchus** (Ehrenb.) V.H.—C; W, 164 × 5μ, valve-view.
var. **splendens** (Kütz.) Grun.—W.
var. **lanceolata** (Kütz.) V.H.—W.
var. **danica** (Kütz.) V.H.—C, 244 × 5μ, valve-view; W, a broad form 188 × 7·5–8μ, valve-view; L.
Vaucheriae Kütz.—C, M.

Asterionella formosa Hass.—C, K, VL, W.
gracillima Heib.—Plankton of Roonah Lough near L.

Tribe **Fragilarieae.**

Fragilaria capucina Desm.—SL, L; D, 35–55 × 11·9–14·7μ, girdle-view; CP, 32–55μ long; M, 33–61μ long; Ac, W.
mutabilis (W. Sm.) Grun.—C, SL, W, L, IT, LG, VL, CI, B, D, CP.
virescens Ralfs.—C, L, I, W.
construens (Ehrenb.) Grun.—C.
***Harrisonii** (W. Sm.) Grun.—D.

Tribe **Meridioneae.**

Meridion circulare (Grev.) Ag.—C; CP, 26 × 11μ apex of valve-face; W, 30–38μ long; D.

Tribe **Diatomeae.**

Diatoma vulgare Bory.—L, CI, D.
anceps (Ehrenb.) Grun.—W.
elongatum Ag.—C, 46–51 × 5·5μ, girdle-face; L, CI, W, LG, VL, CP; D, 60 × 5·6μ, girdle-face; Croaghmore cliffs.
hiemale (Lyngb.) Heib.—S.
var. **mesodon** (Kütz.) V.H.—S; CP, some only 13μ long; D.
var. **tenue** (Ag.) V.H.—C, L.
Denticula tenuis Kütz.—C, SL, LG, D.
var. **inflata** (W. Sm.) V.H.—C.
var. **frigida** Kütz.—C, in several places.

Tribe **Tabellarieae.**

Tabellaria flocculosa (Roth) Kütz.—C, L; W, 22 × 6μ (valve-view); Ac, K, M, IT, SL, I, B, D, Cr, CP.
fenestrata (Lyngb.) Kütz.—C, 57–5 × 4·5, valve-view, average size; L, W, Ac, D, W, LG.

Tribe **Surirelleae.**

Cymatopleura Solea (Bréb.) W. Sm.—W, D.
Surirella apiculata W. Sm.—W.
biseriata Bréb.—C; W, up to 197 × 57·5μ; M; SL, 144 × 50μ.
elegans Ehrenb.—C, 201 × 65μ.
linearis W. Sm.—W.

Surirella ovalis Bréb. var. **ovata** (Kütz.) V. H.—C, B; L, mouth of Bunowen River in brackish water, forms near var. *crumena* (Bréb.), 33–34 × 21–22μ.

var. **angusta** (Kütz.) V. H.—C.

var. **minuta** (Bréb.) V. H.—C, 22·5 × 13μ.

var. **pinnata** (W. Sm.) V. H.—C, L, VL, M, IT, D, SL.

var. **panduriformis** (W. Sm.) W. West.—SL.

var. **SUBMAMILLATA** var. nov.—Var. cellulis late ellipticis apicibus productis in mamillis brevibus. W, 38·5 × 16·5μ, also 30 × 13μ and 29 × 12·5μ.

spiralis Kütz.—B, L, W.

robusta Ehrenb. (*S. nobilis* W. Sm.).—W, 246μ long; SL; M, 310 × 72μ.

var. **splendida** (Ehrenb.) V.H.—W; C, 205 × 76μ.

Tribe **Nitzschieae.**

Hantzschia amphioxys (Ehrenb.) Grun.—C.

Nitzschia curvula (Ehrenb.) W. Sm.—W.

***communis** (Rabenh.) Grun.—B.

****Clausii** Hantzsch.—C, in a freshwater pool close to sea.

***dissipata** Kütz. var. **acuta** V.H.—C, LG.

apiculata (Greg.) Grun.—C, 30–32 × 4–5·5μ, in brackish water.

linearis (Ag.) W. Sm.—C, I, DL; W, 74 × 9μ, girdle-face.

var. **tenuis** Grun.—D.

sigmoidea (Ehr.) W. Sm.—D, 335 × 20·5μ, girdle-view.

***obtusa** W. Sm.—CI; C, a form approaching var. *scalpelliformis* Grun., 92·5 × 6·6μ; L.

var. **scalpelliformis** Grun.—D.

var. **brevissima** Grun.—I, L.

****subtilis** Grun.—D, 53μ long; W, 74μ long; SL, 60 × 4·5, valve-view.

var. **paleacea** Grun.—C, 33μ long, 35 × 4·5 μ from another place; D, 46 × 2·8μ.

parvula W. Sm.—W.

Palea (Kütz.) W. Sm.—C, 57·5 × 5·5μ average; VL, L; D, 40 × 4·3μ, valve-view; W.

var. **debilis** V. H.—C, L, W.

var. **tenuirostris** Grun.—C, 55 × 48μ.

var. **fonticola** Grun.—C, 18μ long; W, up to 28μ long, 4μ broad.

Nitzschia Sigma W. Sm.—L, in several places, also in brackish water, mouth of Bunowen River with *Navicula digitoradiata*; B, W. (C, N, E, also, in sea-water).

var. **rigida** (Kütz.) Grun.—C, I M, Croaghmore cliffs.

Tryblionella Hantzsch. var. **littoralis** (Grun.) V.H.—C.

var. **Victoriae** Grun.—AS.

thermalis (Kütz.) Grun.—L, D; C, 82·5 × 11·6μ.

***vermicularis** (Kütz.) Grun.—C, L; M 196 × 6μ; IT, I, CI; W, 96 × 4·8μ; B; W, 166μ long, girdle-face 10μ broad.

***vitrea** Norman.—W, 81 × 16·6μ (girdle-view).

sinuata (W. Sm.) Grun.—L, C.

Division III. CRYPTORAPHIDIEAE.

Tribe **Melosireae.**

Melosira varians Ag.—C, mostly 12–12·5μ broad in one locality, in another 30–31μ broad; VL, D; W, 15–30μ broad; CP; Cr, 21μ broad average size.

granulata (Ehrenb.) Ralfs.—D, among *Hippuris vulgaris*; C.

Cyclotella operculata Kütz.—C, L, B.

meneghiniana Kütz.—C, 13–13·5μ broad; L, 15μ broad.

kuetzingiana (Thw.) Chauvin.—W, 16μ broad.

comta (Ehrenb.) Kütz.—W.

var. **radiosa** Grun.—W, 43–45μ broad.

Class MYXOPHYCEAE (Cyanophyceae)

Sub-Class I. Glaucocystideae.

Glaucocystis nostochinearum Itzig.—L.

Sub-Class II. Archiplastideae.

Order I. COCCOGONEAE.

Fam. **Chroococcaceae.**

Chroococcus limneticus Lemm.—K, D, VL; DL, 8–10μ broad.

***membraninus** (Menegh.) Näg.—C, usually quadrigeminate and distinctly angular. Agrees with Kützing's original figure.

***macrococcus** (Kütz.) Rabenh.—M, cells 37–40μ broad; C, IT; Cr, cells 29–32μ broad; I; CI, cells 30–32μ broad; W; D, cells 28–30μ broad; S.W. of D, cells 34–42μ broad, thickness of integuments outside cells 12μ.

Chroococcus minutus (Kütz.) Näg.—D, diameter of cells 5–6μ.

var. **minimus** (V. Keissler) Lemm.—C, L, Mw, M; VL, 2·2–2·5μ broad; D, 2–2·2μ broad.

minor (Kütz.) Näg.—C, in several localities, 3·0–4·5μ broad; M, 3·3–4μ broad.

pallidus Näg.—C, L.

turgidus (Kütz.) Näg.—C, CP; LG, a large form, intensely aeruginose, with cells up to 22·5μ in diameter, sheaths up to 59 × 72μ; W; Cr, average size 18μ broad; S.W. of D, 20–22 broad, with integument 34μ.

Synechococcus aeruginosus Näg.—C, 17·5 × 11μ; IT, W; D, a peculiar subrotund form 24 × 21μ.

f. **ANGUSTIOR** f. nov.—F. cellulis relative angustioribus, circiter 25 × 10μ. C.

***crassus** Arch.—M; C, 31–32 × 20μ; W, 42 × 26·6μ (incipient division showing); B, 35 × 17μ.

f. **crassior** Lagerh.—SL, in a small tarn, 38·4–41·6μ long, 29–38·3 broad, colour almost blue with hardly any trace of green.

MINUTUS sp. nov.—S. cellulis singulis, ellipticis, utroque polo rotundatis, circiter 3·3μ latis, 1$\frac{1}{3}$-plo longioribus, contentu pallide aerugineo et granuloso. *Hab.*—in paludibus divitibus cum desmidiis, diatomis, et algis aliis. M.

***Dactylococcopsis acicularis** Lemm.—B, not more than 1·6μ broad.

***fascicularis** Lemm.—CI; C, a variety or form much less contorted.

rhaphidioides Hansg.—L, a small form 6 × 1μ; C, 14–15 × 2·5–3μ.

Gloeocapsa Magma (Bréb.) Kütz.—CP.

***muralis** Kütz.—Cr, cells ellipsoid, 4 × 6μ, masses brown.

***punctata** Näg.—C, cells 0·8–1·6μ.

***rupestris** Kütz.—L, 6–10μ broad without integuments.

montana Kütz.—C, 3·5–5μ broad without integuments.

Gloeothece confluens Näg.—C, 6–8 × 3–3·3μ; AS, average size 5 × 2·5μ; D, mostly 3–5 × 1·8–2μ.

linearis Näg.—C, SL.

forma **ANGUSTA** f. nova.—F. cellulis 1–1·4 lat. rectis subcurvatisque. LG.

rupestris (Lyngb.) Born.—D.

***Aphanocapsa elachista** W. & G. S. West.—C. 1·4–1·5μ lat.; LR, 1·4–1·6μ; DL, 1–5–2μ, spherical.

Grevillei (Hass.) Rabenh.—C; CR, 3·3–5μ.

***testacea** Näg.—B, 7·5–8μ: C, 8–8·5.

***Aphanocapsa rivularis** (Carim.) Rabenh.—M.

virescens (Hass.) Rabenh.—SL, 6·6—8μ broad.

***Aphanothece conferta** P. Richt.—C, colonies 35–70μ, 2–2·5 × 3–4μ.

microscopica Näg.—SL; LG, 3·5–4 × 6–7μ; VL, B; C, 3·3–4μ × 7·5–8μ, also in brackish water, 3–3 × 7–9μ.

saxicola Näg.—DL, 2–5 × 1–2μ; W, L; S, 2 × 1μ.

***stagnina** (Spreng.) A. Br.—C, 3·3–3·5 × 5–6·7μ; associated and interlaced with the floating gelatinous mass was *Lyngbya Rivulariarum* in plenty.

***Microcystis elabens** (Bréb.) Kütz.—C.

***firma** (Bréb. & Lenor.) Schmidle.—LG, colonies distinct, 20–30μ broad, cells circiter 1μ broad; DL, 1–1·5μ broad.

***Flos-aquae** (Wittr.) Kirchn.—CI, W.

incerta Lemm.—K; S. W. of D, 2μ broad, sometimes slightly ovoid.

***ichthyoblabe** Kütz.—W, K.

marginata Menegh.—C.

MINUTISSIMA sp. nov.—M. cellulis oblongis et confertis, aerugineis, post divisionem subrotundatis, 0·8–1μ latitudine (interdum 1·2μ), 1·1–1·5μ longitudine (interdum 2μ); familiis irregularibus in margine, circiter 40–140μ (interdum majoribus), tegumento hyalino. *Hab.*—in locis paludosis libere natans. C, SL, VL.

stagnalis Lemm.—C, Mw; SL; S. W. of D, 1·5–1·8μ broad.

***Clathrocystis elongata** W. & G. S. West.—DL.

Gomphosphaeria aponina Kütz.—C, L, K.

lacustris Chod.—Plankton of LG, 32–40μ broad usually, also among Bulbochaete attached to *Lobelia Dortmanna*.

Coelosphaerium kuetzingianum Näg.—C, M; plankton of RL and LG; SL; L, in a small lake; W, Cr.

Merismopedium aerugineum Bréb.—D.

elegans A. Br.—C, W; SL, 6–6·6 × 7–8·3μ.

glaucum (Ehrenb.) Näg.—L, SL, C, M, IT, CP, I, SL, CI, W, VL, DL, Cr; D, cells 4–5μ broad.

punctatum Meyen.—Cr, W.

tenuissimum Lemm.—W; C, 1·6–2μ, in another gathering 0·7–0·8μ; Cr, 0·9–1μ, in another gathering 1·2μ.

Eucapsis alpina Clements & Schrautz.—Small tarn on Slievemore. This plant has been recorded only once before, from a pond on a mountain in Colorado, and as no British publication contains it, I give a description:—"Colonies 30–80 mic. in diameter, usually containing 32–128 cells, cubical, free-floating; tegument colourless; cells 6–7 mic. in

diameter, spherical, more rarely elliptic, in cubical families; cell-contents blue-green." I perhaps ought also to add that I had described this plant in my manuscript as a new species of Merismopedium, necessitating an alteration in the definition of the genus; this was some time before I came across a description of Eucapsis, so I think it may be of interest to publish just what I had written before I knew of Eucapsis:—"*Merismopedium cubicum* sp. nov. Familiis e cellulis 64 compositis, 4 longitudine, 4 latitudine, et 4 in altitudine, in strato mucoso distincto et hyalino, cellulis confertis et angulato-globosis, contentis aeruginosis, 5–6·6μ lat. The specimens seen consisted of four families, held together by their gelatinous investment and arranged in a square. The genus Merismopedium will require amending to include this species which had certainly divided in three directions of space as in the bacterial genus Sarcina."

***Holopedium irregulare** (Lagerh.) Hansg.—C, 2–2½μ.

Tetrapedia reinschiana Arch.—Cr, D, DL, L, VL, C.

Fam. **Chamaesiphonaceae.**

***Chamaesiphon incrustans** Grun.—L, on *Cladophora crispata*; AS, C; VL; D, on Copepods.

***curvatus** Nordst.—DL, 3–4μ broad, 18–24μ long.

Order HORMOGONEAE.

Sub-Order PSILONEMATEAE.

Fam. **Oscillatoriaceae.**

Sub-fam. Oscillatorieae.

Oscillatoria Agardhii Gom.—C, in many places, 3·6–4μ broad, 2μ long, also 4·5–5μ broad, cells ½ to ⅔ as long as broad, all distinctly capitate; M, 6μ broad, 3–4μ long; S, 4·2μ broad, ⅔ as long as broad.

amphibia Ag.—C, W; M, 2·5μ broad, 3μ long; CP, 2·5–3μ broad, 4μ long; S; Ac, 2·6–3·1μ broad, 3·6–4μ long.

***angustissima** W. & G. S. West.—C, 0·6–0·66μ broad, in another place 0·7μ broad, 1·1μ long.

formosa Bory.—CP, 5–5·5 broad, average length 3–4μ.

limosa Ag.—M, 11μ broad; C, 16–17μ broad, cells six times shorter than broad; L, 14–15μ broad, cells 5 times shorter than broad; I, 12μ broad, cells 3 times shorter than broad; CI, cells 4 times shorter than broad; M; W, 13·3–14·3μ broad, 2·5–3μ long; Cr; SL, a well-marked form, 9·5–11μ broad, 6–8μ long, apical cell subcapitate; W, 12μ broad, 3·5μ long.

Oscillatoria nigra Vauch.—L; D, 8μ broad.

nigro-viridis Thw.—W.

princeps Vauch.—C, 26·6–28·3μ broad, cells 6 times shorter than broad; W; 23–25μ broad; Cr, 27·5–30μ broad; D, a smaller form, 20μ broad.

splendida Grev.—W.

subtilissima Kütz.—C.

tenuis Ag.—C, 9·5μ broad, 4·5μ long; L; Mw, a form with cells as long as broad; VL; M, 8·4μ broad, 3μ long.

Sub-fam. Spirulineae.

Spirulina subsalsa Oersted.—W; C, thickness of coil 4μ, of trichome 1·3μ, in fresh water in both cases.

major Kütz.—S.W. of D, breadth of spiral 4μ, breadth of filaments 1·6μ, distance between turns 3–4μ.

Sub-fam. Lyngbyeae.

Phormidium inundatum Kütz.—VL.

P. subfuscum Kütz.—W.

tenue (Menegh.) Gom.—Ac, 1·3μ broad, 2μ long; C, mostly 1·5μ broad, but sometimes up to 2·5μ; Mw, LG, L, CI.

Lyngbya aestuarii (Mart.) Lieben.—C, filaments 26μ broad, cells 6–7μ long; VL, filaments 12·5–13·5 broad, cells 1·7μ long.

aerugineo-coerulea (Kütz.) Gom.—L, filaments 3·6–4μ broad, cells 2–2·5μ long; VL, filaments 5·5–5·8μ broad, cells 2·5–3·3μ long; M.

***Diqueti** Gom.—M, filaments 2·5–3μ broad, cells 2·2–3 long.

limnetica Lemm.—D.

martensiana Menegh.—C, filaments 11μ broad, trichomes 6·5μ broad; CP, filaments 7·5–8·2 broad, cells 2·5–3μ long, rosy-violet.

CLIARENSIS sp. nov.—L. filis singulis libere natantibus, rectis vel subrectis, 11·5–12·0μ lat., rigidis, vaginis hyalinis et crassis, 1·7μ crassitudine, trichomatibus coeruleo-aerugineis, contentu granulis sparsis, 6–6·7μ lat. articulis valde inequalibus, diametro semper longioribus, 9–24μ long. (Plate I, fig. 7.) C.

***putealis** Mont.—D, a form not more than 8μ broad with sheath, trichomes 7μ, cells mostly subquadrate.

***Rivulariarum** Gom.—SL, 0·9μ broad; L, C, VL; C, 0·8μ broad; LG, DL, Cr.

subtilis West.—M, 1·5–1·6μ broad, 2·2–2·5μ long; W; I, 1·6μ broad, 2–2·1μ long; RL, 1·6μ broad; L.

Sub-fam. Schizotricheae.

***Inactis tinctoria** (Ag.) Thur.—LG; M, trichomes 1–1·5μ broad.
Dasygloea amorpha Berk.—SL, AS.

Fam. **Nostocaceae.**

Sub.-fam. Heterocystidae.

***Nostoc. minutum** Desm.—W, C; L, trichomes 3–3·3μ broad; LG, I, CI, B. This was often noticed within the empty tests of Rhizopoda.
coeruleum Lyngb.—CP.
***Anabaena confervoides** Reinsch.—C, a small form. 1·4–1·8μ broad, heterocysts 2·5μ broad, 4μ long, subangular; D, trichomes 2μ broad.
Flos-aquae (Lyngb.) Bréb.—L, RL, CI: Cr, trichomes 4–6μ broad, heterocysts 8·5 broad.
var. **MINOR**, var. nov.—Var. ut in forma typica sed latitudine cellularum 2·5–3μ, heterocystis 3·5–4·5μ. C.
Hassallii Wittr.—W.
oscillarioides Reinsch.—VL, 3–3·2μ broad, heterocysts 3·4–3·6μ broad, 4·2–5·4μ long.
variabilis Kütz.—C, 2·5–3μ broad; L, M, B.
***inaequalis** (Kütz.) Born. & Flah.—N. W. of D. trichomes 5μ broad, spores 12·5–15μ long, 6–6·7μ broad, heterocysts sub-spherical, 6μ broad.

Fam. **Scytonemaceae.**

***Plectonema nostocorum** Born.—L; AS. with *Dasygloea amorpha*, *Stigonema turfaceum* and other algae.
***Scytonema amplum** W. & G. S. West—forma **HIBERNICA**, f. nov.—F. filis 13–15μ lat., trichomatibus 3·2–3·5μ lat., aerugineis, vaginis achrois. IT.
Tolypothrix distorta (Hofm.-B.) Kütz.—C, VL, CI; M. sheaths 15μ, trichomes 9μ.
lanata (Desv.) Wartm.—M.
tenuis Kütz.—C.

Fam. **Stigonemaceae.**

Hapalosiphon hibernicus W. & G. S. West.—C: W. 7–9μ broad; M; LG, associated with *Bulbochaete insignis*; S.W. of D, 8–9μ broad in several places.
Stigonema mammillosum (Lyngb.) Ag.—M.
minutum (Ag.) Hass.—C, M, RL, D.
turfaceum (Berk.) Cooke.—I, AS, D.

Sub-order TRICHOPHOREAE.

Fam. **Rivulariaceae.**

Calothrix fusca (Kütz.) Born. et Flah.—L; SL, sheaths up to 13·5μ broad, trichomes 6–8·4μ broad.

parietina (Näg.) Thur.—M.

Rivularia beccariana (De Not.) Born. et Flah.—C, abundant on stones in tumbling rill on Croaghmore, many measured up to 3·5 millimetres, 1 mm. is the usual measurement. This was exceptionally fine in one place where *Trichocolea tomentella* occurred.

haematites (DC.) Ag.—W.

nitida Ag.—On rocks near Roonah Point near L.

echinulata (Sm.) Born. et Flah.—C; plankton of LG.

[Such plants as *Rivularia atra*, which always grow subject to salt-water influence, I have purposely left to the marine algologist.]

Class FLAGELLATA.

Dinobryon cylindricum Imhof. var. **divergens** Lemm.—C.

elongatum Imhof., var. **undulatum** Lemm.—CP, D.

protuberans Lemm.—C, I, CI.

sociale Ehrenb.—D, VL, M.

Sertularia Ehrenb.—C.

var. **thyrsoideum** (Chod.) Lemm.—C, CP, S. W. of D.

Euglena viridis Ehrenb.—C, L, W, CP.

***Synura uvella** Ehrenb.—S. W. of D.

Class PERIDINIEAE.

Glenodinium pulvisculus (Ehrenb.) Stein.—C, M, I, CI, SL, Cr, D.

Ceratium hirundinella O. F. Müller.—K, Ac, LG, VL.

cornutum (Ehrenb.) Clap. et Lachm.—Cr; SL, associated with abundance of *Anuraea cochlearis* and *Notholca longispina*.

Tripos (Ehrenb.).—DL. These agreed with published figures of this plant, the examples were scarce, and may have been brought to the fresh-water lake (which is close to the sea) by the numerous gulls.

Peridinium tabulatum (Ehrenb.) Clap. et Lachm.—SL.

Willei Huitfeldt-Kaas.—C, As, D, SL.

Associations of Algae.

Associated with *Oedogonium Braunii* as the dominant feature in one pool in Clare Island were:—*Pediastrum tetras* in great abundance, *Coelastrum sphaericum* frequent, *Lyngbya Rivulariarum* mostly clinging to and around the Oedogonium, *Anabaena inaequalis* mostly agglutinated to the Oedogonium by its sheath, and various forms of *Scenedesmus quadricauda* with *Tetrapedia reinschiana*. Mixed up with the rest, but in much smaller quantity, were:—*Scenedesmus obliquus, S. acutiformis* v. *brasiliensis, Pediastrum boryanum* v. *productum, Tetraedron caudatum, Ankistrodesmus falcatus, Merismopaedia tenuissima, Dactylococcopsis fascicularis* v. *subrecta, Staurastrum punctulatum* var. *pygmaeum, Cosmarium laeve* var. *octangularis, C. humile, C. Meneghinii, C. punctulatum* var. *subpunctulatum.*

In a pool near the light-house on Clare Island the following were in a mixed association with *Sphagnum cuspidatum* and *S. subsecundum*:—*Eremosphaera viridis, Ulothrix variabilis, Chlorobotrys regularis, Ophiocytium cochleare, Botryococcus Braunii, Asterococcus superbus, Scenedesmus bijugatus, Dimorphococcus lunatus, Schizochlamys delicatula, Microthamnion kuetzingianum, Glenodinium cinctum, Chroococcus minor, Nostoc microscopicum, Navicula viridis, N. Tabellaria, Vanheurckia rhomboides* v. *saxonica, Netrium Digitus, Closterium Lunula, C. Cynthia, C. calosporum, C. turgidum, Euastrum bidentatum, E. elegans, E. Didelta, E. binale, Micrasterias apiculata*, v. *fimbriata, M. angulosa, M. rotata, Cosmarium angulosum* v. *concinnum, C. Cucumis, C. Brebissonii, C. difficile* v. *laeve, Xanthidium antilopaeum, Tetmemorus granulatus, T. Brebissonii, Staurastrum margaritaceum, S. aciculiferum, S. polymorphum, S. hirsutum, Desmidium cylindricum, Hyalotheca dissiliens*, &c.

An association in a small pool on the top of Croaghmore, Clare Island, at about 1,500 feet elevation, contained as the main feature *Chroococcus turgidus*; in much smaller quantity were *C. macrococcus* and *C. pallidus*; *Tribonema bombycina* was also in quantity; the rest consisted of *Vanheurckia rhomboides* v. *saxonica, V. vulgaris, Navicula viridis, Gloeocystis vesiculosa, G. rupestris, Aphanocapsa testacea, Mesotaenium macrococcum* v. *micrococcum, Euastrum binale* v. *Gutwinskii, Cosmarium Cucurbita, C. sphagnicolum, Staurastrum margaritaceum, S. Avicula* v. *subarcuatum*, &c.

Another association from a pond of fairly aerated water near the hotel, Clare Island, was chiefly *Rhizoclonium hieroglyphicum* and *Cladophora flavescens*, amongst which were *Ulothrix variabilis, Myxonema nanum, Lyngbya Rivulariarum, Characium Pringsheimii* epiphytic on a sterile Oedogonium,

Scenedesmus horridus, Cosmarium laeve, Merismopaedia glauca, Synedra pulchella, Diatoma elongatum, Fragilaria mutabilis, Rhoicosphaenia curvata, Navicula elliptica, N. cryptocephala, N. amphisbaena, &c.

In an association in a pool on Croaghmore, among a small quantity of a barren Œdogonium and a Bulbochaete the dominant species was *Closterium moniliferum*, and *Netrium Digitus* was sub-dominant; the rest are enumerated in point of order as to their prevalence:—*Tabellaria flocculosa, Spondylosium pulchellum, Cosmarium angulosum* v. *concinnum, Oocystis solitaria, Cylindrocystis Brebissonii, Chlorobotrys regularis, Navicula Brebissonii, Hillhousia* sp., *Achnanthes exilis, Mastogloia Smithii, Euastrum pectinatum, E. denticulatum, Micrasterias denticulata*, &c.

Associated in very varying proportions with *Cladophora flavescens* as the dominant alga (considering bulk only) in one pool (quite a different locality from the last one for the same alga) on Clare Island were:—*Mougeotia* sp. (sterile), *Cosmarium subtumidum* v. *minor, C. suberenatum, C. laeve* v. *cymatium, C. Botrytis* v. *mediolaeve, Cocconema gastroides, C. Cistula, Cocconema leptoceras* v. *elongata, Achnanthes exilis, Gomphonema olivaceum, G. parvulum Cocconeis Placentula* and its variety *lineata* (by far the most abundant diatom epiphytic on the Cladophora), *Denticula tenuis* v. *frigida, Epithemia turgida, Eunotia major, Navicula limosa, N. cryptocephala, N. seminulum, N. lanceolata* v. *phyllepta*, &c.

The following were associated with *Utricularia minor* in Lough Avullin in Clare Island; the first four enumerated were dominant collectively; if any of the four showed prevalence, it was the first one:—*Cosmarium rectangulare (gotlandicum), Chlorobotrys regularis, Xanthidium Smithii, Staurastrum aciculiferum, S. margaritaceum, S. punctulatum, S. muticum* f. *minor, Spondylosium pulchellum, Euastrum binale, Tetmemorus Brebissonii, Penium Cylindrus, Hyalotheca dissiliens, Schizochlamys delicatula, Oocystis solitaria, Crucigenia rectangulare, Botryococcus Braunii, Chroococcus macrococcus, Gloeocapsa montana* (probably washed in from turfy bank), *Vanheurckia rhomboides* and its var. *saxonica, Binuclearia tatrana, Mougeotia* sp. (sterile), *Oedogonium* (2 sterile spp.).

An association (Clare Island) among a gathering of *Mougeotia gracillima* with zygospores and another sterile species of *Mougeotia*, consisted of the following, enumerated as nearly as possible in the order of their prevalence:—*Tetmemorus granulatus, Hyalotheca dissiliens, Pleurotaenium Trabecula* v. *clavatum, Closterium striolatum, Tabellaria flocculosa, Euastrum bidentatum, Staurastrum punctulatum, S. orbiculare* v. *Ralfsii, S. Meriani, S. sexcostatum, Euastrum pectinatum, Myxonema nanum, Cosmarium tinctum, Surirella pinnata*, &c.

Another Sphagnum-pool, chiefly *S. plumosum*, Clare Island, yielded a very mixed association, no species showing dominance:—*Tetmemorus granulatus, T. Brebissonii, T. laevis, Netrium Digitus, Staurastrum sexcostatum, Euastrum dubium, E. denticulatum, E. ansatum, E. Didelta, E. bidentatum, E. binale* f. *minor, Micrasterias truncata* (the last two rather more abundant), *M. denticulata, Cosmarium Regnellii* (rather frequent), *C. pygmaeum, Closterium intermedium, C. Lunula, Eremosphaera viridis, Anabaena Flos-aquae* v. *minor, Synedra Acus, S. pulchella, Vanheurckia rhomboides* and its var. *saxonica, Navicula Tabellaria, N. mesolepta* and its var. *Termes, N. viridis, N. major, Tabellaria flocculosa, Eunotia lunaris, Dinobryon Sertularia*, &c.

A tuft of *Microspora abbreviata* was examined from Clare Island for its associates; the three first enumerated were the most abundant; all are placed in the order of their relative abundance in the gathering:—*Cosmarium rectangulare, Chlorobotrys regularis, Staurastrum aciculiferum, Netrium Digitus, Oocystis solitaria, Vanheurckia rhomboides* v. *saxonica, Ulothrix variabilis, Œdogonium* (sterile), *Euastrum binale, Micrasterias truncata, Euastrum bidentatum, Tetmemorus laevis, Gymnozyga moniliformis, Staurastrum margaritaceum*, &c.

Associated with a submerged species of Hypnum on Clare Island were:—*Eremosphaera viridis, Chlorobotrys regularis, Euastrum bidentatum*, and *Vanheurckia rhomboides* var. *saxonica*, the four together showing dominance; scattered among these occurred, but in much less proportion, *Tolypothrix tenuis, Ulothrix variabilis, Binuclearia tatrana, Microspora pachyderma, Gloeocystis gigas, Oocystis solitaria, Micrasterias truncata, Euastrum binale* with varieties, *Netrium Digitus, Tetmemorus granulatus, T. laevis, Cosmarium rectangulare, C. tinctum, C. Cucurbita, Spondylosium pulchellum, Staurastrum cuspidatum, S. punctulatum, S. muticum* v. *minor, Penium didymocarpon, Mesotaenium endlicherianum, Arthrodesmus Incus* v. *minor, Navicula viridis, N. mesolepta, Tabellaria flocculosa, Merismopedium glaucum, Chroococcus macrococcus, C. turgidus, Oscillatoria Agardhii, Dinobryon protuberans*, &c.

An association consisting of minute algae mostly, from a ditch near the chapel, Clare Island, was thus constituted:—*Desmidium Swartzii* and *Micrasterias denticulata* as the main features, the former species more abundant; then the following, all in small proportion, the first three being a little more abundant than the rest:—*Pleurotaenium truncatum, Closterium costatum, C. rostratum, C. pronum, C. Archeriarum, Euastrum oblongum, Penium Navicula, Spirotaenia condensata, Cosmarium subcostatum, C. ochthodes, C. Meneghinii, C. formosulum, C. Botrytis, Mougeotia viridis, Stauroneis Phoenicenteron, S. anceps, Navicula gibba, N. cryptocephala, Surirella robusta,*

S. biseriata, and a very small quantity of a barren Oedogonium (*Hydra vulgaris* was also present).

A large patch of *Cladophora glomerata* from the cliffs of Croaghmore had an association of diatoms upon and among it; the epiphytic *Cocconeis Pediculus* was the truly dominant one, and almost hid some parts of the Cladophora from view. The other species occurred in varying proportions, and I have written down the chief of them in the approximate order of their frequency:—*Cocconema gastroides, C. cymbiforme, C. Navicula, C. Brebissonii, Epithemia Sorex, E. zebra* and its variety *proboscidea, E. Hyndmanni* (small forms), *Eunotia Arcus* v. *minor, Synedra Acus, Gomphonema gracile* v. *dichotomum, Achnanthes exilis, Cocconema ventricosum, Diatoma elongatum, Navicula gracilis, N. viridis* (small forms), *Nitzschia Sigma* v. *rigida, Synedra Ulna, Gyrosigma Spencerii* v. *nodifera, Stauroneis anceps*, &c.

Near Dugort, Achill Island, associated in a pool along with *Batrachospermum vagum* were *Euastrum bidentatum* and *Spondylosium pulchellum* in fair quantity; next in point of numbers came *Desmidium cylindricum* and *Ophiocytium cochleare*, then in less quantity *Oocystis solitaria, Chlorobotrys regularis, Mougeotia* (sterile), *Oedogonium* (sterile), *Vanheurckia rhomboides* v. *crassinervia*; after these, and quite scattered, were *Penium Digitus, P. Navicula, Tetmemorus granulatus, Closterium Lunula, C. juncidum, C. acutum* var *Linea, Staurastrum margaritaceum, S. tetracerum, S. paradoxum, Cosmarium pygmaeum, C. subtumidum, C. pyramidatum, Euastrum ansatum, E. binale, Micrasterias truncata, Hyalotheca dissiliens* (with zygospores), *Eremosphaera viridis, Merismopedium glaucum, Tetrapedia reinschiana, Chroococcus minutus, Tabellaria flocculosa, Nitzschia Palea, N. subtilis, Navicula Brebissonii, N. viridis, N. nobilis, Vanheurckia rhomboides*, &c.

An association near the summit of Croaghaun, Achill Island, 2,192 feet elevation, consisted of the following in a very mixed manner, no species approaching either dominance or subdominance:—*Mougeotia* (sterile), *Oedogonium* (sterile), *Batrachospermum vagum, Binuclearia tatrana, Microspora abbreviata, Oocystis solitaria, Scenedesmus obliquus, Chlorobotrys regularis, Arthrodesmus octocornis, Staurastrum paradoxum, S. tetracerum, Closterium intermedium, Cosmarium tatricum, C. Cucurbita, C. Phaseolus* v. *elevatum, Euastrum binale, E. denticulatum, Navicula viridis, N. Brebissonii, Vanheurckia rhomboides* v. *saxonica, Eunotia lunaris*, &c.

Associated in a scattered manner with *Bulbochaete insignis* in Lough Gall, Achill Island, were:—*Hapalosiphon hibernicus, Lyngbya Rivulariarum*, 2 sterile species of *Spirogyra*, 1 of *Zygnema*, 2 delicate species of *Oedogonium*, (one was not more than 3·3μ in diameter, and might be either *inconspicuum* or *excisum*; the thickest specimens of the other were 5μ broad, the size of

pusillum, *Caelosphaerium kuetzingianum*, *Aphanotheca microscopica*, *Dactylotheca Braunii*, *Staurastrum paradoxum*, *S. denticulatum*, *Euastrum binale* v. *hians*, *Scenedesmus quadricauda*, *Pediastrum glanduliferum*, &c.

A large tuft of a sterile Vaucheria from near Westport was examined to ascertain what was the association of other algae *amongst* it. It turned out to be mostly a Diatom association; I enumerate some—the chief of the species present, in the order of their prevalence:—*Tabellaria flocculosa*, *Fragilaria capucina*, *Synedra Ulna*, *Amphora ovalis*, *Navicula viridis*, *N. nobilis*, *N. viridula*, *Eunotia praerupta*, *E. pectinalis*, *Cocconema gastroides*, *Surirella ovalis*, *S. biseriata*, *Gomphonema montanum* v. *commutatum*, *Nitzschia Palea*, *Meridion circulare*, *Stauroneis anceps*, *Navicula limosa*, *N. bicapitata*, *N. appendiculata*, *N. pusilla*, &c. A few chlorophyllaceous algae were also present in small quantity:—*Ulothrix aequalis*, *Ankistrodesmus falcatus*, *Selenastrum gracile*, *Staurastrum orbiculare*, *S. punctulatum*, *Cosmarium Botrytis* and *Closterium Cynthia*.

MARINE DIATOMS.

The following contractions for localities have been used:—

AS = Achill Sound.
BB = Bellacragher Bay.
C = Shores of Clare Island (no definitely indicated place thereon).
CB = Clew Bay.
CNE = Clare Island, N.E. shore, includes a number of different gatherings.
K = Kinnacorra, Clare Island.
M = Mulranny.

Class BACILLARIACEAE (Diatomaceae).

Div. I. RAPHIDIEAE.

Tribe **Cymbelleae**.

Amphora angularis Greg.—CB.
*marina V. H. (*non* W. Sm.)—AS.
salina W. Sm.—CB, C; CNE, 28-41μ long; L, mouth of Bunowen River, 38μ long.
*Proteus Greg.—AS.
*veneta Kütz.—CB, CNE.

Tribe **Naviculeae**.

Gyrosigma angulatum (Quek.) O.K.—CB, 150 × 31·6μ.
affine (Grun.) O.K.—AS, a narrow form 173 × 28·5μ.

Gyrosigma balticum (W. Sm.) O.K.—CB, 260 × 28μ; CNE.

var. **ATLANTICUM** var. nov.—G. cellulis minoribus brevioribusque constante sed formae ejusdem ut in forma typica. CB.

distortum (W. Sm.) O.K.—CB, 92 × 16·6μ.

formosum (W. Sm.) O.K.—CB, 425 × 31μ.

Hippocampus (Hass.)—CB.

***rigidum** (W. Sm.) O.K.—CB.

strigilis (W. Sm.) O.K.—CB, 540 × 40μ.

Orthotropis lepidoptera (Greg.) Cleve.—CNE, 108μ long.

maxima Greg.—AS, 103 × 16·6μ, valve-view.

Plagiotropis elegans (W. Sm.) Grun.—C, up to 270μ long.

Schizonema Grevillei Ag.—C.

Navicula abrupta Greg.—M, 50 × 22μ.

***advena** Ad. Schm.—AS.

var. **parca** Ad. Schm.—AS; CNE, 37 × 12μ.

aspera Ehrenb.—CB, 66 × 14μ, a small form, also 105 × 14·5μ; CNE, 100 × 19μ, 104–16μ, 104 × 21μ, also short forms 56 × 14μ, 96 × 22μ, 140 23·5μ; AS, 63 × 21μ girdle-face; K.

Bombus Ehrenb.—AS, 63 × 27·5μ, isthmus 17·5μ; CNE, 50 × 20μ, isthmus 12·5μ; also 50–52 × 18μ, 55 × 24μ.

***balnearis** Grun. var. **MAJOR**, var. nov.—Var. cellulis duplo longioribus et latioribus quam forma typica, 70 × 22μ. CNE.

cancellata Donk.—CB, 68 × 16·5μ; CNE, 70 × 20·8μ.

cincta (Ehrenb.) Kütz.—C, 37–39 × 7·5–8μ (in a somewhat brackish place).

Crabro Ehrenb.—C, 96 × 31·6μ, isthmus 22·5μ.

digitoradiata Greg.—C, 50 × 10μ; L, mouth of Bunowen River, 69 × 12·5μ.

var. **Cyprinus** (W. Sm.) V.H.—AS, 72 × 19μ; CNE, 65 × 14·2μ.

didyma Ehrenb.—AS, 50 × 29μ; C, 29 × 12·5μ, common, a small form; CNE, 34–39 × 15–16μ, 12·5–13μ at isthmus.

***forcipata** Grev.—CB, 35 × 15μ; AS, 37 × 18μ; CNE, 31 × 12μ.

formosa Greg.—CNE, 148μ long.

fusca Greg. var. **hyperborea** (Grun.) V.H.—AS, 70 × 32·5μ.

var. **delicatula** Ad. Schm.—C, 47 × 23·5μ, a small form; CNE, 47 × 21μ.

granulata Bréb.—CB, 58 × 30μ, slightly retuse at sides, others 88 × 47μ, neither retuse nor almost flat at sides.

humerosa Bréb.—AS, 50 × 25μ.

interrupta Kütz.—CB, 53–65μ long, rather small forms; CNE, 57 × 19μ, 12·5μ at isthmus, a narrower form 60 × 17μ, 12·2 at isthmus.

Liber W. Sm.—CNE, large forms up to 170 × 23μ, also 92 × 18μ.

Navicula Lyra Ehrenb.—CB, 124μ long; AS, 115μ long; C.

f. **MINOR**, forma nova.—F. cellulis typicis in forma, sed multe minoribus, 64 × 28·2μ. Cn.

musca Greg.—C, 46 × 16·5μ; AS, 46 × 19μ, isthmus 15·2μ.

var. **PARVA**, var. nov.—Var. cellulis multe parvioribus. CB, 33 × 14·2μ; AS, 35 × 13·8μ, isthmus 9·1μ.

mutica Kütz.—C, very variable; M.

palpebralis Bréb.—AS; L, at mouth of Bunowen river, 56 × 20μ, valve-view.

Smithii Bréb.—C, a small form 54 × 25μ; AS, also small forms; CNE.

var. **MINOR**, var. nov.—Var. cellulis semper minoribus, 46 × 26μ. C.

trevelyana Donk.—K, 131 × 36μ girdle-view.

var. **MINOR**, var. nov.—Var. cellulis brevioribus et relative latioribus in visa cinctuare. AS, 60μ long, 20μ at widest part of girdle-face; a relatively shorter form.

****vacillans** Ad. Schm.—CNE, 25 × 10μ, constriction slight.

***Berkeleya Dillwynii** (Ag.) V.H.—CNE, 38 × 6μ.

Scoliopleura latestriata (Bréb.) Grun.—AS, 100 × 20μ.

Tribe **Gomphonemeae.**

Rhoicosphenia curvata (Kütz.) Grun. var. **marina** (W. Sm.) V. H.—C, L.

Tribe **Achnantheae.**

Achnanthes subsessilis Ehrenb.—C, CB; M, 36 × 12μ, valve-view.

brevipes Ag.—C; M, 56 × 12·5μ, a small form; L, 58 × 15·8μ; CNE, 56–63μ long.

***delicatula** Kütz.—C; M, 18–22 × 10μ, valve-view.

longipes Ag.—C, CB.

parvula Kütz.—AS, 13·3 × 8·3μ, some specimens occurred up to 21μ long; C.

Tribe **Cocconeideae.**

****Cocconeis danica** Flug.—CB.

***dirupta** Greg.—CB, 31 × 24·2μ; CNE, 29 × 23μ, 25 × 21μ, 18 × 13μ, 28 × 21μ; K.

molesta Kütz.—C, 17μ long; CNE, 18–20μ long, also up to 28 × 20μ, a large form.

pinnata Greg.—C, CB.

Scutellum Ehrenb.—C, AS; BB, extremely abundant; CNE, K.

f. **parva** V. H.—AS; CNE, from 10 to 6μ up to 25 × 18μ; M, K.

Div. II. PSEUDORAPHIDIEAE.

Tribe **Synedreae.**

Synedra affinis Kütz.—C, CB, CNE.
var. **parva** Kütz.—CNE, 31–55μ long, frequent.
var. **fasciculata** Kütz.—M, 57 × 5μ valve-view.
investiens W. Sm.—CB, C; up to 50 × 6μ valve-view, girdle-view 5μ; CNE, 30μ long, 3·8μ broad, girdle-view, frequent.
barbatula Kütz.—AS, 33 × 8μ.
Gallionii Ehrenb.—C, 176 × 10μ valve-view; AS, up to 216μ long; CNE, 116 × 9·1μ, 156 × 10μ; K, up to 225μ long.
nitzschioides Grun.—C.
****Asterionella japonica** Cleve.—CB.

Tribe **Fragilarieae.**

****Cymatosira lorenziana** Grun.—CB; CNE, 34μ long.
***belgica** Grun.—CB, 32μ long.
***Campylosira cymbelliformis** (A. Schm.) Grun.—CNE, 29–37μ long.

Tribe **Raphoneideae.**

***Raphoneis Surirella** Grun.—C; CB, 36–37 × 17μ.

Tribe **Licmophoreae.**

Licmophora flabellata (Carm.) Ag.—C; AS, very abundant, sizes measured were 97–180 long, 18μ broad girdle-view, 7μ valve-view.

Tribe **Tabellarieae.**

****Grammatophora angulosa** Ehrenb.—C, AS, K.
marina (Lyngb.) Kütz.—C, AS; CNE, 44μ long; K.
serpentina (Ralfs) Ehrenb.—C, 44–66μ long; CB, AS; CNE, 72·5–90μ long, also 47–64μ long × 9·5–10μ broad.
var. **pusilla** (Grev.) V.H.—AS.
Rhabdonema adriaticum Kütz.—C, 71–93μ long, valve-view 18·5–19μ; AS, 85μ long; CNE, 63–68μ long.
arcuatum (Ag.) Kütz.—C, 40μ long; AS; CNE, 33–54μ long.
minutum Kütz.—C, 15–27μ broad (only 10μ sometimes); CNE, up to 33μ broad; M; AS, 26μ broad; K.
****Striatella unipunctata** Ag.—CB, AS.
***delicatula** (Kütz.) Grun.—CNE, 10–13μ long.

Tribe **Surirelleae.**

Surirella fastuosa Ehrenb.—CNE, 81 × 50μ, 85 × 56μ; K.
var. **lata** (W. Sm.) V. H.—CB, 82·5 × 34μ; C, 76 × 38μ; CNE, 73 × 36μ, 68 × 41μ, 77 × 40μ.

Tribe **Nitzschieae.**

Hantzschia virgata (Roper) Grun.—L, at mouth of Bunowen River, 110 × 13μ, valve-view.
Nitzschia angularis W. Sm. var. **affinis** Grun.—C, 71 × 9μ.
apiculata (Greg.) Grun.—CB; CNE, 33·3 × 6·6μ.
bilobata W. Sm. var. **minor** Grun.—CNE, as small as 30 × 13μ, girdle-face.
***commutata** Grun.—CB, 86 × 12·5μ; CNE, 48μ long.
fasciculata Grun.—L, 76μ long.
***communis** Rabenh., var. **abbreviata** Grun.—C.
constricta (Greg.) Grun.—CNE, 45 × 14μ, width of constriction 11·8μ, other gatherings 41·7 × 14·2μ, width of constriction 12·5μ, 48 × 15·2μ, at constriction 13μ.
****lorenziana** Grun.—CB.
var. **incurva** Grun.—CB.
plana W. Sm.—CNE, 135 × 17μ.
punctata (W. Sm.) Grun.—AS, 24 × 14μ; CNE, 30 × 15·5μ; not at all subrostrate, obtuse. Also from brackish water near D.
spectabilis (Ehrenb.) Ralfs.—CB, up to 420μ long.
Tryblionella Hantzsch. var. **levidensis** (W. Sm.) V. H.—CB.
var. **littoralis** Grun.—CNE, 55μ long, 25μ broad.
***vitraea** Norm. var. **recta** (Hantzsch) V. H.—CB.

Division III. CRYPTORAPHIDIEAE.

Tribe **Chaetocereae.**

Sub-tribe Rhizosolenieae.

Guinardia flaccida (Castr.) Perag.—CB.
Rhizosolenia alata Brightw. var. **gracillima** (Cl.) V. H.—M.
***imbricata** Brightw. var. **Shrubsolii** (Cl.) V. H.—CB.
setigera Bright.—M.
styliformis Bright.—M.

Sub-tribe **Euchaetocereae.**

Chaetoceros decipiens Cl.—CB.
didymus (Ehrenb.) Cl.—CB.
***paradoxum** Cl.—CB.
***teres** Cleve.—CB.
***Wighamii** Brightw.—M; CB, 16–20μ broad.

Tribe **Melosireae.**

Skeletonema costatum (Grev.) Cl —CB, 10μ broad.
Melosira Borreri Grev.—AS; CB 41μ broad.
f. **MINOR** f. nov.—Lat. 11·6μ. CB.
nummuloides (Bory) Ag.—C, 33μ broad.
var. **hyperborea** Grun.—C, 12–15μ broad.
sulcata (Ehrenb.) Kütz.—AS, 24μ broad; CB, 23μ broad, also smaller forms
f. **minor** Richmond.—CNE.
***Druridgea geminata** Donk.—C.
***Hyalodiscus subtilis** Bail.—CB, 17–18μ broad; C, 21μ broad; AS, 23μ broad.
stelliger Bail.—CNE, 42–66μ broad, another gathering 36μ broad.
Cyclotella striata (Kütz.) Grun.—C; CB, 41μ broad; AS; CNE, sometimes not more than 20–22μ broad.

Tribe **Biddulphieae.**

Biddulphia antediluviana (Ehrenb.) V. H.—C, breadth of valve-view 42μ; CB; CNE, breadth of valve-view 43–52μ.
***laevis** Ehrenb. f. **minor** V. H.—C, CB, AS.
aurita (Lyngb.) Bréb.—CB, 24–25μ long; AS, 25–26μ long; CNE; C, 33μ long.
pulchella Gray.—CB, 87–90μ long, breadth at middle 58μ.
Smithii (Ralfs) V. H.—C, 42μ broad; CNE.
***Triceratium elegans** Grev. f. **pusilla** V. H.—CB, 14·5μ lat.

Tribe **Eupodisceae.**

Auliscus sculptus (W. Sm.) Ralfs.—CB, 52·5 × 48μ, valve-view.

Tribe **Heliopelteae.**

Actinoptychus undulatus Ehrenb.—CB, 46–70 broad; AS; CNE, 50–94μ broad.
***splendens** (Shadb.) Ralfs.—AS.

Tribe **Coscinodisceae.**

Coscinodiscus perforatus Ehrenb.—C, 74–80μ broad.
excentricus Ehrenb.—CNE.
Actinocyclus subtilis (Greg.) Ralfs.—CNE, 46–73μ broad.

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DESCRIPTION OF PLATES.

Plate I.

Fig.

1. *Euastrum oblongum* Ralfs, after division, one semicell not completely developed. × 250. Mulranny.

2. *Reinschiella curvata* sp. nov. × 250. Clare Island.

3. *Zygnema leiospermum* De Bary. × 300. Dugort. To show that the individual cells become physiologically sexual when conjugating.

4. *Oedogonium* sp. × 300. Collected in April; every other cell was often firmly encrusted—sometimes many cells successively—with what looked like an oxide of iron; and in some cases there seemed to be the remains of two successive coatings.—Clare Island.

5. *Closterium angustatum* Kütz., var. *asperum* var. nov. × 232. Westport.

6 *Closterium Toxon* West, var. *validum* var. nov. × 300. Clare Island.

7. *Lyngbya cliarensis* sp. nov. × 300. Clare Island.

8. *Tetmemorus Brebissonii* (Menegh.) Ralfs, abnormal. × 300. Clare Island.

9. *Tetmemorus*, abnormal. × 250. Dugort.

10. Zygospore of *Tetmemorus laevis* (Kütz.) Ralfs. × 300. Dugort.

11. *Euastrum*, abnormal division. × 300. Clare Island.

12. do. do., × 300. Dugort.

13. *Closterium eboracense* Turn., var. *achillense* var. nov. × 100. Sraheens Lough.

14. *Micarasterias denticulata* Bréb. × 250. To show variability of the polar lobes. Clare Island.

Plate II.

Fig.

15. *Closterium Lunula* (Müll.) Nitzsch. To show apices. × 228. Dugort.

16. *Closterium eboracense* Turn. var. *achillense* var. nov. To show apices. × 420. Sraheens Lough.

17 &18. *Micrasterias denticulata* Bréb., after division, the new semicells not completely developed; one with abnormality of the polar lobe. × 250. Clare Island.

19. *Cosmarium Ralfsii* Bréb., var. *rotundatum* var. nov. × 250. Westport.

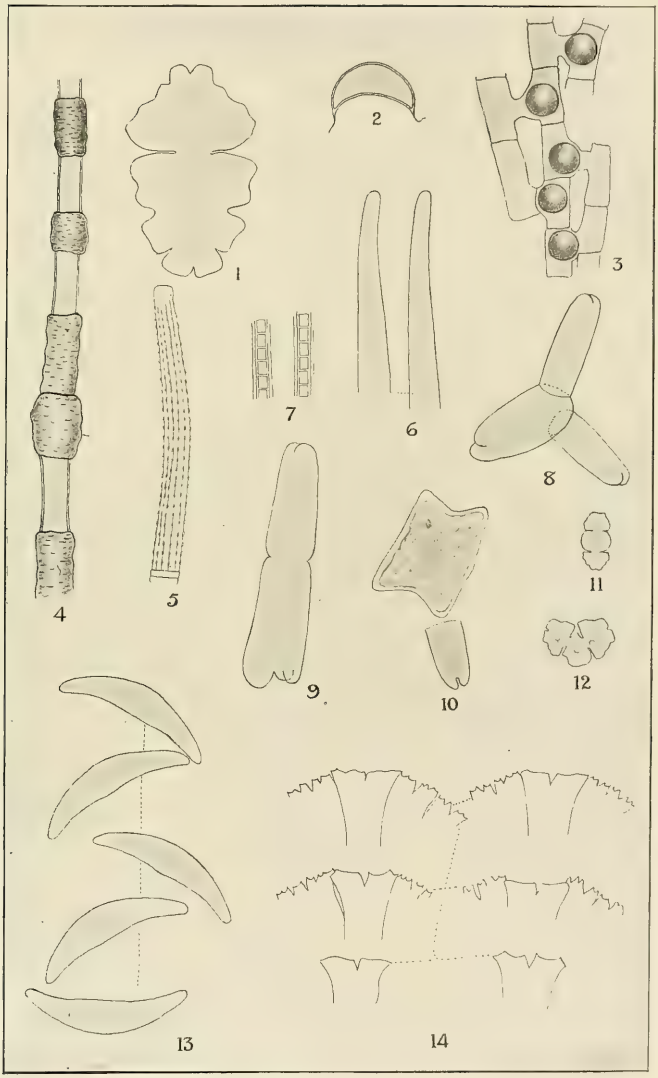
20. do. do. var. *montanum* Racib. × 300. Dugort.

21. *Eunotia lunaris* (Ehrenb.) Grun. var. *emarginatovelida* var. nov. × 500. Dugort.

22. *Navicula peregrina* Kütz., var. *producta* var. nov. × 300. Clare Island.

23. To illustrate the same as Fig 3. × 300. Dugort.

24. *Zygnema* sp. with a distinct mucous investment, as in *Hyalotheca dissiliens*. × 300. Clare Island.



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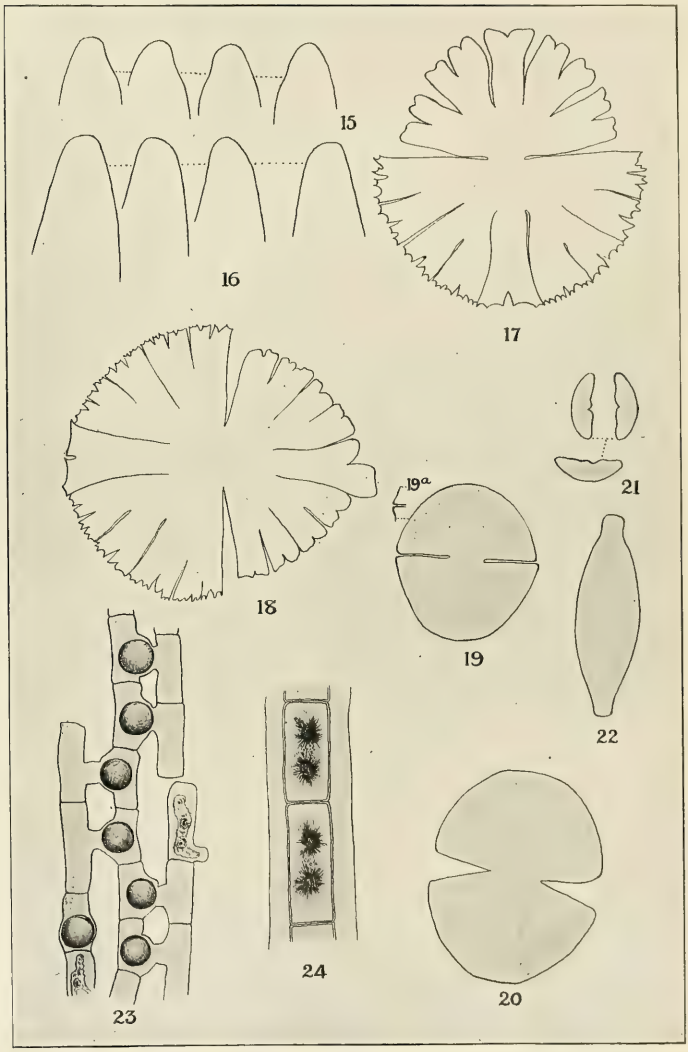

CLARE ISLAND SURVEY.—WEST: FRESH-WATER ALGAE.

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