

XI.

THE FRESH-WATER SPONGES OF IRELAND.

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PLATES XXVI-XXIX.

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INTRODUCTION.

SPONGES constitute the phylum Porifera, the lowest of the Metazoa or multicellular animals. They are a very isolated group, without any connecting links between them and other groups of multicellular animals.

The vast majority of sponges are marine, living at all depths, from between tide-marks to the farthest abysses of the oceans. One family only, the Spongillidae, live in fresh water, and certain species belonging even to this family have occasionally been found in brackish ponds and estuaries in different parts of the world.

Fresh-water sponges exhibit a considerable diversity of structure, and are divided into a large number of genera and species. Of these species, Ireland possesses only five, a contrast to the marine sponges found off our coasts, which are already known to number nearly two hundred different kinds.

Certain marine sponges, namely, the bath-sponge and some of its nearest allies, were known at an early period. There are several allusions to them in the literature of classical times. Aristotle realized that sponges belonged to the animal kingdom, but after his time opinions on the subject varied. Writing in the year 1824, Gray ("Zoological Journal," vol. i) summed up the views of the earlier naturalists. He writes:—"The true nature of these curious bodies has for a long while been an object of great doubt to all Naturalists, for we find that most of the *Ancient Natural Historians* apparently regarded them as animals . . . On the revival of learning . . . all those who would examine for themselves considered them as vegetables." Thus we see that during a long period sponges were considered by some writers to be animals, by others plants. As plants they were thought to be most nearly related to the fungi or to the algae. More often they were classed as Zoophyta, or "plant-animals," belonging neither to the animal nor to the

vegetable kingdom, but possessing a "third or middle nature," serving to connect the two. Or, as another authority writing in the year 1633 expressed it, they "are not wrought together of the froth of the sea as our Author affirms, but rather of a nobler nature than plants, for they are said to have sence." They are therefore referred by the writer to the "Plant-animalia," that is, "such as are neither absolute plants nor yet living creatures, but participate of both." While yet another writer defines the Zoophyta, among which he classes sponges, as "having stems vegetating and changing into animals." Several authorities maintained that sponges were merely shelters built by worms or other animals for their own use, or were nests built by certain aquatic insects for the reception of their eggs.

During the eighteenth and early part of the nineteenth centuries naturalists still differed as to whether sponges should be regarded as plants or animals, and it was not until the middle of the latter century that their animal nature was definitely established.

The earliest references to the fresh-water sponges must be looked for in works on botany. The first mention of them was apparently made by John Ray in the first volume of his "Historia Plantarum," published in 1686. He describes a sponge from the River Yare under the title "*Spongia ramosa fluviatilis Newtoni*." From his description it is evidently a branching specimen of *Spongilla lacustris*. A few years later, in 1691, Leonard Plukenet in his "Phytographia," Part I, Plate 112, fig. 3, gives a clearly recognizable figure of *Spongilla lacustris* from the River Isis, near Oxford, under the description "*Spongia fluviatilis anfractiosa perfragilis ramosissima nostras*." The later references to the fresh-water sponges in Ray's books are chiefly quotations from the two preceding works.

Linnæus in his earlier writings classed the Spongillidae with the lower fungi under the name Lithophyta. Later on he introduced the names *Spongia lacustris* and *Spongia fluviatilis*. Although it is impossible to determine with accuracy what were the sponges referred to, these two specific names have become established, and have long been applied to the two commonest European species, now named *Spongilla lacustris* and *Ephydatia fluviatilis*. These two species were apparently the only ones known for a considerable number of years, although they were described from time to time under different names.

In 1848-9 Carter published papers on the fresh-water sponges of the Island of Bombay, thus making known for the first time the occurrence of fresh-water sponges beyond the confines of Europe. In 1863 Bowerbank published his "Monograph of the Spongillidae" (11), adding to the previously known forms several new species from North and South America and one from Australia. Carter's paper on the known species of *Spongilla* followed

in 1881 (14), and Potts' important monograph in 1887 (33). It would be impossible to enumerate in this short survey even all the more important papers on the fresh-water sponges published about this period, but a complete and valuable list of the literature on the subject up to the year 1892 is given by Weltner (51).

During the last thirty years much work has been done on the structure, physiology, and development of the Spongillidae, while scientific exploration carried on during recent years in many parts of the globe has proved that fresh-water sponges may be found under suitable conditions throughout the world, and new species are being continually added to the number already known.

FRESH-WATER SPONGES IN IRELAND.

Although the fact that fresh-water sponges occur in Ireland has been known for just one hundred years, and although systematic search has recently been made for them in many different parts of the country, only five species have so far been found. They are as follows:—*Spongilla* (*Euspongilla*) *lacustris* auct., *Spongilla* (*Eunapius*) *fragilis* Leidy, *Ephydatia* *fluviatilis* auct., *Ephydatia* *Mülleri* Lieberkühn, and *Heteromeyenia* *Ryderi* Potts.

KEY TO THE IRISH SPONGILLIDAE.

- I. Gemmule-spicules rod-like (strongyla or oxea). Genus *Spongilla*.
1. Skeleton-spicules, smooth oxea; free microscleres present. Gemmules occurring singly, and provided with a pneumatic-coat of very minute cells (sub-genus *Euspongilla*). No foraminal tubule. *Spongilla lacustris*.
 2. Skeleton-spicules, smooth oxea; no free microscleres. Gemmules in a pavement-layer at base of sponge, and in small scattered groups, enclosed in both cases in a common covering of large polygonal cells (sub-genus *Eunapius*). Foraminal tubule present. *Spongilla fragilis*.
- II. Gemmule-spicules amphidises of one kind, with equal discs which are serrated at the edge. Genus *Ephydatia*.
1. Skeleton-spicules typically smooth, but some microspined. Shaft of amphidisc longer than the diameter of the disc; disc not deeply serrated. Bubble-cells absent. *Ephydatia fluviatilis*.
 2. Skeleton-spicules smooth and spined. Shaft of amphidisc shorter than the diameter of the disc: disc deeply serrated. Bubble-cells present. *Ephydatia Mülleri*.

III. Gemmule-spicules amphidiscs of two kinds. Genus *Heteromeyenia*.

1. Skeleton-spicules densely spined. Gemmule-spicules (a) long-shafted amphidiscs, the disc formed of several strong, recurved teeth united at the base; (b) short-shafted amphidiscs, with finely serrated edges to the discs.
Heteromeyenia Rydleri.

Although the number of species is small, yet the fresh-water sponge-fauna of Ireland compares favourably with that of the countries lying nearest to her. England and Scotland together possess the same species. France has the following five: *Spongilla lacustris*, *S. fragilis*, *Ephydatia fluviatilis*, *E. Mulleri*, and *Trochospongilla horrida*. Six species occur in Germany, namely, the five that are found in France, with the addition of *Carterius Stapanovi*. Only about eight species are known to occur in the whole of Europe. One of these, *Heteromeyenia Rydleri*, as far as its European distribution is concerned, is limited to the extreme western outposts of the continent, while the gemmules only of another North American species, *Heteromeyenia repens*, have on one occasion been found in Europe, namely, in a pond in Galicia. Several species of doubtful value have been described from time to time; but the following are generally recognized as comprising the fresh-water sponge-fauna of Europe:—

<i>Spongilla lacustris</i> .	<i>Heteromeyenia Rydleri</i> .
<i>Spongilla fragilis</i> .	<i>Heteromeyenia repens</i> .
<i>Ephydatia fluviatilis</i> .	<i>Trochospongilla horrida</i> .
<i>Ephydatia Mulleri</i> .	<i>Carterius Stapanovi</i> .

Thus Europe is poor in number of species as compared with other parts of the world. At the present time North America is known to possess about twenty-eight species, the Amazon region of South America about twenty, the Continent of Africa over thirty, and India, including Burma, at least twenty-five species and several varieties.

The geographical distribution of the fresh-water sponges found in Ireland is wide. *Heteromeyenia Rydleri* has the most restricted range, being known up to the present only from North America, Ireland, and Scotland. The remaining species occur throughout the entire Holarctic region. *E. Mulleri* appears to be confined to that region, where it extends through North America, Europe, and Northern Asia to Japan. *S. lacustris*, *S. fragilis*, and *E. fluviatilis* are represented by at least local races or varieties in other parts of the world. Thus *S. lacustris* is represented in India. *S. fragilis* occurs in South America, tropical Asia, and Australia, while forms of *E. fluviatilis* are found in tropical Asia, South Africa, and Australia.

HISTORICAL ACCOUNT OF IRISH FRESH-WATER SPONGES.

The following is a list, in chronological order, of the papers in which reference is made to the occurrence of fresh-water sponges in Ireland. Works which mention such sponges only in connexion with the problems of their geographical distribution are included in the general bibliography given at the end of this paper, to which the numbers in brackets refer.

LIST OF REFERENCES TO IRISH FRESH-WATER SPONGES.

1822. FLEMING, J.—*The Philosophy of Zoology.* Edinburgh.
1826. GRANT, R. E.—On the Structure and Nature of the *Spongilla friabilis*.
Edinburgh Philosophical Journal, xiv.
1836. TEMPLETON, R.—A Catalogue of the Species of Annulose Animals and of Rayed Ones found in Ireland, as selected from the Papers of the late John Templeton, Esq., of Cranmore, with Localities, Descriptions, and Illustrations. *Mag. Nat. History*, ix.
1844. THOMPSON, W.—Report on the Fauna of Ireland. Div. Invertebrata.
British Association Report for 1843.
1849. ALLMAN, G. J.—On the Natural History, Structure, and Biological Status of the Fresh-water Sponges. [Summary of Lecture.] *Ann. Report Dublin Nat. Hist. Soc.* for 1848.
1856. THOMPSON, W.—*The Natural History of Ireland*, vol. iv. London.
1868. WRIGHT, E. P.—Notes on Irish Sponges. Part I. A List of the Species. *Proc. Roy. Irish Acad.*, x.
1874. Belfast Naturalists' Field Club: Guide to Belfast and the Adjacent Counties. [Fresh-water Sponges, p. 130.] Belfast.
1878. Guide to the County of Dublin. Prepared for the Meeting of the British Association. Part II. [MACALISTER, A.—Sponges, pp. 1, 2.] Dublin.
1882. BOWERBANK, J. S.—A Monograph of the British Spongiadae. *Ray Soc.*, London, vol. iv, edited by Rev. A. M. Norman.
1893. SCHARFF, R. F.—*Spongilla fluviatilis* in the Barrow. *Irish Naturalist*, ii.
1893. CREIGHTON, R. H.—*Spongilla lacustris* at Ballyshannon. *Irish Naturalist*, ii.
1895. HANITSCH, R.—American Fresh-water Sponges in Ireland. *Nature*, li, p. 511.
1895. HANITSCH, R.—The Fresh-water Sponges of Ireland, with remarks on the general distribution of the group. *Irish Naturalist*, iv.

1899. SCHARFF, R. F., and CARPENTER, G. H.—Some Animals from the Macgillieuddy's Reeks. *Irish Naturalist*, viii.
1902. A Guide to Belfast and the Counties of Down and Antrim, prepared for the Meeting of the British Association by the Belfast Naturalists' Field Club. [NICHOLS, A. R.—Sponges, pp. 236-238.] Belfast.
1905. STEPHENS, JANE.—Note on Irish Fresh-water Sponges. *Irish Naturalist*, xiv.
1908. Handbook to the City of Dublin and the Surrounding District. Prepared for the Meeting of the British Association. [STEPHENS, J.—Sponges, pp. 213-215.] Dublin.
1912. STEPHENS, JANE.—Fresh-water Porifera of the Clare Island Survey. *Proc. Roy. Irish Acad.*, xxxi, Part 60.
1914. STEPHENS, JANE.—[Note on Fresh-water Sponges.] *Ann. Report and Proc. Belfast Naturalists' Field Club*, ser. ii, vol. vii.
1915. STEPHENS, JANE.—[Occurrence of *Ephydatia fluvialtilis* in the River Liffey.] *Irish Naturalist*, xxiv, p. 43.
1915. STEPHENS, JANE. [Note on Fresh-water Sponges.] *Ann. Report and Proc. Belfast Nat. Field Club*, ser. ii, vol. vii.

References in zoological literature to the occurrence of fresh-water sponges in Ireland are few, as can be seen from the foregoing list, and for the most part brief. Apparently the earliest allusion to Irish fresh-water sponges was made less than one hundred years ago by John Fleming in his work, "The Philosophy of Zoology," published in the year 1822. In the course of his description of the Alcyonaria he devotes a few lines to the sponges, and associates them with a "tribe" of the Alcyonaria represented by the genera *Anthelia* and *Cornularia* among others. The author says: "As nearly connected with this tribe in form and the condition of the coral, we may notice the curious natural family of Sponges, the polypi of which are unknown." The only genera mentioned are *Spongia*, *Ephydatia*, and *Tethya*. In a foot-note (vol. ii, p. 614) there is the following remark: "I have given a delineation of the *Ephydatia canalicum* from an Irish specimen, Plate V, f. 4." The figure referred to represents part of a specimen of *Spongilla lacustris*.

In his paper "On the Structure and Nature of *Spongilla friabilis*," published in 1826, Grant stated that "this animal or vegetable production is found spreading over rocks or other solid bodies, at the bottom of lakes, or on the sides of stagnant pools . . . in different parts of Great Britain and Ireland." The sponge referred to is probably *Ephydatia fluvialtilis*.

Templeton's Catalogue, published in 1836, contains the following reference

to fresh-water sponges: "*S. friabilis* Esper. Found very common on the shores of the County Monaghan lakes, during the summer months," and "*S. pulvinata*, Lam., *Ephydatia canalium*, Fleming. Found adhering to the walls of the locks of the Lagan Canal." *S. friabilis* and *S. pulvinata* are usually assigned to *Ephydatia fluviatilis*, while *E. canalium* appears to be *Spongilla lacustris*, and probably both these species were seen by Templeton; but it is useless to inquire too closely into the limits of the species as understood by the older writers, and Templeton's specimens have apparently not been preserved.

William Thompson, in a list of invertebrates found in Ireland, gives *Spongilla fluviatilis* as occurring in the north and west of the country. A few years later Allman emphasized his belief that fresh-water sponges "ought to be viewed as Diatomaceous organisms," and that "the siliceous spicules of the Spongillae were in every respect the representatives of the siliceous frustules of the Diatomaceae." The following localities are given for *Spongilla lacustris*: the Lower Lake of Killarney and some of the lakes of Co. Wicklow.

Thompson, in his "Natural History of Ireland," quotes the earlier references to Irish fresh-water sponges, and gives some additional localities for *Ephydatia fluviatilis*. Under this species he mentions some specimens from a pond at Whitehouse, Co. Antrim, which seemed to be identical with the *Ephydatia canalium* figured by Fleming. This figure, as already stated, is taken from a specimen of *Spongilla lacustris*.

E. P. Wright in 1868 gives additional localities for *Spongilla lacustris*. Of *Ephydatia fluviatilis* he writes:—"To be found apparently in every suitable locality in Ireland. In Dublin very common in the canals, and of too frequent occurrence in the fresh-water pipes of the city."

In the Guides to the Belfast and Dublin districts, prepared in 1874 and 1878 respectively for the visits of the British Association, there are brief allusions to the fresh-water sponges. In the former, *Ephydatia fluviatilis* is recorded for the Lagan Canal (where it still flourishes); in the Guide to the Dublin district it is stated that *Spongilla lacustris* and *Ephydatia fluviatilis* abound, the former in Lough Bray, the latter in the Royal Canal and "elsewhere." It may be stated here that *Heteromeyenia Rydleri* Potts is the only species found on successive visits to both Upper and Lower Lough Bray in recent years.

Several Irish localities for fresh-water sponges are given in the fourth volume of Bowerbank's "Monograph of British Sponges." Dr. Battersby sent the author specimens from the "Lake of Killarney" and Caragh Lake. Some of these were named *Spongilla lacustris*, others *Spongilla Parfitti* (= *Ephydatia*

Mülleri). The former species was also found near Roundstone, Co. Galway. A number of preparations of Dr. Battersby's specimens are to be seen in the Bowerbank Collection of Sponges in the British Museum. Of these the slides of *Spongilla lacustris*, from the "Lake of Killarney," are correctly named. One preparation labelled *Spongilla Parfitti*, from the same locality, is almost certainly *Heteromeyenia Ryderi*; gemmule spicules are absent, but skeleton-spicules agree exactly with those of specimens recently collected in the neighbourhood of Killarney. A section of a sponge from Caragh Lake, also labelled *Spongilla Parfitti*, contains a number of gemmules; the gemmule spicules are very irregularly shaped, but the section is apparently taken from a specimen of *Ephydatia Mülleri*.

In the "Irish Naturalist" for 1893 Dr. Scharff records the finding of a specimen of *Ephydatia fluvialtilis* in the River Barrow, and Dr. Creighton the finding of *Spongilla lacustris* in Columbkille Lough, Co. Donegal. The latter specimens were later on named *Tubella pennsylvanica* Potts, by Dr. Hanitsch, but eventually they proved to be *Heteromeyenia Ryderi* Potts.

About this time Dr. Scharff collected fresh-water sponges in several parts of Ireland, and sent them to Dr. Hanitsch for identification, with the result that the latter, after a preliminary notice in "Nature," published an extremely interesting paper in the "Irish Naturalist" in 1895 on the fresh-water sponges of Ireland, discussing the general distribution of the group, and reviewing the state of knowledge of the European *Spongillidae*. In this paper Dr. Hanitsch announced the discovery in Ireland of three species of fresh-water sponges up to that time known only in North America. These were *Heteromeyenia Ryderi* Potts; *Tubella pennsylvanica* Potts; and *Ephydatia crateriformis* Potts. The identification of the last-named was considered doubtful. The author also gave descriptions of three other species at that time known to occur in Ireland, namely, *Spongilla lacustris*, *Ephydatia fluvialtilis*, and *Ephydatia Mülleri*, adding a description of *Spongilla fragilis*, with the remark that the species was sure to be found some day in Ireland. That statement has since been justified by the discovery of the species in several parts of the country. With reference to *Heteromeyenia Ryderi*, *Tubella pennsylvanica*, and *Ephydatia crateriformis*, the first only has been found subsequently in Ireland. It proves to be the commonest species in the areas in which it occurs. The question of the other two species will be discussed later (p. 214). It must suffice for the present to state that the supposed specimens of these species proved to be *Heteromeyenia Ryderi*.

It has long been known that certain plants and invertebrates are common to the west of Ireland and to North America, and the attention of workers at the problems of geographical distribution was naturally attracted by the

discovery in Ireland of *Heteromeyenia Ryderi*, and, as was supposed at the time, of two other species with a similar distribution. We find, therefore, during the next few years that the chief references to Irish fresh-water sponges were made in connexion with the question of their distribution. Dr. Scharff in several of his books and papers (35, 36, 37) and Professor Carpenter (13) cite the distribution of these fresh-water sponges, along with that of certain other invertebrates and plants, in support of the theory of the existence of a former land-bridge between North America and Europe. Later on, when two of the three sponges were found in India, the species were naturally quoted as good examples of discontinuous distribution (3).

Two or three short notices giving additional Irish localities for some of the species bring us up to the commencement of the Clare Island Survey, when for the first time in this country a systematic search for fresh-water sponges was undertaken in a definite area, namely, in western Mayo and in the adjacent islands off the coast. In point of view of mere number of species, the result of the Survey was disappointing, only *Spongilla fragilis* being added to the list, while *Tubella pennsylvanica* and *Ephydatia crateriformis* had to be deleted. The chief points brought forward in the report may be briefly referred to. First, that sponges were fewer in number of species, and grew as a rule with less luxuriance in lakes on the limestone than in the fresh waters of the non-calcareous areas; and, secondly, that *Heteromeyenia Ryderi* was absent from the fresh waters of the limestone areas. It is satisfactory to state that these observations have been confirmed by work done subsequently in many parts of Ireland. Thirdly, it was found that *Heteromeyenia Ryderi* assumes different forms in lakes and rivers, which forms are closely analogous to the varieties of the species described from North America.

A few short notices giving additional localities for some of the species bring the list of references to Irish fresh-water sponges to a close.

The material on which the present paper is based has been collected for the most part by the present writer in different parts of Ireland during the past ten years. Many areas have been very thoroughly searched, but several parts of the country have been left almost untouched owing to various reasons—for instance, two or three unusually wet seasons which delayed the work, and, during the last few years, the increasing difficulties of travelling in Ireland for the purpose of collecting natural history specimens. In particular, the midlands have been neglected, and further work in parts of the north and in the south would add to our knowledge of the distribution of the various species.

The writer wishes to record her thanks to other workers who kindly helped by collecting specimens in different parts of the country, in particular to the following:—Messrs. D. C. Campbell, N. H. Foster, R. A. Phillips, R. L. Praeger, R. Welch, and Mr. and Mrs. A. W. Stelfox. Special mention should be made of the constant help given by the late Major H. Trevelyan, who on his many fishing expeditions to the counties of Donegal and Fermanagh undertook to search for fresh-water sponges, and who became a most enthusiastic collector. Thanks are also due to the Fauna and Flora Committee of the Royal Irish Academy for a grant which enabled the writer to collect in the more remote districts of south-west Cork and Kerry.

SUPPOSED OCCURRENCE OF *TROCHOSPONGILLA PENNSYLVANICA* (POTTS) AND
SPONGILLA CRATERIFORMIS (POTTS) IN IRELAND.

In addition to the discovery of *Heteromeyenia Ryderi* in Ireland, Dr. Hanitsch (20, 21) announced the finding of two other species new to this country, namely, *Tubella pennsylvanica* from Columbkille Lough, Co. Donegal, and *Ephydatia crateriformis* from Park Lough, Hungry Hill, Co. Cork, the latter species being only named provisionally. Gemmules were not found in any of the specimens. No further trace of sponges belonging to these two species, now referred to the genera *Trochospongilla* and *Spongilla* respectively (3, p. 118 and p. 83), has been discovered in Ireland; but when once systematic field work was undertaken *Heteromeyenia Ryderi* was found in great abundance in different parts of the country, and its variability soon became recognized. As I have stated in a previous paper (41), it was impossible not to be struck with the agreement of Dr. Hanitsch's description of *Trochospongilla pennsylvanica* and *Spongilla crateriformis* with forms of *Heteromeyenia Ryderi* taken in different Irish localities. It was determined therefore as opportunity offered to obtain further material for examination from the lakes in which Dr. Hanitsch's specimens had been taken.

As already described (41), visits made to Columbkille Lough by the late Major Trevelyan and by the present writer on several occasions during the summer and autumn of 1911 resulted in the finding of a sponge which grew there in great abundance underneath the stones along the shores of the lake. Its skeleton-spicules agreed exactly with Hanitsch's description of the sponge he had called *Tubella pennsylvanica*, and with a preparation of one of his specimens now in the British Museum. Hundreds of specimens were collected without finding any gemmules, but finally a few gemmule-bearing sponges were taken in the month of October, and these proved that the sponge was *Heteromeyenia Ryderi*.

The description of the fragments of sponge doubtfully ascribed by Hanitsch to *E. crateriformis* agreed so well with poorly developed specimens of *Heteromeyenia Ryderi* (41, p. 6) that a visit was paid to Park Lough in August, 1917, in the hope of definitely settling the question of the identity of the sponge from this locality. Park Lough is a very small lake, lying on the lower south-western slopes of Hungry Hill, at an altitude of 300 feet. It has boggy shores, with steep turf banks at the western end, and a few stones lie on the soft peaty bottom at the eastern end. The lake thus does not present favourable conditions for the growth of sponges; but a thorough search along its shores resulted in the finding of a fair number of small specimens. These were growing for the most part on the under surface of stones that were laid loosely, one on top of the other, stretching out from the shore to form a sort of rough pier under the water. Three or four specimens were found on the stems and roots of water-plants. Similar specimens were found a little way down the stream, draining the lake, where a stony bottom afforded some suitable ground for sponges. All the specimens obtained were very soft in texture, yellowish in colour, and tended to be slightly lobed; in other words, externally they agreed exactly with poorly developed specimens of *Heteromeyenia Ryderi*, such as one would expect in an unfavourable habitat. About this time a minute fragment of the original material, collected in Park Lough by Dr. Scharff in May, 1893, was discovered among the sponges preserved in the National Museum. A comparison of the spicules of this sponge with those of the specimens recently collected proved that they all agreed exactly with Hanitsch's description of his doubtful *E. crateriformis*. Fully developed gemmules were not present, but a few scattered amphidises were discovered which proved beyond doubt that the sponge was a form of *Heteromeyenia Ryderi* with slender spicules, such as occurs where the conditions are not favourable to a vigorous growth. In addition to the developing amphidises figured by Hanitsch (21, fig. 5), a very few mature amphidises of both kinds were found in the fragment collected in 1893.

Specimens of *Trochospongilla pennsylvanica* and *Spongilla crateriformis* from North America, identified by Potts, and a specimen of the latter species from India, were available for examination. In this connexion it is interesting to note that the two North American species which have to be deleted from the Irish list have, within recent years, been found in India (3).

The supposed occurrence of *Trochospongilla pennsylvanica* in Scotland may also, perhaps, be referred to in this place.

Some years ago Dr. Annandale (2) collected two species of sponges in Loch Baa, in the Island of Mull, Scotland. One of these was a form of

Spongilla lacustris, the other was named *Tubella pennsylvanica* Potts. An examination of one of Dr. Annandale's slides of the latter species in the British Museum showed that the sponge from which the preparation was made was undoubtedly the lake form of *Heteromecynia Ryderi*. Unfortunately gemmules were not present, and I have not succeeded in procuring any further specimens of the sponge from Scotland.

HABITAT AND GENERAL DISTRIBUTION OF FRESH-WATER SPONGES IN IRELAND.

Fresh-water sponges occur throughout Ireland in lakes, ponds, rivers, and streams. They also occur in the canals, in old quarry-holes, and even in bog-drains. They are to be found in mountain tarns and streams up to a height of 2,200 feet, as well as in the largest lakes and rivers of the lowlands.

In this country fresh-water sponges usually grow on and under stones, but they also grow on water-plants, and, in lowland rivers, they have been found on the submerged roots of trees, such as the alder, and on rotting, submerged tree-stumps and branches. With regard to lakes, sponges are most abundant in those which have rocky or stony shores, or have at least a stretch of stone-strewn beach, but they also grow, though never luxuriantly, in lakes which are almost entirely surrounded by high banks of peat, and in which the water is deep-brown in colour from the peat. In these lakes on the bogs the sponges are occasionally found on the submerged stumps of the trees (for the most part Scotch Fir) that in former times grew in abundance in areas now covered by bogs and lakes. Sponges have even been seen growing on a sod of turf lying under water in a stream.

When the bottom consists of mud, the "chief enemy" of sponges, they grow raised above it on the stems of reeds or other water-plants, or on the stone-work and wood-work of the walls of mill-streams, canal locks, and other artificially constructed waterways.

Fresh-water sponges are occasionally found in brackish water in different parts of the world. So far they have not been found in brackish water in Ireland, although search has been specially made for them. For example, the tidal river which drains Furnace Lough, Co. Mayo, was carefully examined, but without success, as well as the southern end of the lake where the water is brackish. Sponges were abundant in fresh water at the northern end of the lake. On the other hand, a marine species of Polyzoa *Membranipora membranacea*, which establishes itself readily in brackish water, was found all along the river, in the southern part of the lake, and even in fresh water at the northern end, where it grew in company with *Ephydatia fluviatilis*.

Speaking generally, as long as there is a suitable substratum on which sponges can establish themselves, it is but seldom that one will return empty-handed from a search in any lake or river. But, as is always the case when this group of animals is concerned, the general rule has exceptions.

As far as my experience goes, sponges are not found in mountain streams in Ireland, unless there is a lake, however small, in the course of the stream. They do not occur in the streams flowing into the lake, but are to be found in the out-flowing stream or streams at a point immediately below the lake. Even when the sponges are few in number and small in size in the lake itself, just below it they often spread out in masses over the under surface of the larger stones, and if these upper stones are removed they are to be seen carpeting a lower layer of stones in the bed of the stream. The species found in such situations are *Heteromyenia Ryderi* and, more rarely, *Spongilla lacustris*. If the mountain stream is small, the sponges appear to die out again further down its course, or at least they do not occur in such abundance.¹

In lower-lying country sponges are found in the larger streams and rivers whose course does not pass through a lake. In this case they do not appear to grow very near its source. Probably it is owing to an insufficient food supply in a river near its source, and in a mountain stream, unless there is a lake in its course to act as a sort of reservoir, that sponges are not found in these situations.

Sometimes sponges cannot be found when shore-collecting in lakes which appear to be eminently suited to their growth, possessing, for example, clean stone-strewn beaches and clear water. No reason can be assigned to account for their absence. But it is possible in some cases after a very dry summer, when the water-level is unusually low, and the sponges are killed along a wide strip of shore, which is thus exposed, that it may take some time for them to reach again, at least in their former numbers, to their usual level. For instance, Lough Gill was examined for sponges in July, 1914, and they were found growing in abundance on the metamorphic rocks in certain places, and in smaller numbers on the limestone along other parts of the shore (43). The water was exceptionally low that year, and dried sponges were seen on the stones well above the water-level. A visit to

¹ In this connexion it is interesting to quote a statement of Dr. Annandale's in a paper (8) received after the foregoing was written, in which he discusses the occurrence of sponges in mountain streams in India. He writes: "I have not yet found any sponge in a small mountain torrent such as those at Khandalla, in which food is probably deficient; but when these streams are dammed to form ponds in which aquatic vegetation grows up, sponges soon make their appearance."

the same places in July, 1916, resulted in the finding of a very few small specimens, in the course of three days' search, on the metamorphic rocks in the lake, while none was seen on the limestone. In the tropics, where gemmules are produced in such abundance at the approach of the dry season, a fresh growth of sponges is ensured when the water again reaches its winter level. With the occasional exceptions of *Ephydatia fluviatilis*, and in a less degree *Spongilla lacustris*, gemmules are not abundant in lake sponges in Ireland, so that there is not much chance of sponges which are left high and dry during an unusually rainless summer being reproduced *in situ* by their means. In this connexion it may be stated that, on the whole, gemmules are not produced in very great numbers by fresh-water sponges in Ireland, no doubt owing to the temperate climate. The river form of *Heteromeyenia Ryderi*, and sometimes *Ephydatia fluviatilis*, may give rise to a certain abundance of gemmules, but I have seen nothing in Irish specimens at all comparable to the masses of gemmules produced by sponges in the tropics. Dr. Annandale, who has such an extensive knowledge of the tropical Spongillidae, comments on the scarcity of gemmules in a collection of sponges from France and Switzerland examined by him (4, p. 393). His remark would apply perhaps even more forcibly to Irish specimens. Although not produced in extraordinary numbers, gemmules may be found apparently at almost any time of the year. Again, owing to our temperate climate, there would appear to be no particular need to produce them at any special season. They are, however, more abundant on the whole in the late summer and autumn.

I have never found sponges along the shores of lakes, such as Crotty's Lough in the Comeragh Mountains, or Lough Shinnagh in the Mourne Mountains, that are used as a water-supply for neighbouring towns and cities. This is, perhaps, to be accounted for by the rapid and frequent changes in the water-level in these lakes.

Sponges were not found in any of the lakes in the Mourne Mountains, although, apart from Lough Shinnagh, the lakes appeared suited to their growth. Sponges occur in such abundance and with such regularity in mountain tarns throughout Ireland that their apparent total absence from the Mournes is noteworthy.

The position in which sponges grow with the greatest luxuriance in this country is in a stream or river which drains a lake, and at a point a greater or less distance below the lake. This applies both to small mountain streams, as already described (p. 217), and to the large lowland rivers. For example, about half a mile below Lough Allen the pebbly bed of the River Shannon was found to be literally carpeted with growths of *Spongilla lacustris*. For

the most part the sponge sent up branches from an encrusting base, but unbranched, encrusting specimens were also common. Some miles down the river the sponge grew in fairly numerous isolated patches, but in nothing like the abundance in which it flourished at the first-mentioned point. The western shore of Lough Allen had been examined on the same and previous days, and proved to be almost bare of sponges, a few small specimens of *Spongilla lacustris* being found in a sheltered bay at the south-western end of the lake. The extreme scarcity of sponges in the lake thus contrasted strongly with their abundance in the river. Again, in County Sligo, the bed of the Drumcliff River, a hundred yards or so below Glencar Lough, was covered by a luxuriant growth of the same species, both branching and encrusting specimens again occurring. Glencar Lough itself yielded only a few small specimens. In non-calcareous areas *Heteromeyenia Ryderi* often grows in out-flowing streams, with stony bottoms, just below a lake both in the mountains and in low-lying localities. As this species grows hidden from the light, the uppermost layer of stones must be removed before the sponge can be seen practically covering the bed of the stream, as well as the lower surfaces of the top layer of stones.

I have not been able to find any reference in the literature of fresh-water sponges which would show that a similar rule with regard to the growth of sponges has been observed to hold good in other countries—namely, that sponges occur most luxuriantly in a stream or river that drains a lake, and at a spot a little distant below the lake. Edward Potts (30, p. 218) noticed, indeed, that *Spongilla lacustris* was particularly abundant at an outlet from the Fairmount Reservoir, “its stems forming a complete matting over many yards of surface,” and Dr. Annandale (6, p. 65, p. 72) remarks of a certain species, *Nudospongilla mappa* Annandale, which occurs both in the Lake of Tiberias and in the River Jordan, that the largest specimens were taken from the Jordan near its exit from the lake. These are isolated instances, but they tend to show that the rule, as one would expect, probably holds good in other countries.

In the course of the Clare Island Survey two differences were noticed between the sponges in the lakes of the limestone area examined and those in the lakes lying on non-calcareous rocks (41). First, that sponges were less numerous, and, as a rule, of less luxuriant growth in the lakes on the limestone; and, secondly, that *Heteromeyenia Ryderi* was not found in any of the lakes on the limestone, but occurred in abundance in neighbouring lakes on non-calcareous rocks. These two points are further confirmed by the field-work since carried out in many other parts of Ireland.

With regard to the first point, the statement that sponges grow, as a

rule, less luxuriantly in lakes on the limestone still holds good, but it must be noticed that they sometimes grow in abundance on the limestone in rivers which drain a lake as just described. In the localities quoted, both the River Shannon and the Drumeliff River flow over the limestone at the spots indicated. But it must be remembered that the River Shannon at the place described drains Lough Allen, a large lake lying for the most part on the Lower Coal Measures, and that the bed of the river was largely made up of slaty fragments carried down from the Coal Measures. Glencar Lough, however, lies on the limestone.

The stones in many limestone lakes are covered with a thick, soft, calcareous deposit which seems to afford an unfavourable substratum for the growth of sponges, and which may be the cause of their scarcity in those lakes (41, p. 4). *Spongilla lacustris* and, more rarely, *Ephydatia fluviatilis* are able to establish themselves on such calcareous deposits, but they do not flourish on them.

As regards the second point, *Heteromeyenia Rydleri* has not been found growing on the limestone in any part of Ireland. It occurs on all sorts of non-calcareous rocks—granite, sandstone, mica-schist, basalt, and felstone. As suggested in a former paper (41, p. 4), the reason for the absence of *Heteromeyenia Rydleri* from limestone areas may, perhaps, be a physical one. The favourite habitat of the species, for the most part the only one in Ireland, is the under surface of stones. In lakes on non-calcareous rocks the stones are clean, and lie loosely on one another, thus affording shelter from the light and a free access of water to the sponge. In the lakes on the limestone the stones are often half-buried in mud, and in addition are often covered with a thick limy deposit. Such conditions would seem to be totally unfavourable to the growth of *Heteromeyenia Rydleri*. On the other hand, the species is equally absent from lakes and rivers where the limestone is cleaner, and affords freer under surfaces to the growth of sponges. *Heteromeyenia Rydleri* has not been found in the lakes which lie partly on the limestone and partly on non-calcareous rocks. The only exception to this statement, up to the present, is the finding of two small specimens of the species in the extreme north-western arm of Lough Corrib, which large lake lies for the most part on the limestone. But this north-western arm lies on non-calcareous rocks, and receives the drainage of the surrounding non-calcareous country: it is united only by a narrow channel with the main body of the lake, so that this part of Lough Corrib is to all intents a separate lake. The species was looked for in vain in the main body of the lake, which lies on the limestone.

As a general rule, *Spongilla lacustris* and *Heteromeyenia Rydleri* grow side

by side in lakes and rivers on non-calcareous rocks. If only one species is present, that species is almost always *Heteromeyenia Rydleri*, which is thus the most widely spread as well as the commonest sponge in the areas in which it grows. Very rarely three species are found growing together in any lake or river. On only two or three occasions were the two foregoing species found in company with a third, namely, with *Ephydatia fluviatilis*. For example, these three species were found together in Lough Nacorra and Moher Lough, in County Mayo. *Ephydatia fluviatilis*, however, varied in its appearance in these lakes, as it was found one year in abundance, leaving no trace of its presence in the following year. In limestone rivers and lakes *Spongilla lacustris* and *Ephydatia fluviatilis* sometimes occur together, but often only one or the other is present. The remaining species—*Spongilla fragilis* and *Ephydatia Mülleri*—are too rare to admit of any general statement about their occurrence. The fact that rarely more than two out of the five species grow side by side at a given spot in Ireland is a contrast apparently to the mode of occurrence of fresh-water sponges in some other parts of Europe. For example, all five species known in France are met with at one spot in the River Saône, close to the fresh-water station recently established in the Côte d'Or (Topsent).

The same species of sponge may be found year after year in any given lake or river in this country. The only noticeable exception to this appears to be the occurrence of *Ephydatia fluviatilis* in the west of Ireland. This species varied in its appearance from year to year in a couple of lakes in County Mayo in which it had been found (41, p. 3). But it should be noted that *Ephydatia fluviatilis* is a rare species in the west, and is evidently not well established there.

To sum up the distribution of fresh-water sponges in Ireland—*Spongilla lacustris* occurs throughout the country in both limestone and non-limestone areas, both in low-lying lakes and rivers and in mountain tarns and streams.

Heteromeyenia Rydleri is only found in the fresh water of non-limestone districts, hence it occurs all round Ireland in the maritime counties which lie off the limestone, and is absent from the central limestone plain. It is commoner in mountain lakes and streams than the preceding species.

Ephydatia fluviatilis grows in both limestone and non-limestone areas. It is rare in the west, and has not yet been found in the south-west. It is quite common in the eastern counties from north to south. The species has not been taken in mountain tarns and streams. With the exception of Lough Nacorra, in County Mayo, which lies at 589 feet, it is only known from quite low-lying localities.

The remaining two species are very rare. *Spongilla fragilis* has been

taken in five widely separated localities, lying in the extreme north and south and in the west and north-west, while *Ephydatia Müllerii* has only been found so far in the River Erne, at Enniskillen; the River Tolka, in County Dublin; and in Caragh Lake, in County Kerry.

Family SPONGILLIDAE.

Spongilla (Euspongilla) lacustris auct. (Pl. XXVI, figs. 1, 2.)

This species is found all over Ireland, both in limestone and non-limestone districts. It flourishes in lakes and rivers and in the canals, and is the most widely spread species in Ireland, but in the areas where *Heteromeyenia Ryderi* occurs it is by no means the commonest; while in some of the eastern counties, in County Dublin for example, it is much rarer than *Ephydatia fluvialilis*.

Like all the fresh-water sponges in Ireland, *S. lacustris* usually grows on stones, either on the upper surface, when it is branching or massive, or on the under surface, when it forms thicker or thinner encrustations. It sometimes grows on water-plants, and has been found on the submerged roots of trees, such as the alder, growing on the banks of rivers, and on the stonework of canal locks. Branching specimens, which are so typical of the species, are of much rarer occurrence in Ireland than encrusting ones.

As is usually the case with fresh-water sponges, *S. lacustris* is bright green when growing exposed to the light; when sheltered from the light it is greyish-white or pale yellowish. In lakes with very peaty shores it is sometimes a dull purplish-brown colour. An interesting variety of colour was exhibited by specimens growing in great profusion on the pebbly bed of the River Shannon, about half a mile below Lough Allen. Some of the sponges were a fairly bright, though not a vivid, green, but all were tinged more or less with a dark grey colour. Some were of a uniform dark grey externally and a pale yellowish green colour internally. One large specimen was ash-grey in colour, with most of its branches tipped with white, which rendered it very conspicuous even at some little distance. Another branching specimen was in part green, in part coloured similarly to the foregoing. These sponges were loaded with particles of silt brought down from the Coal Measures on which the greater part of Lough Allen lies.

S. lacustris is found commonly in mountain lakes and in their out-flowing streams, but it is comparatively rare in the higher mountain tarns, and has only been taken at three or four localities lying at an altitude of 1,000 feet or over. It was found in a little tarn at 2,200 feet on Mount Brandon in the Dingle peninsula, and in the stream draining the lake. It was also taken lower down the mountain in the stream draining Lough Nalaeken (1,000 feet),

in Lough Boy, County Cork (1,800 feet), and in the out-flowing stream. In addition, spicules belonging to the species were found mixed with specimens of *Heteromeyenia Ryderi* from Lough Eagher, County Kerry (1,550 feet). *H. Ryderi*, which almost invariably accompanies *S. lacustris* in non-limestone districts, is much more commonly found in these mountain tarns; but it is to be noted that *S. lacustris* alone was found in the little tarn at 2,200 feet on Mount Brandon, which is the highest altitude at which a fresh-water sponge has been found in Ireland.

In many of the low-lying lakes and rivers the growth of *S. lacustris* is vigorous, the skeleton spicules are robust and are united into thick fibres by a considerable quantity of spongin, and microscleres are present in the greatest abundance. For example, the species was seen spreading in masses several square feet in extent over a large boulder in Lough Feeagh, County Mayo. The pebbly bed of the River Shannon below Lough Allen was literally carpeted with branched and unbranched specimens. An equal profusion of specimens was seen in similar situations, while in the tree-bordered stretches of some of the rivers in the south-eastern part of the country the species may be seen coating the tangled roots of alders for yards along the banks.

The skeleton-spicules in these large specimens usually vary between 0·2-0·3 mm. in length, and have a maximum thickness of 0·013 mm., or more rarely 0·015 mm. The free microscleres are as a rule between 0·07-0·12 mm. in length, and have a maximum diameter of 0·008 mm. The gemmule-spicules vary between 0·05-0·13 mm. by 0·006-0·01 mm. (Pl. XXVI, fig. 1).

The gemmules themselves have no granular layer, or, if present, it is poorly developed. Very rarely it is well developed.

A great contrast to this vigorous growth of *S. lacustris* is presented by a certain form of the species which is characteristic of the mountain lakes, and also of the low-lying western lakes of the non-limestone areas (Pl. XXVI, fig. 2). This form occurs in small, more or less oval, patches on the under surface of stones. These patches are thicker towards the centre and thin out towards the edges. They are pale yellowish in colour, soft to the touch, and slightly hispid owing to the ends of the spicule-fibres projecting beyond the dermal surface. One or more small oscula are situated towards the centre of the sponge. This form of *S. lacustris* is easily distinguished at sight from the lake form of *Heteromeyenia Ryderi*, with which it is almost invariably associated, by its colour, its greater hispidity, and more particularly by its extreme softness.

The main skeleton-fibres are very slender, usually between 0·015-0·04 mm. in diameter. These are united at fairly long intervals by transverse fibres, consisting of a single spicule or of a bundle of a few spicules at right angles

to them. The spongin is very scanty, so that the entire skeleton is weak and is loosely held together. The whole appearance of the skeleton is thus a great contrast to that presented by robust forms of the species, in which both main and transverse fibres may reach a diameter of 0.15 mm., and may possess a considerable quantity of spongin closely binding the spicules.

The skeleton-spicules are long, but slender. They usually vary between 0.22-0.33 mm. in length, and have a maximum diameter of 0.01 mm. In some cases the maximum diameter is about 0.006 mm.

The free microseleres are also slender, being about 0.002-0.004 mm. in diameter. Usually they are few in number, but sometimes they are present in fair quantities.

Gemmules are present as a rule in considerable numbers, and may appear as early in the year as June. They are usually without a granular layer, or with this layer very feebly developed, and are of a clear pale yellow colour. They vary considerably in size, but do not appear, on the whole, to be smaller than in more typical specimens.

The gemmule-spicules seem to be absent from some specimens; in others they are present in scanty numbers. They measure, as a rule, between 0.008-0.13 mm. by 0.003-0.005 mm.

In lakes in which this small form grows there may sometimes be found small green finger-like specimens, perhaps only half an inch in height, on the sides of the stones. In one lake only, namely, in Lake Nacorra, County Mayo, were long branching green specimens found, about a foot in height. In these sponges the branches were very soft and slender. The spicules, too, were slender, quite resembling those of the small encrusting specimens growing under the stones.

The small encrusting form of *S. lacustris* is described at some length by Dr. Annandale (2) from specimens found by him on the under surface of stones in Loch Baa, in the Isle of Mull, Scotland. It is considered by him to be possibly a distinct local race.

This phase of *S. lacustris*, so characteristic in its extreme form, is connected by every intermediate link with other specimens of *S. lacustris* which grow as more robust encrustations on the under surface of stones in lakes and streams on both calcareous and non-calcareous rocks. It has been traced from the lakes in which it grows down the streams that drain the lakes. As is the case with other species, *S. lacustris* grows most luxuriantly in these streams at a point a little distance below the lakes. Hence in such situations it extends in much larger patches on the under surface of stones; but there is no appreciable difference in the size or shape of the spicules, or in the relative abundance of the gemmule-spicules.

Girod (18) has noticed that in the mountain lakes of Auvergne the gemmules borne by *Spongilla lacustris* are devoid of a granular layer, and possess sometimes a few gemmule-spicules. In the rivers the gemmule-spicules increase in numbers until they form a compact covering of closely placed spicules (*S. lacustris*, var. *jordanensis*, Vejd.), and all intermediary stages have been seen in passing from the still waters of the mountain lakes to the currents of the River Allier and its tributaries. In Ireland the gemmules are without the granular coat, or have it very poorly developed in specimens in the low-lying lakes and rivers, as well as in those in the mountain tarns and streams. In one case only, namely, in a specimen from a stream in County Antrim, were gemmules seen with a well-developed granular coat in which the spicules were more or less vertically placed, exactly as figured by Vejdovsky (49, Pl. II, fig 13A). These gemmules were brown in colour, owing to the presence of a distinct chitinous coat outside the granular layer, as described by the same author (49, p. 17); and only a few of them were present, the majority of the gemmules being of the usual yellow colour, and with the granular layer poorly developed.

LOCALITIES.

KERRY.—L. Coomasaharn, Caragh L. and Caragh R., Middle Lake and Meeting of the Waters, Killarney; L. Avoonane and out-flowing stream, L. Cruttia (coll. R. Welch), stream from L. Nalacken (1,000 ft.) and lake at 2,200 ft. and its outlet on Mt. Brandon; L. Doon (1,000 ft.), L. Duff and out-flowing stream, L. Gall, L. Clogharee and out-flowing stream, L. Adoon, L. Eagher (1,550 ft.), Cloonee Lakes and Cloonee R., L. Inchiquin and out-flowing stream, L. Cummeenadillure and out-flowing stream.

CORK.—L. Avaul Little near Glengarriff, L. Boy (1,800 ft.) and out-flowing stream.

WATERFORD.—Ballyscanlan L., near Tramore.

GALWAY.—Near Roundstone (12), and many small lakes in the neighbourhood of Craigga More; L. Corrib, at many points along its shore; L. Bofin and out-flowing stream, Arderry L., L. Shindilla, Glendalough L., Nacoo-garrow L. and out-flowing stream, Loughaureirin, Athry L., Derryclare L. and out-flowing stream, Owengowla R., Ballynahinch L. and Ballynahinch R., L. Maumwee, L. Rea (coll. R. A. Phillips).

CLARE.—L. Atorick (coll. by R. A. Phillips).

KILKENNY.—R. Nore at Inishtioge; R. Barrow at Graiguenamanagh.

CARLOW.—R. Barrow near Tinnahinch.

KING'S CO.—Near Portarlinton (39).

KILDARE.—Canal between Sallins and Naas.

WICKLOW.—L. Dan, L. Tay, and Annamoe River.

DUBLIN.—Grand Canal, Royal Canal.

ROSCOMMON.—L. Key, R. Boyle, Oakport L., L. Arrow, R. Shannon, L. Gorinty.

MAVO.—Sraheens L., Achill Island; J. Pollagowly, L. Skahaghadrantan, L. Feeagh and out-flowing stream; L. Beltra, Clogher L. near Westport; L. Mallard, Drumminahaha L., Dambaduff L. and out-flowing stream, Carrowbeg L. near Newport (39); L. Islandeady, Castlebar L., L. Nacorra and out-flowing stream; Moher L., L. Cahasy (coll. J. N. Halbert), L. Nahaltora, Glencullin L., Doo L., Fin L., Tawnyard L., Lugaloughaun. For all the foregoing see (41).

SLIGO.—L. Gill (43), Glencar L., and Drumcliff R., L. Arrow, L. Derrymasallagh.

LEITRIM.—Glenade L., Glencar L., R. Shannon, L. Allen (S.-W. shore), Belhavel L.

CAVAN.—Bailey's Bridge and Baker's Bridge (coll. R. Welch), Killakeen (21), Upper and Lower L. Maeanan; near Belturbet (coll. Miss Clifford).

MONAGHAN.—Mill-stream in Rossmore Castle Demesne (coll. A. W. Stelfox).

FERMANAGH.—L. Erne, at many points along the N. shore, and off the islands in the lake, and Derinty L., Meenaghmore L., and Garvay R. (coll. Major Trevelyan), R. Erne, Lower L. Maeanan.

DONEGAL.—Rath L., Golagh L., L. Lee, Columbkille L. (coll. Major Trevelyan), Garry L. (coll. R. Welch), L. Aluirg and outlet (coll. A. W. Stelfox), Doon L., L. Kiltorris, Pound L., L. Fad near Narin, L. Birroge, L. Roshin, R. Erne, L. Unshin and out-flowing stream, Knader L., L. Inn, L. Fad near Merville.

ARMAGH.—Camlough R. (21).

DOWN.—Canal at Hillsborough (coll. N. H. Foster and A. W. Stelfox).

ANTRIM.—L. Neagh and stream at Woodburn (39), mountain lakes to the west of Carnlough, at about 1,000 ft. (coll. Major Trevelyan).

DERRY.—R. Bann, near Toome (coll. R. A. Phillips and A. W. Stelfox).

Spongilla (Eunapius) fragilis Leidy (Pl. XXVI, fig. 3).

This species, which has an almost world-wide distribution, is very rare in Ireland. Up to the present it has been found in five widely scattered localities in the north, west, and south of the country.

Spongilla fragilis was first found in Ireland in the course of the Clare Island Survey (41). It was discovered in the Owengarr River, which drains

Doo Lough, Co. Mayo; it occurred just below the lake in large patches, and in considerable abundance, and in fact has not since been found growing so luxuriantly in this country. In the following year a few small specimens were taken along the shores of Lough Erne by the late Major Trevelyan. Later on the species was discovered in Lough Fad (636 feet) on Fair Head, where it occurred in certain numbers, although not a trace of it was found in the neighbouring lakes on Fair Head, Lough-na-Cranog and Doo Lough, in both of which *Heteromeyenia Ryderi* abounded (42). A second visit was paid to Lough Fad two years later, when *Spongilla fragilis* was again seen. A few small specimens were found in the River Suir at Kilsheelan, Co. Tipperary; and, finally, one small specimen and an isolated patch of gemmules were discovered in the river flowing from Derryclare Lough, Co. Galway. A special search for further specimens was made at the last-named locality, but without success. A careful look-out has indeed always been kept for this species, with the foregoing small results.

Spongilla fragilis was found growing on the under surface of stones, in which situation it was of a pale yellowish colour. One small specimen growing on the side of a large stone was bright green.

The Irish specimens call for no special remark; they are quite typical of the species. The skeleton-spicules measure 0.18–0.25 mm. in length by 0.005–0.01 mm. The gemmule-spicules vary a good deal in length from one specimen to another; they are usually between 0.007–0.13 mm. in length by 0.003–0.006 mm.

LOCALITIES.

TIPPERARY.—R. Suir at Kilsheelan.

GALWAY.—Owenmore R. below Derryclare L.

MAYO.—Owengarr R. below Doo L. (41).

FERMANAGH.—L. Erne off Caldragh Island and Screedan Rock, coll. Major Trevelyan (41).

ANTRIM.—L. Fad on Fair Head (42).

Ephydatia fluviatilis (auct.) (Pl. XXVII).

Ephydatia fluviatilis grows in the rivers, streams, and lakes of Ireland, both in limestone and in non-limestone districts, and is usually especially abundant in the canals. It is one of the rarer species in the west, and has not yet been taken anywhere in the south-west of the country, nor in Co. Donegal, although a considerable amount of collecting has been done in these areas. On the other hand, it is a common species in some of the eastern and south-eastern counties. In Co. Dublin, for example, it is by far

the commonest species, and indeed the only one found so far in the rivers of that county, the Liffey, Dodder, and Tolka, with the exception of *Ephydatia Mülleri*, found in the last-named on one occasion; but it has not yet been recorded for the neighbouring county of Wicklow. It has been found here and there throughout the midlands, where a more detailed search may prove it to be fairly common.

Like all the fresh-water sponges in Ireland, *E. fluvialis* usually grows on stones. It may form thick encrustations or rounded cushion-like masses on the upper surfaces of the stones, or thinner crusts on their lower surfaces. The species is found, but more rarely, on the stems and leaves of water-plants, on the wood-work of the locks of canals, on rotting, submerged branches, or on the living roots of alder trees growing on the banks of rivers.

The sponge is dark green in colour when exposed to the light, and pale yellowish or greyish when growing in shaded places. In texture it varies considerably: one specimen may be hard, another quite soft. In the former case the sponge possesses robust skeleton-spicules: when the texture is very soft the spicules tend to be slender.

With the exception of its occurrence in Lough Nacorra in Co. Mayo, which lies at an altitude of 589 feet, *E. fluvialis* has been found only in low-lying lakes and rivers in Ireland. Unlike *Spongilla lacustris* and *Heteronopsis Ryderi*, it has not been found in mountain tarns nor in their out flowing streams. On the continent of Europe it appears also to prefer low-lying localities, but in Asia it has been taken at very high altitudes. In the Kumaon Lakes of the Western Himalayas, for example, it occurs at 4,000–6,400 feet (9), and in Issyk-Kul Lake in Turkestan at 5,300 feet (55).

As a rule, *E. fluvialis* is vigorous in its growth, with well-developed skeleton-fibres and robust spicules, but in situations where the conditions would appear to be unfavourable it has been found of very small size, with very slender spicules loosely united into poorly developed, weak fibres. In several lakes in the west of Ireland, where the species does not appear to be well established, the sponge, although growing in considerable quantities, possessed very slender spicules.

Green and actively growing specimens crowded with gemmules have been found throughout the year. Gemmules are apparently produced in far greater numbers in this species than in any other of the fresh-water sponges growing in Ireland, with the probable exception of *E. Mülleri*.

The skeleton-spicules of *E. fluvialis* vary more than is perhaps generally recognized, both in a single specimen and from one specimen to another. When it is stated that they vary considerably, that, for instance, spined as

well as smooth spicules occur, it may usually be taken that the writer does not distinguish between *E. fluviatilis* and the closely allied species *E. Mülleri*. For example, the majority of forms described by Potts (33) under *E. fluviatilis* are really *E. Mülleri*. Waller (50), writing on the varieties of *E. fluviatilis*, describes a series of English specimens. The first three specimens described, and their spicules figured, are typical *E. Mülleri*, with smooth and spined oxea and short amphidises. The remaining two are typical *E. fluviatilis*, with smooth oxea and longer amphidises. But the presence of minutely spined megascleres in *E. fluviatilis* (as distinguished from *E. Mülleri*) has been noted from time to time by several writers, and the occurrence of these spicules has sometimes been considered as an important character for the establishment of new varieties. Vejdovsky (49) alludes to small, slightly spined oxea in specimens of *E. fluviatilis* from Bohemia. Topsent (48) notes the occurrence of microspined oxea in a specimen from the River Vesle, and in the same paper quotes Traxler ("Foltdani Kozlöny," xxv, 1895) as having observed similar spicules in the species. He also describes (48) spined oxea as being abundant in his *E. fluviatilis* var. *syriaca*, from the River Barada, near Damascus and from Lake Huleh in Syria. Kirkpatrick (22) describes them in his *E. fluviatilis*, var. *capensis*, from South Africa, and Ammandale (7, 9), in his *E. fluviatilis*, sub-sp. *himalayensis*, from the Western Himalayas. Weltner (54) refers to the presence of microspined spicules in European examples of *E. fluviatilis*, and in specimens of the same species from Turkestan (55).

With regard to the specimens of *E. fluviatilis*, obtained in Ireland, a careful examination shows that almost every spicule-preparation contains a few, in most instances very few, microspined megascleres. In some cases, generally when the spicules are fairly thick, the spination is very obscure, so that the spicules, even under a high power of the microscope, appear to be merely roughened. In other cases, generally when the spicules are slender, the spines are well developed, and often quite numerous. The thicker microspined oxea of the varieties *syriaca* and *himalayensis*, just alluded to, and the more slender oxea, with minute, sharp spines, of the variety *capensis* are exactly similar to the spined oxea to be seen in various Irish specimens of *E. fluviatilis*. The slender spicules appear to have more tendency to be spined than the more robust ones. This is carried to an extreme, perhaps, for the species in interesting specimens from the pond in the Zoological Gardens, Dublin, in which many of the spicules, which are all rather slender, are thickly covered with fairly strong spines (Pl. XXVII, fig. 3). This peculiarity was not limited to one specimen, but was seen in all the samples collected in two successive years. The sponge was not abundant, and was

not of a vigorous growth. It was in the form of small, thin patches, growing chiefly on the under surface of stones. Numerous gemmules were present, which were furnished with slender, quite normal amphidises. The absence of bubble-cells was another character which prevented any confusion of these specimens with *E. Mülleri*.

In specimens of *E. fluviatilis* that may be regarded as typical the megascleres do not vary very much in size and shape. In such examples they are fairly stout, slightly curved, smooth oxea, tapering gradually to a sharp point at each end. Some have a very slight swelling in the centre of the shaft, and a very few are microspined (Pl. XXVII, fig. 1). It may be mentioned that Topsent (48) has already noted that there is often a slight swelling in the centre of the oxea of typical specimens found in France. In other specimens the oxea are similar to the foregoing, but are much more slender. They may be gradually pointed, as in specimens from Lough Beltra, Co. Mayo, or abruptly pointed, as in examples from Furnace Lough, in the same county (Pl. XXVII, fig. 2). Some of the oxea have a central swelling, and a number are very minutely spined. In specimens from the pond in the Zoological Gardens, Dublin, as already mentioned, the rather slender, spined spicules are very numerous (Pl. XXVII, fig. 3).

Again, other specimens of *E. fluviatilis* have typical megascleres, namely, fairly thick, slightly curved, gradually pointed, smooth oxea; but among these is a considerable admixture of straight, or nearly straight, spicules which are shorter and thicker, and which taper abruptly to a point at either end. Some of the spicules have a slight central swelling, and a few are microspined (Pl. XXVII, fig. 6). These lead on to other specimens, in which the majority of the megascleres are short, very thick, nearly straight or slightly curved spicules, which taper abruptly, or more rarely gradually, at either end (Pl. XXVII, fig. 4). A few of these are microspined. When short, thick spicules, either microspined or smooth, are formed to the complete or almost complete exclusion of the longer, more typical oxea, a peculiar form of *Ephydatia fluviatilis* results, which, for the sake of clearness, will be dealt with later on.

As well as the variations just described, abnormally formed spicules may be present in greater or less numbers in any specimen of *E. fluviatilis*. For example, the oxea may have one end rounded off, or even knobbed, or a series of swellings may be present along the shaft of the spicules (usually in slender, poorly developed spicules, and in young spicules), or the oxea may be reduced to a sphere, with or without one or two spike-like projections. Weltner (53) gives figures of some of these abnormalities.

With regard to the measurements of the foregoing spicules, the more

typical oxea measure between 0.24 and 0.47 mm. in length. They do not vary so much as this in a single specimen. Their most usual length is between 0.25 and 0.37 mm. Their maximum diameter is usually 0.013 mm.; but it varies from 0.008 to 0.015 mm. in different specimens. The shorter, thicker megascleres present in many specimens are, as a rule, between 0.22–0.26 mm. in length, and have a maximum diameter of 0.02 mm.

The gemmule-spicules of *E. fluviatilis* vary also to some extent. In the more typical specimens of the species the shaft of the amphidisc is smooth, or is so minutely spined that it looks merely roughened; or it may have one to several long, sharp spines projecting from it. The disc is indented; it is either divided into a number of fairly even, small teeth, or it is cut by several deeper indentations into broader sections, the outer edges of which are toothed. The teeth themselves may be very finely spined. In specimens which are not so robust in growth, and which possess rather slender megascleres, the amphidiscs are slender also, and there is more tendency for them to develop irregularities such as have been described and figured from time to time by various writers; for example, by Wierzejski (56), which writer notes in passing that the skeleton-spicules are slender in the specimens examined by him possessing irregularly shaped amphidiscs. The shaft, for instance, may be thickly covered with long spines, and may project as a sharp point beyond one or both discs. The discs themselves may be variously developed, and may often be merely an irregular bunch of strong spines projecting from the thickened ends of the shaft, or they may be reduced to one or two strong spines projecting at various angles, so that the spicule assumes an irregularly star-shaped form.

The amphidiscs are 0.025–0.027 mm. in length, and the diameter of the disc is 0.015–0.02 mm.

LOCALITIES.

WATERFORD.—Bally L. to the north of Dunmore.

TIPPERARY.—R. Suir at Kilsheelan, Anner R.

KILKENNY.—R. Barrow at Graiguenamanagh.

WEXFORD.—R. Bann near Camolin.

CARLOW.—R. Barrow near Tinnahinch.

GALWAY.—L. Corrib near Oughterard, Coole L. (coll. R. A. Phillips).

KING'S CO.—Lake in Birr Castle Demesne (coll. R. A. Phillips).

KILDARE.—R. Barrow at Mageney (34), Rye Water, at Leixlip.

DUBLIN.—R. Liffey, R. Dodder, Raheny ponds (21), stream at Edmondstown, Grand Canal, Royal Canal, R. Tolka, pond at Crumlin, pond in Zoological Gardens.

MAYO.—Furnace L., L. Beltra, Knappaghmore L., Moher L., L. Nacorra.

SLIGO.—L. Gill (43), L. Arrow, Dargan L. (coll. A. W. Stelfox).

FERMANAGH.—L. Scolban and Garvay R. (coll. Major Trevelyan).

DOWN.—Stream at Saintfield, canal at Hillsborough (coll. N. H. Foster).

ANTRIM.—Lagan Canal and disused reservoir near Cave Hill (coll. W. H. Patterson).

DERRY.—Enagh L. (coll. D. C. Campbell), R. Bann between Derry and Antrim (coll. R. A. Phillips and A. W. Stelfox).

Ephydatia fluviatilis (auct.) var. (Pl. XXVI, figs. 4–9).

Certain sponges have been collected in the west and south of Ireland which have proved difficult to determine, as the skeleton-spicules vary a good deal in the specimens from the different localities, and gemmules have not been found, although nearly all the examples were taken in the late summer. The sponges usually grew in great abundance at a given locality, and as many as one hundred specimens have been preserved from a single spot. The skeleton-spicules of these sponges are short, often very thick oxea, the majority in one specimen spined to their tips, in another smooth. Examples collected in two localities, namely, in the Drumcliff River draining Glenear Lough, County Sligo, and in the River Boyle below Oakport Lough, County Roscommon, seem to offer a clue to their identity.

The skeleton-spicules vary in an unusual degree in the sponges from these two rivers, more particularly in those from the Drumcliff River, some of them being very similar to the spicules just alluded to. Although gemmules were not found, yet a fair number of scattered amphidiscs are to be seen in the spicule preparations. These amphidiscs quite agree with the corresponding spicules of typical specimens of *Ephydatia fluviatilis*. It has been concluded, therefore, that the foregoing sponges represent a variety or phase or race of *E. fluviatilis* which does not produce gemmules, or at least produces them with extreme rarity, and which possesses, to the exclusion of the more typical skeleton-spicules, one or other form, such as occurs as an occasional abnormality in typical specimens of *E. fluviatilis*. The abnormal spicules, which occur only occasionally in some specimens, may occur in numbers in others, which undoubtedly are quite typical of that species. For convenience, these peculiar sponges are referred to as *E. fluviatilis*, var.

The sponges, including those from the above-mentioned rivers, agree in external appearance. They form thin, more or less circular, patches on the upper and under surfaces of stones; they are very hard to the touch, their surface is even, but is seen under the lens to be minutely hispid from the tips of the terminal spicules of the main skeleton-fibres, which project very

slightly above the surface. The specimens are of all sizes, up to about 20 mm. in diameter. Those from the rivers tend to be rather larger, but this is usually the case with sponges taken in such a habitat (see p. 219). In this connexion it may be mentioned that Dr. Annandale (5) describes and figures specimens of the Himalayan race of *E. fluviatilis*, which were growing on stones in the form of flat, circular films. A few of the Irish specimens tend to be thicker, and are like little rounded cushions, while a number of examples taken from the River Erne early in the year form small, smooth, rounded masses growing on water-plants, and are rather soft to the touch.

The oscula are small, but are rendered more conspicuous by the well-marked, branching, sub-dermal canals which radiate from each osculum.

The sponges are bright green in colour when exposed to the light, and greyish-white when shaded from it. In the latter case they resemble to a remarkable degree the lake-form of *Heteromeyenia Ryderi*, but, unlike that species, they flourish on the limestone. The specimens are nearly always densely crowded with embryos.

With regard to the structure of the skeleton, the main fibres run vertically upwards from the base to the upper surface of the sponge, branching once or twice in their course. They consist of multiseriably arranged megascleres, bound together by a small amount of spongin. The tips of the terminal bundles of spicules project very slightly above the surface of the sponge. The main fibres are united by single spicules, or by bundles of two or more spicules lying at right angles to them.

In specimens from various points along the shores of Lough Erne and of Lough Gill, from Lough Feeagh, County Mayo, and Lough Derg, County Tipperary, the megascleres are rather short, fairly thick, or sometimes very thick, abruptly pointed oxea, which are microspined to the very tips. A few among them are smooth. In some examples many of the oxea have a central swelling; in others only a few possess it. In the sponges from Oakport Lough, County Roscommon, and Ballyscanlan Lough, Co. Waterford, for example, the spicules are very similar to the foregoing in shape and size, but are smooth. The spicules from the latter locality have often a central swelling of the shaft, and are particularly like those described and figured by Müller (27) for a sponge which he regarded as a probable variety of *E. fluviatilis*, and which will be referred to more fully later on.

Gemmule-spicules have been very carefully searched for in many preparations made from these sponges, but without success, except for one malformed amphidisc found in one of the Ballyscanlan Lough specimens.

The size of the megascleres varies somewhat from one specimen to another; they are, on the whole, between 0.18-0.27 mm. in length. In some

specimens the maximum diameter is 0·015 mm., but in others it is 0·02 mm., or even as much as 0·027 mm. The spicules are thus decidedly shorter and thicker than the typical oxea of *E. fluviatilis*, but more nearly resemble the short, thick spicules often to be found in that species.

The specimens from the Drumeliff River and the River Boyle, already alluded to as affording a clue to the identity of these sponges, are exactly similar to them in external appearance, being hard to the touch, and growing in thin, more or less circular, patches. With regard to the spicules, the Drumeliff River sponges possess many short, thick, abruptly pointed, smooth, or microspined oxea, and in addition longer, more slender, gradually pointed smooth oxea, some of which possess a central swelling. These latter are like the oxea of typical specimens, which often, it must be remembered, also possess many short, thick spicules, some of them microspined. The sponges possess in addition a few scattered amphidiscs, which are quite the typical *E. fluviatilis* shape. The specimens from the River Boyle closely resemble the Drumeliff River examples, and, like them, possess scattered amphidiscs. Typical specimens of *E. fluviatilis* were absent from both these localities, so that the amphidiscs must belong to the specimens in which they were found, and are not a chance admixture, as so often happens.

Sponges were collected in the lakes drained by these rivers, in Glencar Lough and in Oakport Lough respectively, which possessed rather short, thick spicules, without the longer ones found in the river specimens (compare the change in the megascleres of *Heteromeyenia Ryderi* under similar conditions), nor were any amphidiscs found even after prolonged searching. With regard to the presence of gemmule-spicules in lake and river sponges, it is interesting to quote Dr. Annandale's reference to the production or non-production of gemmules. He states (6, p. 74) that "evidence, moreover, is accumulating that the adoption of a limnic as distinct from a fluviatile mode of life is liable to produce degeneration of the gemmules in fresh-water sponges." The most notable instance so far known is *Heteromeyenia Ryderi*, which, both in North America and in Ireland, produces gemmules with great rarity in lakes, and in great abundance in rivers.

To return to the consideration of the megascleres of the foregoing sponges, if it were imagined that spicules, such as those figured on Pl. XXVI, figs. 9, b, c, were produced to the exclusion of the other types of spicules, the result would be a sponge possessing spicules similar to those from Ballysculan and Oakport Loughs (Pl. XXVI, figs. 5 and 7).

A similar type of spicule to that figured on Plate XXVI, fig. 9, c, is also commonly found in perfectly typical specimens of *E. fluviatilis*, such as that figured on Pl. XXVII, fig. 4. Again, if spicules, such as those figured

on Pl. XXVI, fig. 9, d, e, were produced to the exclusion of other types, the resulting sponge would possess spicules somewhat similar to those of the sponges from Lough Erne, Lough Derg, and Lough Gill (Pl. XXVI, figs. 4, 6, and 8). With these may be compared the microspined spicule taken from a perfectly typical specimen of *E. fluviatilis* (Pl. XXVII, fig. 5). It may be noted that these peculiar sponges have up to the present only been found in the west and south, where the typical *E. fluviatilis* appears to be rare. They occurred in abundance in the localities in which they were found. No trace of such a form was discovered in County Dublin, for example, where *E. fluviatilis* is extremely common, and where there was abundant opportunity for collecting at different seasons of the year.

Reference has been made to a sponge from the River Lahn, near Marburg described by Müller (27) as a probable variety of *E. fluviatilis*. In this the spicules are short, thick, smooth oxea, with a central swelling; they are very similar to the spicules of the sponges from Ballyscanlan Lough (Pl. I, fig. 5). In addition, the River Lahn sponge possesses a number of scattered amphidises like those of *E. fluviatilis*; some of them are rather abnormal in shape, but similar forms are often found in quite typical examples of that species.

Wierzejski (56), writing on the abnormalities of the spicules in the Spongillidae, refers to Müller's specimen, and says that he has no doubt but that it is an abnormal form of *Ephydatia*. He refers also to the fact that when abundant material of any of the European Spongillidae is examined, many abnormalities of the various kinds of spicules are to be seen, and sometimes these abnormal spicules are so predominant that one seems to see new varieties, or even new genera.

LOCALITIES.

WATERFORD.—Ballyscanlan L. near Tramore.

TIPPERARY.—L. Derg in Barrett's Bay, dredged at 14 feet (coll. R. Southern).

ROSCOMMON.—Oakport L. and R. Boyle at Cootehill.

GALWAY.—L. Rea (as *E. Mülleri*, 21), and recently collected on several occasions in the lake by R. A. Phillips.

SLIGO.—L. Gill at Rockwood (as *E. Mülleri*, 43), Glencar L., and Drumcliff R.

LEITRIM.—L. Gill at O'Rorke's Castle (as *E. Mülleri*, 43).

FERMANAGH.—L. Erne off Caledragh Island and Eagle Island (coll. Major Trevelyan), R. Erne at Enniskillen (coll. R. Welch).

Ephydatia Mülleri Lieberkühn. Pl. XXVIII, fig. 1.

Ephydatia Mülleri is apparently the rarest of the fresh-water sponges found in Ireland, only two undoubted specimens having been collected within

recent years. One, dredged in the River Erne at Enniskillen, is merely a small mass of gemmules held together by the remnants of the sponge of the previous year's growth. The other is a very fine cushion-like specimen, about 180 square mm. in extent, which was found growing at the base of an overhanging rock in the River Tolka, near Ashtown, Co. Dublin. It was pale yellow in colour, and the surface was slightly ridged. The whole sponge was crowded with gemmules, and the characteristic large vesicular cells, commonly called "bubble cells," were present in great abundance. Another large sponge growing within three or four yards of it looked exactly like it, but was softer in texture, and proved to be a perfectly typical *Ephydatia fluvialilis*. A careful search was made along the river, both at the time of finding these sponges and in the following year, for further specimens of *E. Mulleri*, but without success. *E. fluvialilis* is quite common in the river.

The spicules of both the River Erne and the River Tolka specimens of *E. Mulleri* are quite typical of the species: in neither case could they be confused with the spicules of any of the specimens of *E. fluvialilis* found in this country, although the distinction usually made between the two species, namely, that one possesses only smooth, the other spined as well as smooth skeleton-spicules, can no longer be maintained. The megascleres of the *E. fluvialilis* found in the pond in the Zoological Gardens, Dublin, it is true, approach closely to the corresponding spicules of the Erne *E. Mulleri*, which are rather slender, but the spicules of the former are longer.

The presence of bubble-cells in *E. Mulleri* at once distinguishes it from the closely allied *E. fluvialilis*.

Sponges found in different parts of Ireland have been attributed to *E. Mulleri* from time to time. Of Bowerbank's slides of *Spongilla Parfitti* (= *E. Mulleri*), in the British Museum, his preparation made from one of Dr. Battersby's specimens from the "Lake of Killarney" (12, p. 169), is without gemmules, but the megascleres appear to be undoubtedly those of *Heterosigma Ryderi*, a species which is very common in the Middle Lake of Killarney. Another of Bowerbank's preparations, labelled "*Spongilla Parfitti*, Caragh Lake," is evidently *Ephydatia Mulleri*. It contains many gemmules which possess very irregularly shaped amphidiscs.

Judging from Hanitsch's figures of the skeleton-spicules of a sponge from Lough Rea, Co. Galway (21, Pl. 4, fig. 4 a, b), his specimens were not *E. Mulleri*, but belonged to the peculiar race or variety of *E. fluvialilis*, described on p. 232. Sponges recently collected in Lough Rea also belong to that race. The same remark applies to the specimens named *E. Mulleri* by the present writer in the Report on the Sponges of the Clare Island Survey (41), and from Lough Gill (43).

The Irish material of *E. Müller*i is obviously too scanty to allow of any study of the variations which may occur in the species. The megascleres of the River Erne sponge are rather slender; they measure 0·2–0·25 mm. in length by 0·008–0·01 mm.; those from the River Tolka specimen are robust, measuring 0·225–0·3 mm. in length by 00·13–0·018 mm. The amphidises in both cases have a length of 0·01–0·013 mm., with a disc 0·02 mm. in diameter.

LOCALITIES.

KERRY.—Caragh L., as *Spongilla Parfitti* (12).

DUBLIN.—R. Tolka near Ashtown.

FERMANAGH.—R. Erne at Enniskillen (coll. R. Welch).

Heteromeyenia Ryderi, Potts.

*Heteromeyenia pictovens*is, Potts.

Heteromeyenia Macouni, MacKay.

(Pl. XXVIII, figs. 2–8.)

This species was described by Edward Potts in the year 1882 from specimens found in a small stream flowing into the Delaware River, below Philadelphia (29). Three years later it was recorded from the State of New Hampshire; and at about the same time Potts described as new a sponge collected in several lakes in Nova Scotia (32). This sponge he named *Heteromeyenia pictovens*is. Before long, however, Potts was forced to the conclusion (33, p. 244) that *H. pictovens*is, as well as other forms he had collected in the meantime, had not sufficient claim to be ranked as distinct species. He accordingly redescribed the typical form of *H. Ryderi*, adding the following varieties: *pictovens*is, *Walshi*, and *Baleni*. The species was at this time known in the strip of country along the Atlantic coast of North America from Nova Scotia to Florida and in the State of Iowa. Later on it was recorded from Indiana (23).

In the year 1890 Dr. A. H. MacKay, the discoverer of the *pictovens*is form of *H. Ryderi*, described a sponge from Sable Island (26). It grew in abundance in the only fresh-water lake on the island, which is itself merely a great sand-bank twenty miles long by about a mile wide, lying one hundred miles off the coast of Nova Scotia. The sponge was considered to be a distinct species, and was named *H. Macouni*. At the same time, the author noticed its likeness to certain forms of *H. Ryderi*, with slender spicules, and suggested that it might have to be reduced to a variety of that species. From an examination of some of the type material kindly given me by Dr. MacKay, I have come to the conclusion that the Sable Island sponge cannot be separated specifically from *H. Ryderi*. It is, indeed, exactly similar to

specimens of that species taken in a lake on Inishbofin, off the Galway coast, which are here grouped with the *Baleni* form of *H. Ryderi*.

Some years before the Sable Island sponge was described, the discovery of *H. Ryderi* in a lake in the west of Ireland was announced (20, 21). During the following ten years the species was recorded from three or four other localities in Ireland, and, finally, the recent field-work carried out in many parts of the country has proved that it is widely distributed in Ireland in non-limestone areas, in which areas it is the commonest species of fresh-water sponge.

H. Ryderi is now known to occur in Scotland, where it was recorded by Dr. Annandale under the name *Tubella pennsylvanica* (see p. 215).

Heteromeyenia Ryderi is well known to be a very variable species, and its extreme forms differ very much from each other both in external appearance and texture, and in the shape and size of the skeleton-spicules. That they differ so much is shown by the fact that they received names as distinct species: *H. Ryderi* Potts, *H. pictovens* Potts, *H. Macouni* MacKay. Potts soon recognized the great variability of the species in North America, and described how, "in spite of an exceedingly rebellious disinclination," he was forced to the conclusion that the forms which had passed through his hands must be regarded as belonging to one and the same species.

When systematic collecting of fresh-water sponges was undertaken in Ireland, it was realized before long that *H. Ryderi* was equally variable on this side of the Atlantic; and it is interesting to notice that the species assumes closely similar forms in both countries (41, p. 9). We have the typical *H. Ryderi* from streams and rivers, the hard, compact form (var. *pictovens*) from lakes, and the slender-spiculed form (var. *Baleni*) from lakes in which the conditions are unfavourable to robust growth of the sponge. The form with slender branches (var. *Walshi*) has not yet been found in Ireland.

The spicules in both American and Irish specimens are the same, except that the macroscleres are slightly thicker, on the whole, in the former, and the discs of the shorter gemmule-spicules are less deeply indented. Probably the growth of the sponge is more vigorous in every way in North America than in Ireland. The slender-spiculed specimens in both countries have the shorter gemmule-spicules possessing deeply indented discs.

Although the forms are thus closely paralleled in these widely separated countries, yet there is an interesting difference in their mode of growth. In North America the various forms of the species grow in situations exposed to the light (the first-found specimens were growing on the upper surface of stones), and their colour is described as light green or vivid green. In

Ireland the sponge grows in situations sheltered from the light, nearly always under stones. It is pale yellowish or greyish-white in colour. On the rare occasions on which the sponge was found in places where a certain amount of light penetrated to it, there was still no trace of any green colouration. One or two specimens indeed were taken which were dull green in colour, but these were penetrated in every direction by a green filamentous alga.

H. Ryderi is only found in Ireland on non-calcareous rocks. The North American localities for the species are not given in sufficient detail to enable one to decide if it always avoids limestone areas in that continent. Dr. MacKay, the discoverer of the *pictorensis* form of the species, writing from Nova Scotia, informs me that so far this form appears to be found in non-calcareous regions in that province. Potts states that the species has been taken chiefly in the States, along the Atlantic coast. The eastern maritime States of North America are for the most part free from limestone, so that it is possible that the species avoids calcareous rocks in North America as it does in Ireland.

As *H. Ryderi* avoids the limestone, its distribution in Ireland is very striking. It is absent from the whole centre of the country which constitutes the Great Limestone Plain of Ireland, and it is confined to those parts of the maritime counties which are formed of non-calcareous rocks. It is not confined to the west, as was thought on its first discovery in Ireland, but occurs in the north and south, as well as in the east. It grows in low-lying lakes and rivers, as well as in mountain tarns and streams. It is usually the only species found in the higher mountain lakes. The highest altitude at which the species has been taken is 1,868 feet.

As already stated, the various forms assumed by *H. Ryderi* in Ireland approximate closely to three varieties of the species described by Potts from North American specimens. These varieties are united by specimens showing every possible gradation between them, yet the great majority of the specimens obtained may be assigned to one or other of the three main types. The arrangement proposed in the report on the fresh-water sponges of the Clare Island Survey is therefore adhered to here for convenience of description and of reference. The three main types under which the specimens are grouped are as follows:—

- Group I.—*Heteromeyenia Ryderi* Potts. Typical or River Form.
- Group II.—*Heteromeyenia Ryderi* Potts, form *pictorensis*, Potts or Lake Form.
- Group III.—*Heteromeyenia Ryderi* Potts, form *Baleni*, Potts.

GROUP I.

Heteromeyenia Ryderi Potts. Typical or River Form.

This form occurs in rivers and streams, and corresponds to the typical *Heteromeyenia Ryderi*, described from specimens taken in "shallow, flowing water" in North America.

In this country the sponge grows nearly always under the shelter of stones, but sometimes spreads from them to envelop the stems of water-plants. Occasionally it is found on dead, submerged branches. The smaller specimens are more or less circular in outline; they are thickest in the middle, and thin out towards the edges, so that the upper surface is somewhat dome-shaped. The larger specimens spread out into lobed, encrusting masses of irregular shape, but sometimes of considerable size. The sponge is pale yellowish in colour, very soft to the touch, and very fragile. The surface is even; but under the lens the dermis is seen to be raised up on the tips of the main skeleton-fibres into very minute points. In preserved specimens, at least, the main fibres sometimes pierce the dermis and project very slightly. The oscula are small and inconspicuous, being about 1-2 mm. in diameter.

The skeleton is made up of main fibres, usually about 0.02-0.03 mm. in thickness, which run upwards through the sponge and occasionally branch. They consist of spicules in usually three to four rows. When the spicules are more slender, a greater number of them lie side by side. These main fibres are the length of one spicule apart, and are united by spicules at right angles to them, which usually lie singly, but sometimes are in bundles of two or three. These transverse fibres do not form continuous fibres. In places the skeleton is confused, but usually becomes more regular towards the surface of the sponge.

Spongin is very scanty in quantity.

The skeleton-spicules are slightly curved, occasionally straight oxea; they taper evenly to both ends, which are pointed. The shaft is thickly covered with rather small spines, except at the extreme tips, which are smooth. Unlike the skeleton-spicules of the lake form of the species, these oxea are very constant in shape, and vary only in length and thickness from one specimen to another. They measure usually from 0.2-0.33 mm. in length, with a maximum diameter of 0.01 mm., or even 0.015 mm.

The longer gemmule-spicules have a straight shaft, usually rather thickly set with strong spines, which are straight or curved. At either end of the spicule are four to six terminal, strongly curved spines. These spicules measure 0.04-0.055 mm. in length.

The shorter gemmule-spicules have a straight shaft set with usually one to several strong, straight spines. Sometimes the shaft projects for a short distance above the disc. The terminal discs are toothed, the indentations being deeper than in the corresponding American form. The length of these amphidiscs is 0·03–0·035 mm.; the diameter of the disc is 0·02 mm.

Gemmules occur in great numbers in the typical form of *H. Ryderi*; and they have been found mature as early in the year as June. When mature they are a bright yellow colour. Their diameter varies from 0·5 mm. to 0·7 mm.

GROUP II.

Heteromeyenia Ryderi Potts, form *pictovensis* Potts, or Lake Form.

This form grows in lakes, and is very compact and hard to the touch. It corresponds to the form, at first named *H. pictovensis*, which was discovered in lakes in Nova Scotia.

The sponge is pale yellowish or greyish-white in colour. It is circular in outline, and is usually not more than 20 or 30 mm. in diameter, but sometimes reaches a diameter of 50 or 60 mm. The surface is even, but under the lens is seen to be raised up into minute points by the tips of the main skeleton-fibres, which penetrate the dermis, and project very slightly. The sponge is thickest in the middle, and especially in the larger specimens is sometimes raised up into knob-like elevations. The oscula are about 1 mm. in diameter, but are rendered more conspicuous by the fact that immediately below the dermis numerous furrows radiate from them in all directions. In the autumn the sponge begins to die away at the centre, so that many specimens are found in the form of a flat ring, the centre of the sponge having completely decayed away.

The skeleton is arranged in the same way as in the typical form. The main fibres, which are about 0·025–0·05 mm. in thickness, are a spicule-length apart, and are therefore more closely placed than in the typical form, as the spicules in the lake form are shorter. In the interior of the sponge the skeleton is very confused, but becomes more regular towards the surface.

The skeleton-spicules show great variation. The shaft is straight or slightly curved, and terminates at each end in a longer or shorter point, or one or both ends may be rounded off. It is densely covered with sharp spines throughout its entire length. Sometimes the spines are scattered more sparsely along the middle of the shaft, and are crowded towards the ends. The smaller the spines the more thickly are they placed. Some spicules are set with comparatively few very strong spines. Some specimens possess fairly uniform spicules, others very varying ones, but

usually one or other type of spicule predominates in a specimen, and all the specimens from a given lake have the same types of spicules. The spicules also vary very much in both length and thickness. They usually measure from 0.12–0.25 mm. in length. The variation is not so great in a single sponge; and in many the maximum length is 0.2 mm. The maximum thickness is commonly 0.015 mm., but may be as much as 0.02 mm. In specimens with very robust spicules there often occur very short thick spicules, measuring about 0.05–0.08 mm. by 0.02 mm., or even 0.025 mm.

The gemmule-spicules are the same as in the typical form, but are sometimes more robust. The gemmules are very scarce, and very many specimens may be collected from neighbouring lakes in the autumn without finding a single gemmule. When present, the mature gemmules are bright yellow, and are the same size as those of the typical form.

Embryos are often present in the lake form in great numbers.

GROUP III.

Heteromeyenia Rydleri Potts, form *Baleni* Potts.

This form usually occurs in small, lobed masses on water-plants. It is very soft to the touch, and of a pale yellowish colour. More rarely it grows in small, soft, more or less circular, whitish-grey films on the under-surface of stones. In the former state it resembles the typical *H. Rydleri*; in the latter, it approaches the *pictorensis* form in external appearance.

The skeleton is arranged on the same plan as in the preceding forms; but, owing to the extreme slenderness of the skeleton-spicules, at first sight it appears to differ considerably. The main fibres, which are about 0.02–0.03 mm. in thickness, run upwards in an irregular manner through the sponge, dividing occasionally. They consist of multiserially arranged spicules, and are united by single spicules, or by bundles of spicules, which do not form continuous fibres. Other oxea lie scattered irregularly through the sponge. The whole arrangement of the skeleton is often rather confused.

The skeleton-spicules are straight or slightly curved oxea, which taper evenly to sharp points. The shaft, except at the ends, is thickly covered with very fine spines. The spination cannot be made out on the thinnest spicules. The oxea are about 0.16–0.26 mm. in length. The maximum diameter is about 0.005 mm.; but most of the spicules are much finer.

Both kinds of gemmule-spicules are exceedingly slender. The terminal, recurved spines of the longer are usually straighter than in the typical form, and the discs of the shorter ones are deeply indented. Thus the difference between the two kinds of amphidiscs is less marked than in the

more robust forms of the species. In specimens with very slender spicules the shafts of the amphidiscs are smooth. The shafts of thicker amphidiscs are furnished with one or more spines.

Gemmules are usually fairly numerous. They measure about 0·5–0·7 mm. in diameter, and thus are as large as those in the stronger forms of the species. It may be noted that gemmules are scarcest in the most robust form (*pictovensis*, Potts).

H. Rydveri, form *Baleni*, is merely a starved form of the species. It occurs in very small quantities in the lakes and streams in which it is found.

The spicules of the specimens found in Church Lough, Inishbofin, agree in every particular with those of the sponge from Sable Island, which was named *H. Macouni* MacKay (26). The measurements of the spicules from these widely separated islands are of interest. In the Sable Island sponge the oxea are 0·15–0·26 mm. long, with a maximum diameter of 0·005 mm. The longer amphidiscs are 0·035–0·05 mm. long; the shorter, 0·018–0·026 mm. long. In the Inishbofin sponge the oxea are 0·16–0·24 mm. long, with a maximum diameter of 0·005 mm. The longer amphidiscs are 0·035–0·04 mm. long; the shorter, 0·025–0·03 mm. long.

These extreme forms are not sharply divided from the form referred to on page 244, which occurs fairly abundantly in certain lakes. Specimens have been collected which show every link between the two.

Although the lake and river forms differ so much from one another, all the intermediate links between them can be obtained by collecting the sponge in a lake where it grows abundantly, and then tracing it down the course of the stream which drains the lake. This has already been described in the case of a lake, Lugaloughaun, in Co. Mayo (41). Since that account was written many other localities have been searched, always with similar results, namely, that at a varying distance below a lake, usually just below it, the hard lake form of *H. Rydveri* dies out and the soft, lobed, river form takes its place. In several instances specimens of *H. Rydveri*, apparently like the lake form, were found at some little distance down the river. Hard, compact specimens were taken several hundred yards down a rapid stream, flowing from Lough Unshin in Co. Donegal (41, p. 14); but they differed from the lake specimens in being much larger, and in possessing mature gemmules. Their spicules also had begun to change. In the lake the skeleton-spicules were straight, and their ends were usually rounded off. They measured 0·125–0·175 mm. by 0·015 mm. In the specimens from the stream all the spicules had pointed ends, and many of them were slightly curved. They were longer and more slender, measuring 0·135–0·25 mm. by

0.01 mm. Similar hard specimens were taken in the Caragh River, about half a mile below Caragh Lake, Co. Kerry; but here again the spicules had changed slightly, being longer, more slender, and possessing longer points than those of the lake specimens. In Connemara, where the lakes are often united by channels, sometimes only a few yards in length, really typical specimens of *H. Ryderi* were not found. In these short, though sometimes rapid, streams, *H. Ryderi* was hard; but, as in the foregoing cases, the spicules had begun to change in shape.

Dr. Amundale (3, p. 40 and p. 126) notes a similar change in the external appearance of an Indian fresh-water sponge, *Corrospongilla lapidosa*, according as it occurs in still or running water. In the former the sponge grows on the under surface of stones, in small crusts, which have a flat surface, except where the oscula are raised on conical eminences. In running water the sponge grows in broad sheets, which have a corrugated surface. This resembles the change in appearance of *H. Ryderi*. On the other hand, the Indian sponge is harder in texture in running water than it is in the lake, the opposite being the case with *H. Ryderi*. Apparently the spicules do not differ in the lake and river forms.

A form of *H. Ryderi* intermediate between the hard lake form and the typical river form is found in Irish lakes, where the conditions are apparently unfavourable to robust growth, but yet where the sponge grows fairly abundantly. Such lakes are Lough Ouler and Upper and Lower Lough Bray, in Co. Wicklow; the Coumgorra Lakes, Co. Waterford; Lough Eggher, Co. Kerry; and Lough Cunnel, Co. Mayo. These lakes, it may be noted, lie mostly at high altitudes for this country. With the exception of Lough Cunnel, which is at 690 feet, they lie between 1,225 and 1,896 feet.

Externally the sponge taken in the foregoing localities and in other similar situations resembles the lake form, except that it spreads over a greater area, and its outline is not so circular. It is soft to the touch, but is not so lobed as is the river form. On the other hand, its spicules are similar to those of the river form, from which they cannot be distinguished (Pl. XXVIII, fig. 8). In some cases there is, perhaps, a larger proportion of straight spicules than in river specimens. Gemmules are, as a rule, present in fair numbers, another point of difference from the usual lake form. In the report on the fresh-water sponges of the Clare Island Survey, the Lough Cunnel sponge is referred to (41 p. 14) as being of the typical form of *H. Ryderi*. With material from other localities available for examination, I do not now consider this sponge, and others similar to it, to be altogether typical, and believe that, strictly speaking, the typical *H. Ryderi* occurs solely in running water, in streams and rivers.

The foregoing semi-typical form leads on to the *Baleni* form, with very slender spicules, which grows in lakes, where the conditions are still more unfavourable to robust growth, and where the sponge only exists in small numbers, as already described.

H. Rydleri occurs in the semi-typical form just referred to in most of the mountain tarns lying at or above the 1,000 feet contour, and it has also been taken in one or two lakes at a rather less altitude. The maximum size of the skeleton-spicules is 0.27 mm. in length by 0.008 mm., or, in a few specimens, 0.3 mm. by 0.01 mm. In three or four lakes, at or about the 1,000 feet contour, specimens of *H. Rydleri* occur which belong to the *pictorensis* group. But in all these specimens the spicules are more slender than in those specimens found at lower levels, their maximum thickness being 0.01 mm.

Thus the spicules in specimens in lakes lying at higher levels apparently do not reach as great a thickness as they do in low-lying lakes. The spicules of specimens in mountain streams are, as a rule, also slender. On the other hand, all the specimens belonging to Group III have been found at low levels. Potts (31) stated that "the spicules of all species [*i.e.* of fresh-water sponges] increase regularly in size and solidarity as we descend from high altitudes towards the sea-level, where is found the extreme of the series." The author also stated that he had traced the working of this rule more particularly in several variable species, among them *H. Rydleri*. Three years later he again referred to this rule (33, p. 240, foot-note), but in rather less dogmatic language, citing as well some exceptions to it. Hard and fast rules cannot be laid down where fresh-water sponges are concerned, yet, on the whole, it appears to be true that specimens of *H. Rydleri* occurring in lakes in Ireland at higher altitudes do not possess spicules of the maximum thickness for the species. At the same time, it must be remembered that specimens with very slender spicules are often found in low-lying lakes.

LOCALITIES.

KERRY.—L. Coomasaharn, L. Cummernamuck and out-flowing stream, Caragh L. and Caragh R., L. Yganavaun (coll. Hon. M. Spring Rice and Miss L. Stephens), Middle L. and Meeting of the Waters, Killarney; L. Avoonane and out-flowing stream, L. Doon (21) and out-flowing stream, L. Duff and out-flowing stream, L. Gall, stream from L. Nalacken (1,000 ft.), L. Cruttia (coll. R. Welch), L. Camelaun and out-flowing stream, Coumanare Lakes (1,250 ft.) and out-flowing streams, L. Aloon, Cloonce Loughs and Cloonce R., L. Inehiquin and out-flowing stream, L. Cunnmeenadillure and out-flowing stream, L. Eagher, 1,550 ft. (38).

CORK.—L. Avaul, Park L. and out-flowing stream, L. Coomarkane (1,100 ft.) and out-flowing stream, L. Coomadavallig (1,100 ft.) and out-flowing stream, L. Boy (1,800 ft.) and out-flowing stream.

WATERFORD.—Out-flowing stream from L. Cunnshingam (1,262 ft.), Coumgorra L. (1,700 ft.) and out-flowing stream.

GALWAY.—L. Nabillion (coll. G. P. Farran), L. Fee and L. Ballynakill (39), L. Bofin and out-flowing stream, Ardderry L., stream from Seecon L., Glendalough L., Nacoogarrow L. and out-flowing stream, L. Inagh and out-flowing stream, Kylemore L., Owengowla R., Derryclare L. and out-flowing stream, Ballynahinch L. and Ballynahinch R., L. Shindilla, L. Maunwee, L. Corrib (N.-W. arm), L. Sheedagh, L. Skannive and numerous small lakes in the neighbourhood of Roundstone.

WICKLOW.—L. Dan and Avonmore R., L. Tay and Annamoe R., below the lake; L. Ouler (1,868 ft.), Upper L. Bray (1,463 ft.); Lower L. Bray (1,225 ft.) and outlet.

MAYO.—Creggan L., Clare Island; L. Namucka and L. Coolaknick, Inishturk (coll. R. Ll. Praeger and A. W. Stelfox); Church L., L. Gowlanagower and Loughnagroam, Inishbofin (coll. A. W. Stelfox); Sraheens L., Achill Island; L. Cullylea (coll. A. W. Stelfox); L. Feeagh and out-flowing streams, stream from L. Navroony, Moher L. and out-flowing stream, Owenwee R., L. Nacorra, L. Gall, Bellakip R., Bunowen R., L. Nahaltora, L. Cunnel, Glencullin L., Doo L., Tawnyard L., Fin L., Lugaloughhaun and out-flowing stream, Lugacoliwee L. For all the foregoing see (41).

FERMANAGH.—Stream from Tullyvogy L., Tullynalaub L., Tullyloughmore L., L. an Laban, 1,000 ft. (all collected by Major Trevelyan).

DONEGAL.—L. Namfamurive, L. Meenasheagh, L. Achvog, L. Rusheen and L. Awaddy (coll. Major Trevelyan), Columbkille L. and out-flowing stream, Doon L. and out-flowing stream, Pound L., Cam L., L. Unshin and out-flowing stream, Knader L., L. Im, L. Aluirg and outlet (coll. A. W. Stelfox).

DOWN.—Altnadua L.

ANTRIM.—Doo L. and out-flowing stream and L. na Crannog on Fair Head (43); lakes on Carnlough Mountains (coll. Major Trevelyan), L. Vianor, Garron Head (coll. Mrs. Stelfox).

GEOGRAPHICAL DISTRIBUTION OF *HETEROMEYENIA RYDERI* POTTS, AND THE MEANS OF DISPERSAL OF THE SPECIES DISCUSSED.

Heteromeyenia Ryderi is now known to occur in North America, along the eastern portion of the continent, from Florida to Nova Scotia, and in Iowa and Indiana. It also occurs in Newfoundland and on Sable Island. In Europe

it is widely distributed in the non-limestone districts of the maritime counties of Ireland, and it occurs in Scotland.

Dr. Hanitsch, who believed that at least three species with a similar distribution to the foregoing occurred in Ireland, suggested (21) that three agents might have served to carry gemmules of fresh-water sponges from North America across the Atlantic to the west of Ireland—namely, winds, ocean currents, and birds. At one time it was supposed that strong winds could carry the seeds of plants long distances, but many botanists are now agreed that this means of dispersal has been greatly over-rated, and experiments prove that even seeds provided with special aerostatic apparatus are not carried to great distances (see R. Ll. Praeger, *Clare Island Survey*, Part 10, *Phanerogamia and Pterophyta*, *Proc. Royal Irish Academy*, xxxi, 1911). There would be less chance of gemmules being conveyed in this way, as not only are they not provided with wing-like expansions or other structures to enable them to be easily wind-borne, but are, on the contrary, weighted with their armour of siliceous spicules.

As to ocean currents, it has been suggested that the Gulf Stream might have carried gemmules or entire sponges containing gemmules to this country. It is quite impossible to think that a sponge, such as *H. Rydleri*, could stand a voyage across the Atlantic Ocean, even if attached to floating timber, especially when it is remembered that the only forms of this species in which gemmules are abundant are extremely soft and fragile. Nor does it seem probable that separate gemmules should be so conveyed, and this quite apart from the question as to whether they could germinate after prolonged immersion in sea-water.

With regard to the third agent mentioned by Dr. Hanitsch, it is suggested that birds might convey the gemmules, presumably in mud dried on their feet or feathers, as seeds of plants are known to be sometimes carried. In this connexion I would refer to a paper by Dr. Scharff (37), in which he brings forward evidence from the distribution of various plants and invertebrates (among the latter fresh-water sponges) to support the theory of the presence of a former land-bridge between North America and Europe. Referring to Dr. Hanitsch's statement as to the three possible agents for the dispersal of fresh-water sponges, Dr. Scharff says that he considers the only occasional means of transmission to be thought of seriously is that by birds; and even in this case he cites evidence to show that birds probably never fly directly across the Atlantic, nor is there reason to believe that they first set foot on the west coast of Ireland on reaching Europe.

In addition to the points brought forward by Dr. Scharff, I would suggest the following arguments against the transport of gemmules of *H. Rydleri* by

birds, from a consideration of the habitat and mode of growth of that species:—

(1) *H. Rydleri* does not grow where there is mud, but in clear water on the stony beaches of lakes, or on the stony beds of rivers, so that there would be little or no material to cement the gemmules to the feet or feathers of birds.

(2) Gemmules are extremely scarce in the lake form of *H. Rydleri* in North America (Potts and MacKay). In Ireland they are so scarce that hundreds of specimens may be collected even late in the year without finding a single one.

(3) Gemmules are numerous in the river form of *H. Rydleri* in North America (Potts). In Ireland (and ? in North America) they are most abundant in specimens in rapidly flowing clear rivers and streams, with boulder-strewn beds, at a short distance below a lake (see p. 219). The possibility of gemmules becoming attached to birds under these conditions would seem to be slight.

The chances of a successful introduction of the species into Ireland by means of birds would be lessened by the fact that *H. Rydleri* does not grow in this country in lakes or rivers on the limestone, so that a bird carrying gemmules would have to deposit them, if they were to germinate successfully, in fresh water in a non-limestone district; and as the sponge grows with difficulty in lakes with boggy shores, they would have to be deposited in clear water on a stony bottom. Therefore I would consider that the distribution of *H. Rydleri*, as at present known, cannot be explained by any of these occasional means of dispersal; but that it may be cited among the evidences of a former land connexion between North America and Europe.

Dr. Annandale (3, p. 11) refers to this question of the dispersal of fresh-water sponges. In discussing the relationships of the fresh-water sponges and polyzoa of the Malabar Zone of India with those of Africa and of the countries east of India, he mentions aerial currents (in this case the monsoon) and marine currents as possible agents in the dispersal of these animals. But he dismisses both in a few words, as the resting reproductive bodies of the genera in the areas under consideration are either fixed to some solid support or are without a special apparatus to render them light. Dr. Annandale states that the most satisfactory explanation as yet put forward to account for the relationships of these or other groups of animals is that of a former land connexion between the countries involved, that is to say, between Africa and the Malaysia through Malabar, in, perhaps, late Cretaceous times.

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DESCRIPTION OF PLATES.

PLATE XXVI.

Megascleres $\times 330$; free microscleres and gemmule-spicules $\times 600$.

1. *Spongilla lacustris* auct. *a*, megascleres; *b*, *c*, gemmule-spicules; *d*, free microsclere. Stream at Woodburn, Co. Antrim.
2. *Spongilla lacustris* auct. *a*, megascleres; *b*, gemmule-spicule; *c*, free microscleres. Derryclare Lough, Co. Galway.
3. *Spongilla fragilis* Leidy. *a*, gemmule-spicules; *b*, megascleres. Lough Fad, Fair Head, Co. Antrim.
4. *Ephydatia fluviatilis* auct. var. Megascleres. Lough Erne, off Eagle Island.
5. *Ephydatia fluviatilis* auct. var. Megascleres. Ballyscanlan Lough, Co. Waterford.
6. *Ephydatia fluviatilis* auct. var. Megasclere. Lough Derg, Co. Tipperary.
7. *Ephydatia fluviatilis* auct. var. Megascleres. Oakport Lough, Co. Roscommon.
8. *Ephydatia fluviatilis* auct. var. Megascleres. Lough Gill, Co. Sligo.
9. *Ephydatia fluviatilis* auct. var. *a-c*, megascleres; *f*, amphidise. Drumeliff River, Co. Sligo.

PLATE XXVII.

Megascleres $\times 330$; gemmule-spicules $\times 600$.

1. *Ephydatia fluviatilis* auct. *a*, megascleres; *b*, *c*, side and end views of amphidises. River Barrow, at Mageney, Co. Kildare.
2. *Ephydatia fluviatilis* auct. *a*, megascleres; *b*, *c*, *d*, side and end views of amphidises. Furnace Lough, Co. Mayo.
3. *Ephydatia fluviatilis* auct. *a*, megascleres; *b*, *c*, side and end views of amphidises. Pond in Zoological Gardens, Dublin.
4. *Ephydatia fluviatilis* auct. *a*, megascleres; *b*, *c*, side and end views of amphidises. Lagan Canal, Co. Antrim.
5. *Ephydatia fluviatilis* auct. Microspined megasclere. Lough Corrib, near Oughterard.
6. *Ephydatia fluviatilis* auct. *a*, megascleres; *b*, *c*, side and end views of amphidises. Mill-stream from River Dodder, Dublin.

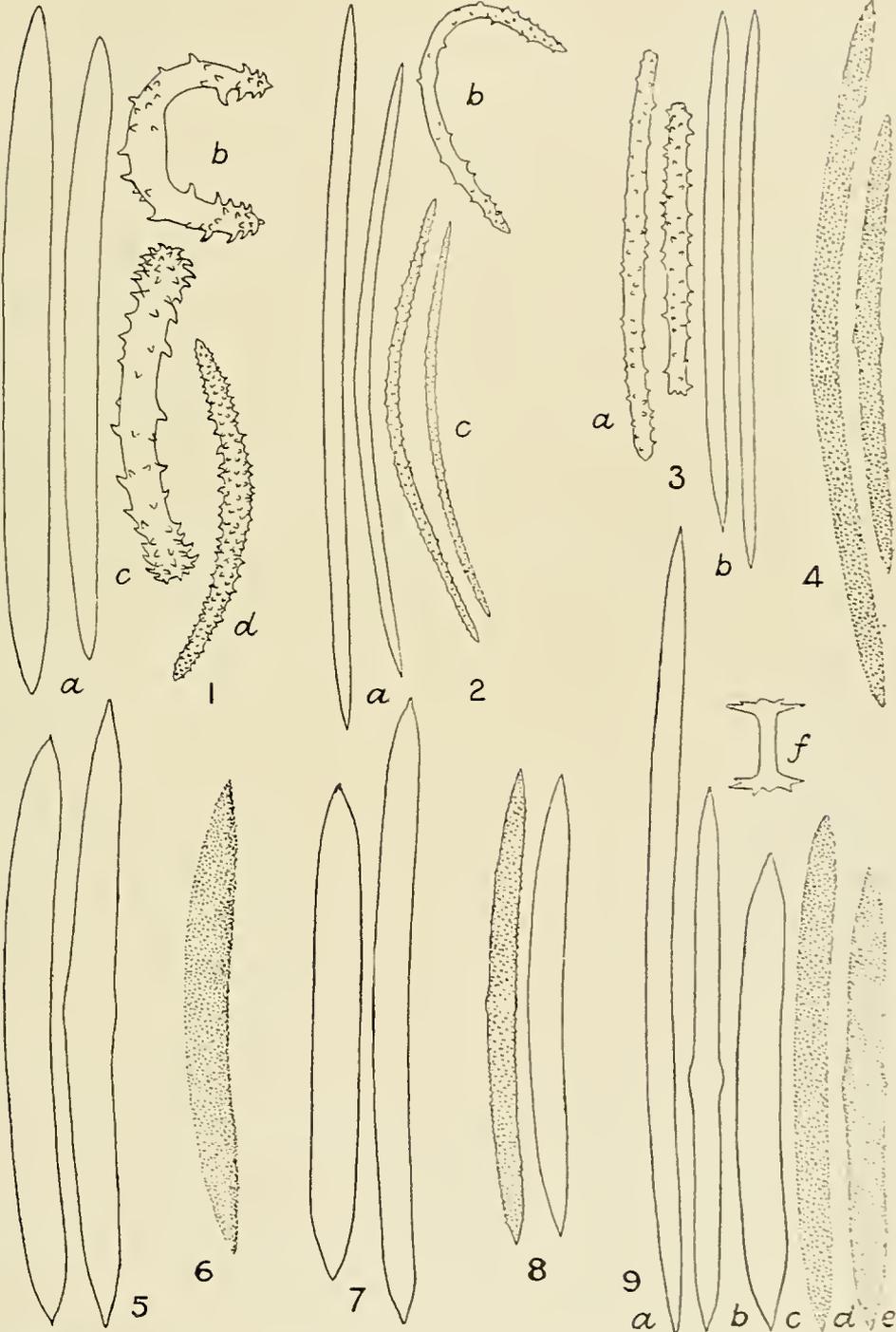
PLATE XXVIII.

Megascleres $\times 330$; gemmule-spicules $\times 600$.

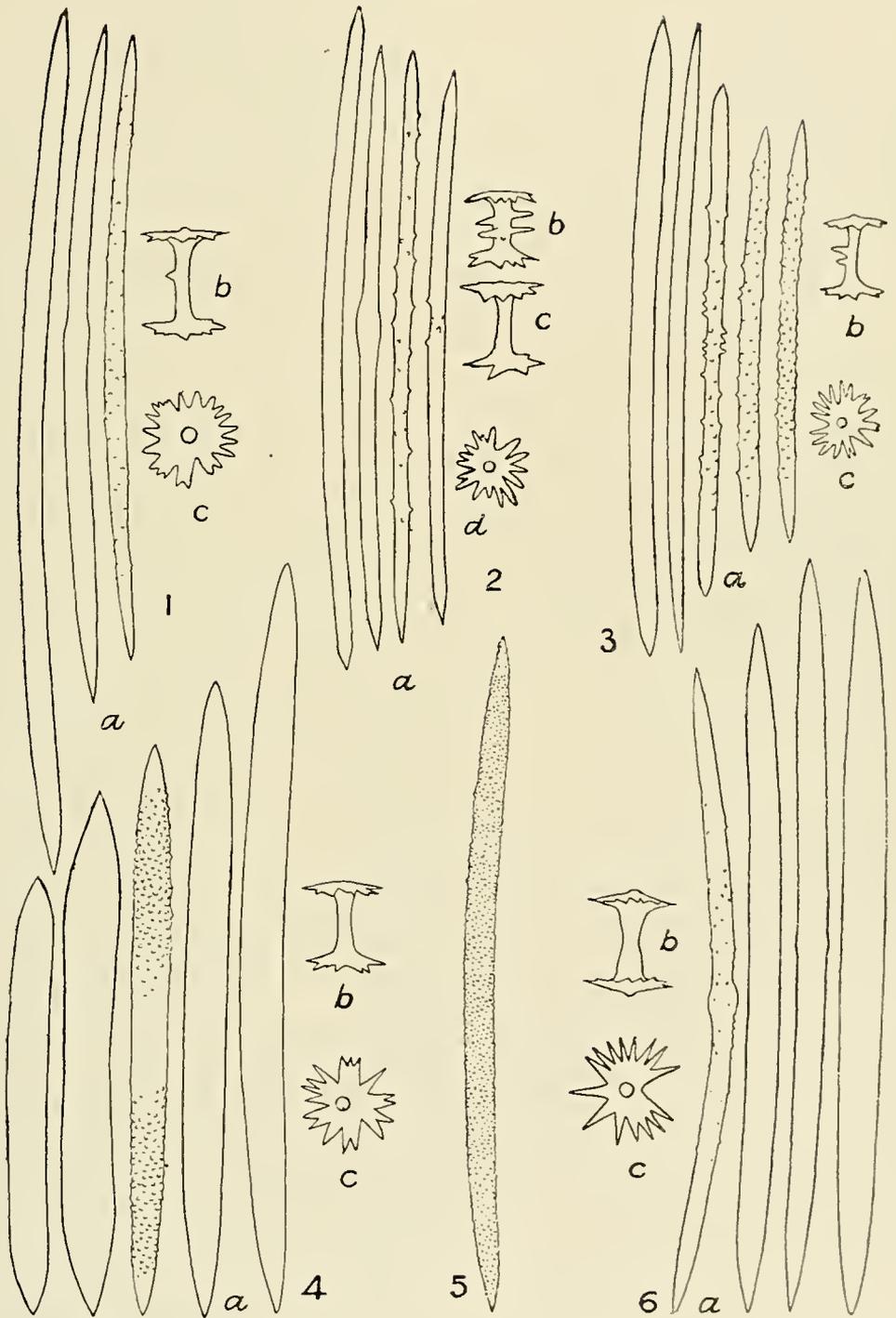
1. *Ephydatia Mulleri* Lieberkühn. *a*, megascleres; *b*, *c*, side and end views of amphidises. River Tolka, Co. Dublin.
2. *Heteromeyenia Rydleri* Potts. Typical form. *a*, megascleres; *b*, *c*, side and end view of shorter amphidises; *d*, longer amphidise. Stream from Comanare Lakes, Co. Kerry.
3. *Heteromeyenia Rydleri* Potts. *a*, megascleres; *b*, *c*, shorter and longer amphidises. Park Lough, Hungry Hill, Co. Cork.
4. *Heteromeyenia Rydleri* Potts, form *Baleni* Potts. *a*, megascleres; *b*, *c*, shorter and longer amphidises. Lough Yganavann, Co. Kerry.
5. *Heteromeyenia Rydleri* Potts, form *pictorensis* Potts. *a*, megascleres; *b*, *c*, shorter; and *d*, longer amphidises. Lough Coolanick, Inishturk, Co. Mayo.
6. *Heteromeyenia Rydleri* Potts, form *pictorensis* Potts. Megascleres. Lough Altanadua, Co. Down.
7. *Heteromeyenia Rydleri* Potts, form *pictorensis* Potts. Megascleres. Lake on Carnlough Mountains, Co. Antrim.
8. *Heteromeyenia Rydleri* Potts. Semi-typical form. *a*, megascleres; *b*, *c*, shorter and longer amphidises. Lower Lough Bray, Co. Wicklow.

PLATE XXIX.

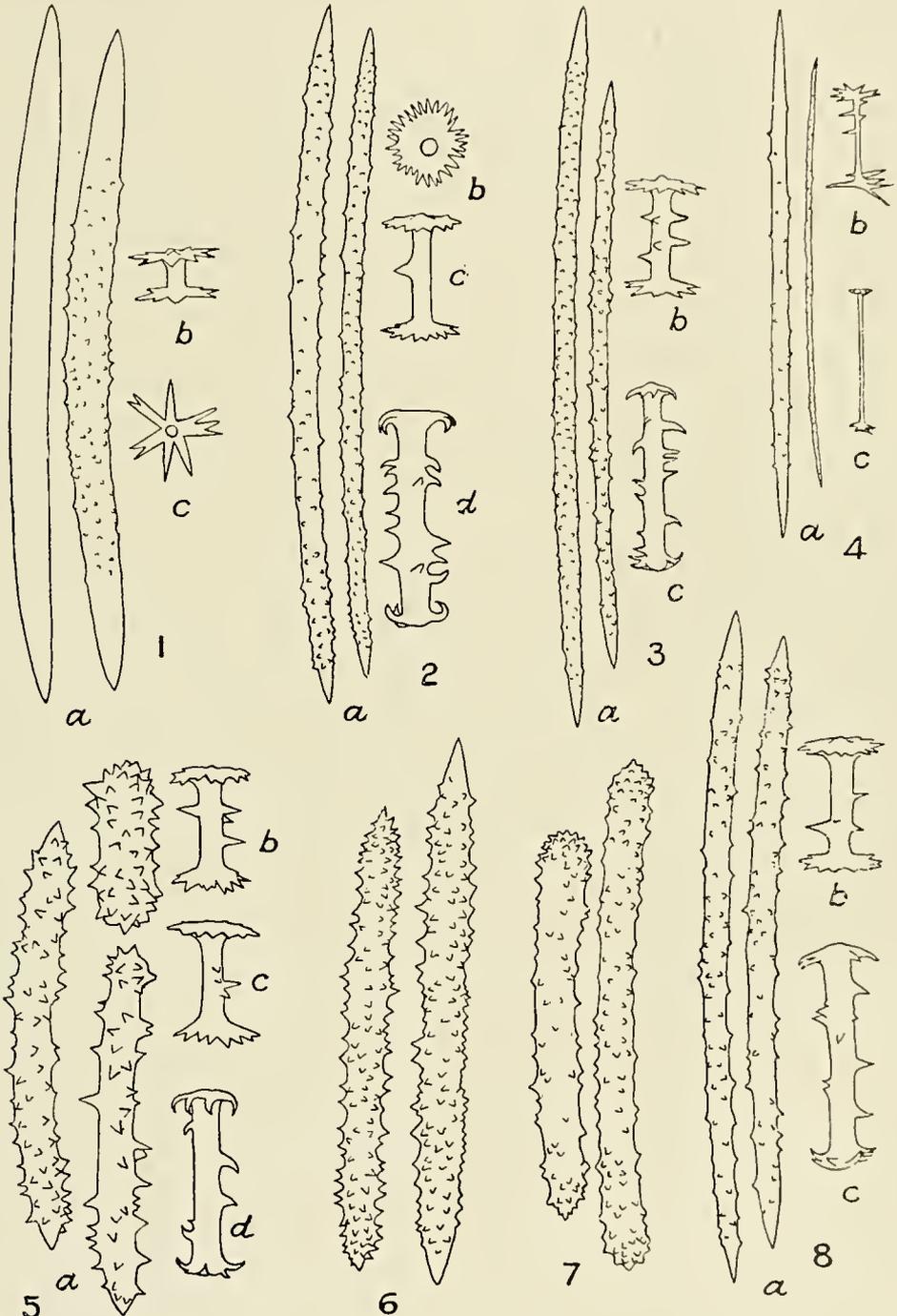
Maps showing the distribution of the fresh-water sponges in Ireland as at present known—fig. 1, *Spongilla lacustris*; fig. 2, *Spongilla fragilis*; fig. 3, *Ephydatia fluvialilis*; fig. 4, *Ephydatia fluvialilis*, var.; fig. 5, *Ephydatia Mulleri*; fig. 6, *Heteromeyenia Rydleri*.



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