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PROCEEDINGS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

VOL. III.

SESSION 1888—9.

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CONTENTS.

PAGE.

Office-bearers and Council, 1888-89. . . . vii.

Report of Council. . . . . viii.

Inaugural Address:—Some Recent Contributions to the Theory of Evolution. By W. A. Herdman, D.Sc., F.L.S., F.R.S.E., President. . . . 1

Second Annual Report of the Liverpool Marine Biological Station on Puffin Island. By W. A. Herdman, D.Sc., F.L.S., F.R.S.E. 23

The Coleopterous Fauna of the Liverpool District. By John W. Ellis, L.R.C.P., F.E.S. . . . 46

Report on a Collection of Tow-net Gatherings made by T. C. Ryley, Esq., on the West Coast of Norway, up to the North Cape, during June and July, 1888. By Isaac C. Thompson, F.L.S., F.R.M.S. . . 78

On the Pineal Eye of the Young and Adult *Anguis fragilis*. By Richard Hanitsch, Ph.D. . . . 87

On Embryonic Fission in Plants. By R. J. Harvey Gibson, M.A., F.R.S.E., F.L.S. . . . 96

PAGE.

On a Deep Sea Tow-net for Opening and Shutting under Water. By William E. Hoyle, M.A. (Oxon.), F.R.S.E. 100

Abstract of Communication, "On the Variations Produced in the Electrical Condition of the Viscera by Stimulation of Adjacent Cutaneous Nerves." By R. Caton, M.D., F.R.C.P. 113

A Simple Schema of the Lymphatic Circulation. By F. Charles Larkin, M.R.C.S. Eng., &c. . . . 115

Report on the Marine Diatomaceæ of the L.M.B.C. District. By Dr. H. Stolterfoth, M.A. . . 117

Report on the Marine Algæ of the L.M.B.C. District. By R. J. Harvey Gibson, M.A., F.R.S.E., F.L.S. . 128

Second Report on the Porifera of the L.M.B.C. District. By Richard Hanitsch, Ph.D. . . . 155

Second Report on the Echinodermata of the L.M.B.C. District. By Herbert C. Chadwick. . . 174

Third Report on the Copepoda of Liverpool Bay (the L.M.B.C. District). By Isaac C. Thompson, F.L.S., F.R.M.S. 181

Appendix to Third Report on the Copepoda of Liverpool Bay (the L. M. B. C. District). By Isaac C. Thompson, F.L.S., F.R.M.S. . . . 192

Third Report on the Higher Crustacea of the L.M.B.C. District. By Alfred O. Walker, F.L.S. . . 195

Second Report on the Polyzoa of the L.M.B.C. District. By Joseph Lomas, Assoc.N.S.S. . . . 214

PAGE.

Second Report on the Nudibranchiata of the L.M.B.C. District. By W. A. Herdman, D.Sc., F.L.S., F.R.S.E., and J. A. Clubb. . . . 225

Second Report on the Tunicata of the L.M.B.C. District. By W. A. Herdman, D.Sc., F.L.S., F.R.S.E. . 240

Report on the Seals and Whales (Pinnipedia and Cetacea) of the L.M.B.C. District. By Thomas J. Moore, Corr. Memb. Zool. Soc. Lond. . . . 261

Appendix.

Laws of the Society. 279

List of Members. 284

Librarian's Report (with List of the Books). . . 288

Treasurer's Balance Sheet. 291

Correction.

Dr. Hanitsch wishes to state that the new Sponge described in his report on p. 169, and figured on plate vii., under the name of *Seiriola compacta*, really consists of two separate Sponges, a Stelletid and an incrusting Suberite. The former is, however, the type of a new genus closely allied to *Stryphnus*, Sollas, and for it the name *Seiriola* may be retained. The family Seiriolidæ must lapse. A revised description of the genus and species will be given in a future paper.

LIVERPOOL BIOLOGICAL SOCIETY.

SESSION III. 1888–9.

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REPORT of the COUNCIL.

Your Council has great pleasure in being able to report to you that the session 1888-9 has been in every way fully as successful as the two preceding ones.

There have, as usual, been eight Ordinary Meetings at University College, and a Field Meeting at Hilbre Island.

The attendance at the meetings has been good, and the interest taken by the members in the work of the Society seems in no way to be diminishing. The number of communications has greatly increased, being half as many again as last year, and they have extended also over if possible a still wider area of Biology.

During the session the Council recommended the appointment of an honorary librarian, and Dr. Hanitsch was accordingly elected to fill the post and to occupy a seat upon the Council. The librarian has been assiduous in his attention to work, and has arranged an exchange of publications with thirty-eight societies of repute, thus establishing our Society as a recognized centre of biological research not only in this country but on the continent of Europe and in America, and at the same time laying the foundations of a good library. A suitable bookcase has been purchased, and it now contains 364 volumes and pamphlets.

During the year the Society has added the names of the following eminent biologists to its list of Honorary Members:—

Dr. Anton Fritsch, Professor of the University and Director of the Museum, Prague.

Dr. Alfred Giard, Professor of Evolution at the Sorbonne, Paris.

Dr. Carl Claus, Professor of Zoology and Comparative Anatomy, Vienna.

During the session two Ordinary Members have resigned and ten have been elected; while twenty Student Members have resigned and twelve have joined the Society. So that the number of members at present on the roll is:—

Honorary	5
Ordinary	62
Student	41
Total	108

The following is a summary of the proceedings at the meetings held during this the third session:—

I. *October* 12*th*, 1888.

1. Election of the Office-bearers and Council.
2. Inaugural Address by the President, Prof. Herdman, D.Sc., on "Some Recent Contributions to the Theory of Evolution."

II. *November* 12*th*, 1888.

1. Description and Demonstration of the Action of a new Deep Sea Tow-net. By W. E. Hoyle, M.A., M.R.C.S.
2. Second Annual Report of the Liverpool Marine Biological Station on Puffin Island. By Professor Herdman, D.Sc., President.
3. Report on the Algæ of Puffin Island, Part I. By R. J. Harvey Gibson, M.A.
4. Some Recent Additions to the Anatomical Museum. By Professor W. Mitchell Banks.

5. Description of a small Collection of Marine Animals received from H.M. King Kalakao of the Sandwich Islands. By I. C. Thompson, F.L.S., Treasurer.
6. The Coleopterous Fauna of the Liverpool District, Part II. By Dr. Ellis, F.E.S.
7. The Pineal Eye of Adult and Young Blind-worms and of the Ophidia. By Dr. R. Hanitsch.

III. *December* 14*th*, 1888.

1. Note on the Discovery of *Venus mercenaria* living near Beaumaris. By T. J. Moore, C.M.Z.S.L.
2. Address on "The Liver in relation to General Metabolism." By Dr. Noel-Paton, Edinburgh.

IV. *January* 11*th*, 1889.

1. Contributions towards the Phylogenetic Classification of Plants, Part I. By R. J. Harvey Gibson, M.A.
2. Note on Variations produced on the Electric Condition of the Viscera by Stimulation of adjacent Cutaneous Surfaces. By Professor Caton.
3. Report on a Collection of Tow-net Gatherings made by Mr. T. C. Ryley on the West Coast of Norway, in June and July, 1888. By I. C. Thompson, F.L.S., Treasurer.
4. Embryonic Fission, or Blastogenesis in Plants and Animals. By R. J. Harvey Gibson, M.A.

V. *February* 8*th*, 1889.

1. Critical Note on the Supposed Relation between *Chelyosoma* and *Pterichthys*. By Prof. Herdman, D.Sc., President.
2. Dimorphism in the Antipatharia. By George Brook, F.L.S.
3. A Simple Schema of the Lymphatic Circulation. By F. C. Larkin, M.R.C.S., Secretary.

4. Report on the Diatomaceæ of the L.M.B.C. District. By Dr. Stolterfoth.
5. Report on the Sponges of the L.M.B.C. District. By Dr. R. Hanitsch.
6. Report on the Echinodermata of the L. M. B. C. District. By H. C. Chadwick.
7. Exhibition of some Timber-boring Insects. By Dr. Ellis, F.E.S.

VI. *March 8th*, 1889.

1. Note on a peculiarly shaped Specimen of *Alcyonium digitatum*. By H. C. Chadwick.
2. Third Report on the Higher Crustacea of the L.M.B.C. District. By A. O. Walker, F.L.S.
3. Third Report on the Copepoda of the L.M.B.C. District. By I. C. Thompson, F.L.S., Treasurer.
4. Report on the Algæ of the L.M.B.C. District, Part II. By R. J. Harvey Gibson, M.A.
5. Some Frogs' Skeletons, illustrating natural fractures and amputations. By F. C. Larkin, M.R.C.S.

VII. *April 12th*, 1889.

1. Note on Terrestrial Isopoda. By A. O. Walker, F.L.S.
2. Prof. Banks showed some Abnormal Thoracic Aortæ.
3. Observations on the Unusual Abundance of the Madder Hawk Moth (*Deilephila galii*) in 1888. By Dr. Ellis, F.E.S.
4. Second Report on the Polyzoa of the L.M.B.C. District. By Joseph Lomas, Assoc. N.S.S.

VIII. *May 10th*, 1889.

1. Note on an Insect Larva parasitic in Men, from British Honduras. By Professor Barron, M.B.

2. Report on the Cetaceans and Seals of the L.M.B.C. District. By T. J. Moore, C.M.Z.S.L.
3. Notes on the Nudibranchiata. By Prof. Herdman and J. A. Clubb.
4. Note on a new Copepod. By I. C. Thompson, F.L.S.
5. Second Report on the Tunicata of the L.M.B.C. District. By Professor Herdman, D.Sc.
6. Second Report on the Pycnogonida of the L.M.B.C. District. By W. B. Halhed.
7. Remarks on M. Carlier's Theory of the Limb Nature of the Jaws of Vertebrates. By G. F. Moore.

IX. *June* 15*th*, 1889.

Field Meeting at Hilbre Island.

Election of Professor Herdman, D.Sc., as President for the session 1889-90.

INAUGURAL ADDRESS

ON

Some RECENT CONTRIBUTIONS to the THEORY of EVOLUTION.

By Professor W. A. Herdman, D.Sc., President.

[Read 12th October, 1888.]

During the quarter of a century that has elapsed since Charles Darwin showed how new species may have been evolved by means of those processes for which he coined the useful term "natural selection," there has appeared an enormous mass of literature dealing with the subject of Evolution, and containing some valuable additions to and modifications of the original theory. I propose to examine a few of the more recent of these contributions critically, with the object of determining how far they ought to change our views in regard to the origin and the mutual relationships of the plants and animals around us.

First, let me remind you briefly of the leading features of the theory of evolution by means of natural selection.

(1) No two plants or animals are exactly the same. In any assemblage of men, sheep, or rose-trees, there are individual differences by which any one of them may be distinguished from the others. This is the principle of Variation. We say, "As like as two peas." We might as truthfully say, "As unlike as two peas:" no two peas are alike in all respects.

(2) Characters, both physical and mental, may be inherited. The offspring bear more resemblance to their

parents or ancestors than they do to other organisms. This is the principle of HEREDITY.

Recognising these two important biological principles, breeders of cattle, dogs, pigeons, &c., are able by carefully selecting individuals with certain variations for breeding purposes, generation after generation, to produce new varieties or races of a very marked nature, and to mould their characters in almost any required direction. This is ARTIFICIAL SELECTION.

Is there amongst animals in a state of nature any similar process of selection by which species may be modified and new forms produced? Charles Darwin and Alfred Russel Wallace, in 1858, showed that there is such a process at work.

All animals and plants tend to increase so rapidly that if left to themselves the members of any one species would, in a comparatively small number of generations, cover the earth. Countless numbers of young are produced for which there is no room and no food, and which must inevitably die. The result of this "rate of increase" is that a constant "struggle for existence" is carried on between those individuals which come into competition—which live in the same neighbourhood, eat the same food, and are exposed to the same enemies. So keen and constant is this struggle that any advantage however slight, any favourable variation, may enable an individual or a set of individuals to get the better of the others—to survive when the rest are killed off. This is known as "the survival of the fittest," and is a process of "natural selection" by which particular variations are singled out as the individuals which survive, breed, and hand down their advantageous characteristics to the next generation. And so, just as artificial selection has produced the various breeds of dogs and races of pigeons, the far more searching

and unerring power of "natural selection,"* biologists believe has been a considerable factor, if not the chief factor, in the evolution of the various species of plants and animals from a common ancestor.†

Darwin was far from claiming for natural selection a universal or an all-powerful action. He admitted that other factors might be at work in the modification of species, and in his book on the "Descent of Man" he showed that many characters in animals which cannot be explained by the action of natural selection, are doubtless due to "sexual selection," the continuous selection by the one sex of those individuals of the other which possess certain attractive features or habits. Darwin also acknowledged to a minor extent the modifying influences of the Lamarckian principles of "use and disuse," and the action of the environment.

Some of the more recent and more advanced evolutionists, however, may be said to out-Darwin Darwin. They apparently go further than their master did in their belief in the all-powerful action of natural selection, and some of the recent essays on evolution have drawn attention to this ultra-Darwinian position, and have urged the claims of other factors upon the consideration of biologists. Perhaps the contribution to this subject which has become

* Prof. C. Lloyd Morgan has recently (Bristol Naturalists' Society's Proc., vol. v., pt. iii., 1888) proposed the term "Natural Elimination" as being more correct. He is quite right, but "Natural Selection" is now too firmly established in biological science to be replaced by another phrase. However, Prof. Morgan's term may be of use as an alternative.

† Mr. P. Geddes informs me that he intends shortly to lay before the Royal Society of Edinburgh a detailed statement of his view, that evolution is the result not so much of a natural selection brought about by a struggle for existence as of self-sacrifice, co-operation and love. This is striking at the root of Darwinism with a vengeance; but it is needless to discuss Mr. Geddes's position until his paper is published and the facts upon which he bases his theory are before us.

the most widely known, and which has excited most discussion during the last couple of years, is Dr. Romanes' essay on "Physiological Selection; an Additional Suggestion on the Origin of Species," read before the Linnean Society of London on the 6th May, 1886.*

Dr. Romanes commences by stating that there are in his view three cardinal difficulties in the way of natural selection, considered as a theory of the origin of species. These are:—(1) That whereas domesticated varieties, the products of artificial selection, are generally fertile with one another, allied species, which we believe are formed in a similar manner by natural selection, are almost invariably sterile. There are exceptions in both cases, but still this great difference does undoubtedly exist. However, I think it can be accounted for without going beyond the influence of natural selection. In the first place the conditions surrounding domesticated varieties are more or less unnatural, and may well account for an increased fertility; and in the second place, turning to variation in a state of nature, it is quite conceivable that the very features which characterize an incipient species, such as a difference in speed, or a peculiarity in colouring, may themselves tend (by giving rise to isolation) to promote breeding between the individuals possessing such features and to put a barrier between them and the parent species. As Darwin has said,† "each newly formed variety would generally be at first local, as seems to be the common rule with varieties in a state of nature; so that similarly modified individuals would soon exist in a small body together, and would often breed together."

(2) Dr. Romanes' next difficulty is the swamping effect which free intercrossing would have upon a variety or

* Journ. Linn. Soc., Zool., vol. xix., p. 337.

† "Origin of Species," 6 Ed., p. 72.

incipient species. This is a celebrated difficulty with critics of Darwinian evolution, and was first forcibly pointed out by the late Professor Fleeming Jenkin, of Edinburgh, in the *North British Review* for 1867.* Prof. Jenkin gives the following illustration of his argument:—

"Suppose a white man to have been wrecked on an island inhabited by negroes, and to have established himself in friendly relations with a powerful tribe whose customs he has learnt. Suppose him to possess the physical strength, energy and ability of a dominant white race, and let the food and climate of the island suit his constitution; grant him every advantage which we can conceive a white man to possess over the native; concede that in the struggle for existence his chance of a long life will be much superior to that of the native chiefs. Yet from all these admissions there does not follow the conclusion that after a limited or unlimited number of generations the inhabitants of the island will be white. Our shipwrecked hero would probably become king; he would kill a great many blacks in the struggle for existence; he would have a great many wives and children, while many of his subjects would live and die as bachelors; an insurance company would accept his life at perhaps one-tenth of the premium which they would exact from the most favoured of the negroes. Our white's qualities would certainly tend very much to preserve him to a good old age; and yet he would not suffice in any number of generations to turn his subjects' descendants white. It may be said that the white colour is not the cause of the superiority. True; but it may be used simply to bring before the senses the way in which qualities belonging to one individual in a large number must be gradually obliterated. In the first generation there will be some dozens of intelligent young mulattoes, much superior in average intelligence to the negroes. We might expect the throne for some generations to be occupied by a more or less yellow king; but can any one believe that the whole island will gradually acquire a white or even a yellow population, or that the islanders would acquire the energy, courage, ingenuity, patience, self-control, endurance, in virtue of which qualities our hero killed so many of their ancestors, and begot so many children; those virtues, in fact, which the struggle for existence would select, if it could select anything?"

This ingenious story of Professor Jenkin's certainly puts the supposed swamping effect which free intercrossing has upon an individual variation very forcibly, but we must

* See "Papers, Literary, Scientific, &c.," vol i., p. 229, 1887.

remember that after all it is only of value as an individual expression of opinion. For my own part, I am inclined to think that in many cases the result might be very different from that given above. Two influences have, I think, been ignored, viz: atavism, or reversion to ancestral characters, and the tendency of the members of a variety to breed with one another. Keeping to the case described above, I should imagine that the numbers of intelligent young mulattoes produced in the second, third, fourth and few succeeding generations would to a large extent intermarry, the result of which would be that a more or less white aristocracy would be formed on the island, including the king and all the chief people, the most intelligent men and the bravest warriors. Then atavism might produce every now and then a much whiter individual—a reversal to the characteristics of the ancestral European—who, by being highly thought of in the whitish aristocracy, would have considerable influence on the colour and other characteristics of the next generation. Now such a white aristocracy would be in precisely the same circumstances as a favourable variety competing with its parent species, and as Darwin has pointed out, in such a case, "If the new variety were successful in its battle for life, it would slowly spread from a central district, competing with and conquering the unchanged individuals on the margins of an ever-increasing circle."*

It may be said that all this is pure speculation, but an actual historic occurrence of a very similar nature has been recorded. It is not a case of a shipwrecked white man influencing the dark coloured inhabitants of an island, but it is the remarkable instance of a single variation in a flock of sheep giving rise to a new and most

* "Origin of Species," 6 Ed., pp. 72, 73.

marked race. The following is Darwin's account of the occurrence:—

"In some few instances new breeds have suddenly originated; thus, in 1791, a ram lamb was born in Massachusetts, having short crooked legs and a long back, like a turn-spit dog. From this one lamb the *otter* or *ancon* semi-monstrous breed was raised. As these sheep could not leap over the fences, it was thought that they would be valuable, but they have been supplanted by Merinos, and thus exterminated. The sheep are remarkable from transmitting their character so truly that Colonel Humphreys never heard of 'but one questionable case' of an ancon ram and ewe not producing ancon offspring. When they are crossed with other breeds the offspring, with rare exceptions, instead of being intermediate in character, perfectly resemble either parent; even one of twins has resembled one parent and the second the other. Lastly, 'the ancons have been observed to keep together, separating themselves from the rest of the flock when put into enclosures with other sheep.'"*

This is a very marked instance of a single variation which was *not* swamped by intercrossing, but on the other hand impressed† its characteristics upon large numbers of descendants, and there would be still less chance of any swamping action in the more ordinary cases of variation where probably a small group of individuals would be found all varying more or less in the one direction. Dr. Romanes complains (loc. cit., p. 343) that Darwin assumes that a new variety would consist of a number of similarly modified individuals, and admits that "if this assumption were granted, there would be an end of the present difficulty," i.e. of his objection to natural selection, on account of intercrossing; but in the first place the assumption is not unwarranted, and secondly Romanes makes precisely the same assumption himself a few pages further on in his paper,‡ in supporting his own theory of physio-

* "Animals and Plants under Domestication," vol. i., p. 104.

† By artificial selection, but the case of the highly favoured white man and his whitish descendants discussed above is also practically a case of artificial selection, and I only bring up the ancon sheep as an argument against Prof. Jenkin's conclusion.

‡ Romanes, loc. cit., p. 352.

logical selection. The individuals of a species vary in different directions around a centre, and therefore in any one line which is favourable there will usually be several more or less marked variations.

Now we must turn to Dr. Romanes' third objection to natural selection as a theory of the origin of species, and that is what is known as the inutility of specific characters, viz. that species are often distinguished by minute characteristics which cannot serve any useful purpose, and therefore cannot have been produced by the action of natural selection. This is a matter upon which the practical naturalist, and the practical naturalist only, can express an opinion. In a letter* to Sir J. D. Hooker, Darwin says, "How painfully (to me) true is your remark, that no one has a right to examine the question of species who has not minutely described many." It is only the naturalist who is intimately acquainted with the characteristics and habits of species who can realize how ignorant we still are of the precise use of many organs, or variations of organs, and who can appreciate the fact that many parts may be of considerable importance although we do not yet understand how. Romanes says that if the majority of specific distinctions were useful we might believe the rest to be so also. Well, I am bold enough to say that I believe the majority of specific characters to be of utilitarian significance, or, what is the same thing so far as the action of natural selection is concerned, to be co-related with other characters which are of importance.

The more deeply one studies any group of animals the more one sees the object of the specific modifications. In the Tunicata, the class I have paid most attention to lately, I am convinced of the practical importance of the specific characters, such as the condition of the muscular

* Life and Letters, vol. ii., p. 39.

system, the arrangement of the vessels in the branchial sac, the number and arrangement of the tentacles, and so on, to their possessors; and even in the case of such apparently trivial characters as the shapes and distribution of the minute spicules throughout the colonies of *Leptoclinum* amongst Compound Ascidians, I know from experience that they affect the hardness and roughness of the colony, and so may be of considerable importance in repelling the attacks of enemies and in keeping the colony free from injurious parasites.

My contention, then, is that Dr. Romanes' three objections can be got over;* that useful variations would not be swamped by intercrossing with the parent forms; that specific characters are really useful to their possessors, and that consequently natural selection is not merely a theory of the origin of adaptations, as Romanes insists, but also a theory of the origin of species, as Charles Darwin believed.

It is now time that I should state what Romanes' theory of physiological selection is. If we suppose that in the members of an incipient variety some slight change takes place in the reproductive system which will render these individuals sterile with the rest of the species, while still fertile amongst themselves, then the result will be that although the varietal characters are useless, and the parent species overwhelmingly more numerous, still there will be no swamping effect because there can be no intercrossing, and our variety will be on the high road to becoming a distinct species.

Romanes gives the following as an illustration:†—

* See also "Physiological Selection," by Henry Seebohm: London, 1886; in which the question is discussed mainly from the ornithologist's point of view.

† Romanes, loc. cit., pp. 352, 353.

"Suppose the variation in the reproductive system is such that the season of flowering or of pairing becomes either advanced or retarded. Whether this variation be, as we say, spontaneous, or due to any change of food, habitat, climate, &c., does not signify. The only point we need here attend to is that some individuals, living on the same geographical area as the rest of their species, have varied in their reproductive systems, so that they can only propagate with each other. They are thus perfectly fertile *inter se*, while absolutely sterile with all the other members of their species. This particular variation being communicated by inheritance to their progeny, there would soon arise on the same area, or, if we like, on closely contiguous areas, two varieties of the same species, each perfectly fertile within its own limits, while absolutely sterile with one another. That is to say, there has arisen between these two varieties a barrier to intercrossing which is quite as effectual as a thousand miles of ocean; the only difference is that the barrier, instead of being geographical, is physiological."

Now although I have been arguing hitherto that natural selection is sufficient to account for the production of new species, I do not mean to say that physiological selection does not occur also. On the contrary, it seems to me that Dr. Romanes has made out a very good case in favour of the possibility of physiological selection occurring; and it may therefore be placed along with certain other processes, after natural selection, as an additional but subordinate factor in the evolution of species. In fact, as Darwin himself recognised, there are probably several distinct processes at work besides natural selection in modifying and diversifying the organic types; and Mr. Herbert Spencer has lately done good service in calling the attention of evolutionists to these somewhat neglected secondary factors.*

The effects of use and disuse in modifying some parts of the animal structure are very liable to be confused with and classed under the action of natural selection, but in such a case as the well-marked degeneration in the entire

* The Factors of Organic Evolution, *Nineteenth Century* for 1886, pp. 570 and 749.

chewing apparatus of some kinds of pet dogs where the jaws are shortened, the teeth degenerate, the muscles are weakened, and their bony attachments become less prominent, there can be no doubt that the change is due to the continued absence of any action on the part of the apparatus sufficient to keep it in its original state of proficiency. Now we are at once brought face to face with a most important question: Can functionally-produced changes of structure be inherited? In the "Zoonomia," Erasmus Darwin contends that they can, and his grandson, Charles Darwin, seems to support this view; but many biologists since have been strongly of opinion that such changes of structure are confined to the generation in which they appear and cannot be handed on by heredity.

A good deal of important evidence has been collected by anatomists which has a bearing upon this matter. To begin with, there can be no doubt that use and disuse modify the body in the individual; the muscles of the athlete, the keen eye of the sailor, the delicate sense of touch in the blind, are well known and convincing proofs that both the structure and the function of various parts of the body may undergo considerable change as the result of continued practice. Some interesting papers by Mr. Arbuthnot Lane have appeared lately in the *Journal of Anatomy and Physiology*, in which the author shows that in certain trades, such as shoemaking, coal-heaving, &c., the effect upon the body is such that the occupation may actually be discovered by an examination of the skeleton of the subject. In the last of these papers, on "The Anatomy of the Shoemaker,"* Mr. Lane gives a most detailed account of the manner in which the characteristic positions and actions of shoemaking have produced effects upon almost every system of the body; while in a

* *Journal of Anatomy and Physiology*, new series, vol. xxii., p. 593.

former paper he was able from a careful examination of the body to discover that the man had been a "trimmer" on board ship, employed in arranging and storing the cargo and coal, and therefore accustomed to lift up and throw heavy weights.

But Mr. Lane goes even further, and in one of his papers, entitled "Can the Existence of a Tendency to Change in the Form of the Skeleton of the Parent Result in the Actuality of that Change in the Offspring?"* he advances the idea that such changes as we are considering can be inherited and intensified, so that in a family of shoemakers the effect in say the grandson may be very much more marked than it was in the grandfather; and Professor Sir William Turner, of Edinburgh, informs me that he is of opinion that the particular habits of a tribe, such as the tree-climbing Australians, or those natives of the interior of New Guinea whose houses are built in the upper branches of lofty trees, not only affect each generation individually, but have an intensified action through the influence of heredity.† In these and other papers by anatomists I find no reference to the action of natural selection, although it is obvious on a little reflection that that process may help considerably, since any favourable variation in the skeleton which enabled its possessor to adapt himself more readily to his peculiar surroundings, such as tree-climbing, would be of advantage in the struggle for existence, and would therefore be marked out for survival by the eliminating action of natural selection.

Another factor in evolution which Herbert Spencer

* *Jour. Anat. and Physiol.*, vol. xxii., p. 215. 1888.

† See his Report on the Human Skeletons obtained during the Challenger Expedition (Zool. Chall. Exp., pt. xlvii.), pt. ii., p. 88; and also *Jour. Anat. and Physiol.*, vol. xxi., p. 473. 1887.

draws attention to is the direct action of the environment.* He points out very truly that this action is accountable for the beginning of that marked difference between the outside and the inside of organisms which is almost universal, and which we recognise when we speak of the ectosarc and endosarc of a Protozoon, the ectoderm and endoderm of the Metazoa, the epiblast and hypoblast of embryos, and when we distinguish a skin, integument or exoskeleton from the organs beneath. The first formed organisms must have been homogeneous protoplasm, and the direct action of the environment or external medium, by causing the first differentiation between the external and the internal layers, and by producing slight differences between the individuals was, as Spencer says, the *primordial* factor of organic evolution, and was the cause of the first variations without which natural selection could not take place.

Although we may admit the modifying effect of the direct action of the environment, still it is exceedingly difficult in any particular case to distinguish between the result of this action and that of natural selection. A few weeks ago, while collecting animals at low tide on the west coast of Scotland, I found in a rock pool a peculiarly coloured specimen of the common sea-slug *Doris tuberculata*. It was lying on a mass of volcanic rock (of which there was a good deal in the neighbourhood) of a dull green colour, partially covered with rounded spreading patches of a purplish pink Nullipore, and having numerous whitish yellow *Spirorbis* shells scattered all over it—the general effect being a mottled surface of dull green and pink peppered over with little round cream-coloured spots. The

* See also Eimer, "Die Entstehung der Arten auf Grund von Vererben erworbener Eigenschaften nach den Gesetzen organischen Wachsens," Jena, 1888.

upper surface of the *Doris* was of precisely the same colours arranged in the same way, so that one could look at it for some little time as it lay in the pool before becoming aware that it was other than a part of the surrounding rock. My companion and I were both greatly struck by the closeness of this mimetic resemblance to the surrounding colouring. We picked up the *Doris* and remarked the brightness and the unusual character of its markings, and then replaced it upon the rock, when it once more became inconspicuous.

Now, there can be no doubt that this protective resemblance was not accidental. It must have been brought about by some modifying influence, but in answer to the question as to what influence had been at work, two sets of evolutionists might give very different answers. The one set of philosophers might say the colouring of this *Doris* is evidently the result of the direct action of the environment; while another set would argue that the condition has been brought about by natural selection acting upon congenital variations produced purely as the result of heredity; and I do not see how, in the present state of our knowledge, an impartial judge could decide which was the correct theory.

My own impression, which, however, I cannot support by any evidence, is that probably both processes were at work in the evolution of this and similar peculiarly coloured specimens. I believe in natural selection as being the most powerful and most constantly acting of the factors, but I think it probable that some influence is exercised directly by the environment, perhaps in the way of producing non-inherited variations in the most advantageous direction, which are then picked out by natural selection. But in order to settle this and many similar questions in the philosophy of Biology, it would be necessary to carry out a series of carefully devised experiments, extending over a number of generations.

The general lines upon which such experiments would be made may be indicated by the questions:—

Would the young of our *Doris* inherit or develope the peculiar colouring if placed in different surroundings? Would they develope a protective colour if placed in such circumstances that the action of natural selection would be prevented as far as possible by the elimination of competition? And would a mimetic resemblance to their surroundings be produced much more rapidly if they were placed under circumstances of severe competition? I fancy the last two questions would be answered in the affirmative, and thus indicate that while natural selection is the more powerful influence, the environment has also some direct effect.

If, however, we agree with Herbert Spencer and some other evolutionists that there are other factors besides natural selection in evolution, that use and disuse, the environment, and physiological selection all play their subordinate parts in the modification of species, and that acquired characters are handed on by heredity to future generations, then we find ourselves at once brought into conflict with the latest and most generally approved theory of heredity to which I must now direct your attention. Many theories have been brought forward to account for the well-known fact that like tends to produce like—that the characters of the parents and other ancestors are handed down to the offspring. Twenty years ago Darwin enunciated his theory of "Pangenesis," which was that

"Every cell of the animal's body, so long as it is not too highly differentiated, throws off gemmules, which are capable of multiplying by fission, and which retain the characteristics of the cells from which they arose, and are capable of reproducing them at some future period by developing into similar cells. These gemmules are transmitted to the offspring by means of the reproductive elements, and may remain dormant in the new individual for a time, or even through a number of generations. When they

finally develop into cells it is as a result of their affinity for allied gemmules produced before them, and which have just attained their full development."*

In 1876, Mr. Francis Galton† proposed a most important modification of Pangenesis to the effect that out of the total number of gemmules contained in the fertilized ovum, and to which collection he applies the term "stirp," only a few develope in that generation into cells, while the rest form a mass of dormant gemmules which are handed on from generation to generation by the reproductive elements, a few of the gemmules developing in each generation into cells and so conveying to the individuals of that generation ancestral characteristics. This idea of a certain portion of living matter which is immortal, being passed on from generation to generation, and forming a connecting link between ancestors and their posterity, has been adopted by nearly all subsequent writers on heredity, and most of the recent speculations may therefore be regarded as modifications of Galton's theory.

In 1883, in a paper read before the Literary and Philosophical Society of Liverpool, entitled "Remarks upon the Theory of Heredity,"‡ I proposed a modification of Galton's theory, which I believe relieved it of a difficulty under which it had laboured. My addition to the theory was, "*that the body of the new individual is formed, not by the development of gemmules alone and independently into cells, but by the gemmules in the cells causing by their affinities and repulsions these cells so to divide as to give rise to new cells, tissues and organs.*" This suggestion gets over the histological difficulty that cells are always formed from pre-existing cells and not from gemmules, and it likewise places the theory of heredity in direct connection

* Variation of Plants and Animals under Domestication, vol. ii., p. 357, 1868.

† Journ. Anthropol. Instit., vol. v., p. 329.

‡ Proc. Lit. and Phil. Soc., L'pool, vol. xxxviii., p. 77, read Nov. 26th, 1883.

with recent observations on cell structure and cell division by showing that the "karyokinetic" changes in the nucleus might be interpreted as the optical expression of the activity of the inherited gemmules in the cell.

This idea of heredity was apparently in the scientific air at that time, since a number of modifications of the theory continued to appear during the following two years leading up to Weismann's very complete and elaborate theory of the continuity of the germ-plasma,* published in 1885. The central idea of this theory is very similar to that of Galton's, and is that the germ cells or reproductive elements arise not from the body of the individual, but direct from the parent germ cell. Thus a living substance, which Weismann calls the germ-plasma, passes over from one generation to another—the germ cells of succeeding generations being related to one another very much as are a series of unicellular organisms, such as *Amœbæ*.

Weismann worked out the theory so admirably, showing its connection with the facts and principles of Biology, and supported it by such powerful arguments, that it was at once received as an important contribution to biological philosophy, and has been largely discussed and pretty generally accepted during the last few years. The only difficulty which I personally feel in regard to it—and it is one which applies equally to all of these allied theories—is its aspect towards acquired characters. If the gemmules or the particles of germ-plasma which produce the body of an individual are derived, *not* from the body of the parent animals, but from their dormant gemmules or germ-plasma, then it is difficult to see how any characters in the parents, produced by such influences as use and disuse and the action of the environment, can be

* "Die Continuität des Keimplasma's als Grundlage einer Theorie der Vererbung," Jena, 1885; and several other papers since.

conveyed, according to this theory of heredity, to the offspring. But we have already seen that there are some reasons for believing that such acquired characters are inherited. Whether, then, are we to relinquish a theory which is in accord with most of the facts of heredity and is supported by strong evidence, or are we to adopt this theory, and deny that acquired characters are inherited because our theory cannot explain such an inheritance. The former would be rash until we have a better theory to substitute: the latter would be unscientific. It is better to take neither course, but to adopt the germ-plasma theory as a provisional theory of heredity, with the addition that acquired characters may be inherited, though we are still ignorant of the process by which that is effected.

In this question of the bearing of acquired characters upon the theory of heredity, we have, then, a most important point in the philosophy of Biology, in regard to which there is still some doubt and some difference of opinion amongst evolutionists, and it is a matter which should, if possible, be settled experimentally. Although a boundless field for work stretches out in every direction around the biologist, still what most seriously demands our attention at present is, I believe, practical work, especially observations and experiments having a bearing upon evolutionary problems—work which will support and control our speculations, and which must be carried on, not in the study, but in the laboratory and the biological station, in the field and on the sea-shore.

There have been during recent years, as we have seen, a number of remarkable essays upon the various parts of the theory of evolution—all of them replete with ideas suggestive of lines of research and subjects for observation and experiment; and the value of these speculations and

suggestions must now be worked out by the practical naturalist. Darwin himself devoted many years to the systematic study of the Cirripedia. He tells us that no one has a right to examine the question of species who has not minutely described many, and that opinion has been recently endorsed by the President of the Biological Section of the British Association.*

A clear and vivid impression of such matters of fundamental importance as the struggle for existence, the action of natural selection, the benefit of protective colouring, the completeness and the advantage of mimicry, and the utility of specific characteristics can only be gained by one who has practically studied the subject by observing the organisms in their living condition amongst their natural surroundings. During the last few years I have had occasion to study somewhat closely the fauna of the sea-shore at different parts of our coast. I have spent many most delightful, and to me most instructive, hours on the rocky beach at Puffin Island, and elsewhere, at extreme low water, watching the animals and plants in their natural conditions; and I am sure that it is of primary importance to all students of natural history, but especially to the philosophic biologist who would concern himself with the problems of evolution, that he should thus become practically acquainted with the different forms of life in their native haunts, that he should see for himself their variations and their resemblances, their habits, and their complicated relations to all around them.

Of all the regions of the sea and land, so far as my experience goes, by far the most prolific of animal life is that region of the shore which is known as the upper edge of the Laminarian zone. It lies just beyond

* Nature, vol. xxxviii., p. 474, Sept. 13th, 1888.

the ordinary beach, and is only exposed at the lowest spring tides. It is the zone where the great tangled brown masses of the oar-weed or *Laminaria* are found, and it is there that marine invertebrate life is to be seen in its greatest profusion; it is there that the competition is keenest between allied forms of animals, that the struggle for existence is carried on most fiercely; it is there probably that evolution is going on most rapidly, there that its conditions may most advantageously be studied.

On turning over a large stone on this region of the shore, or when coming suddenly upon a small pool or a little cave, the sides of which are clothed with various forms of animal life, it is extremely instructive to the evolutionist to notice which are the most conspicuous forms, and to try to account for their want of any protective colouring or attempt at concealment. My experience is that the animals which first attract attention are those which move rapidly, such as many of the Crustacea and of the Annelids. The movements which render these animals conspicuous conduce in most cases to their escape from enemies, but it is interesting to find that some animals which are able to move have actually acquired the habit of lying perfectly still so as to escape observation.

The next most conspicuous animals I find to be the pure white calcareous and some of the scarlet and other bright-coloured siliceous sponges. Now, these are all of them animals which are very completely protected from enemies by the numerous sharp-pointed spicules with which they are provided. The gleaming white Compound Ascidians (*Leptoclinum*) may be placed in the same category, as they likewise are all richly supplied with sharp-pointed spicules. Some of the Polyzoa are also very highly coloured and at once attract attention, but they seem to be all forms which are either well protected from

possible injury by their calcareous armour, such as the Escharidæ and other relations of *Lepralia,* or else are well supplied with snapping sharp-beaked avicularia, such as the species of *Bugula,** &c. Most of the other animals, which are defenceless, will be found to be either of quiet greys and browns or other dull shades, or to be protected by a marked resemblance in their colouring to the stones and sea-weeds on which they lie, or to some of the above-mentioned conspicuous animals which are able to take care of themselves.

A few marked instances of this mimetic resemblance to other organisms have come under my notice. One of these was the case of a brilliant red Turbellarian worm (*Leptoplana* sp. ?), which was found at Puffin Island creeping on the surface of a colony of *Mucronella coccinea* of the same colour; and several of the other Turbellarians resemble the Compound Ascidians upon which they are found. Another example was a pinkish purple Amphipod (*Calliopius norvegicus*), which was exactly of the same tint as one of the encrusting Nullipores in the shore pools. I watched this animal for a considerable time one morning at Puffin Island, and found that in its many excursions about the pool it very rarely left the parts coloured like itself, and that when I removed it to a patch of bare rock it at once took refuge again on the protecting Nullipore.

Another of the fundamentals of evolution which is well illustrated by the fauna of the Laminarian zone is "variation," a subject which requires careful observation and experiment as much as any in the wide range of Biology. It is most important, on account of the obvious bearing upon species, that we should know something of

* The orange-coloured *Bugula turbinata* is certainly one of the most conspicuous animals about low water mark at Puffin Island.

the limits of variation—if indeed there are any—and the conditions which determine its direction and extent in any particular species. The relative importance also of the external conditions on the one hand and of the mixing of hereditarily acquired maternal and paternal and their respective ancestral tendencies on the other hand in influencing variation is still quite unknown, and is well worthy of the attention of the able and enthusiastic young biologist who is ambitious of leaving a name immortal in the annals of his science, and who does not shrink from what is perhaps the most difficult and the most laborious piece of work awaiting investigation. That man who can tell us—not as a mere matter of more or less probable speculation, but as an accurate induction from careful and adequate observation and experiment—why certain variations occur and what conditions influence them, has reserved for him a position in the Temple of Evolution second only to that of Charles Darwin himself.

SECOND ANNUAL REPORT of the LIVERPOOL MARINE BIOLOGICAL STATION on PUFFIN ISLAND.

By W. A. Herdman, D.Sc., F.L.S., F.R.S.E.,

DERBY PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, LIVERPOOL; CHAIRMAN OF THE LIVERPOOL MARINE BIOLOGY COMMITTEE, AND DIRECTOR OF THE STATION.

[Read 9th November, 1888.]

The Report upon the foundation and first season's work of the Puffin Island Marine Biological Station which was read before this society at the corresponding meeting to this one in last session, brought the account of the affairs of the station up to December, 1887. Since then the usual work has been carried on steadily during the past year, without break and without any very striking feature. The committee are glad to be able to report that the station has been largely taken advantage of during some of the spring and summer months, and that as a result a great mass of material has been collected, and a good deal of practical work has been carried on.

The following biologists have visited and worked at the station since the opening in the end of May, 1887:—

DATE. 1887.	NAME.	WORK.
May.	A. O. Walker, F.L.S., Chester	Amphipoda and higher Crustacea.
..	Dr. Ellis, F.E.S., Liverpool	Actiniaria.
...	R. J. Harvey Gibson, M.A., F.R.S.E., University College, Liverpool	Algæ.
...	Prof. Herdman, D.Sc., F.L.S., University College, Liverpool	Tunicata and general.
...	J. Lomas, A.N.S.S., Liverpool	Polyzoa.
...	J. A. Clubb, University College, Liverpool	General.
...	J. Vicars, Bootle	Nudibranchiata.
...	Prof. Reginald W. Phillips, B.Sc., University College, Bangor	Algæ.

DATE.	NAME.	WORK.
1887.		
June.	Prof. F. T. Paul, University College, Liverpool.	General.
...	I. C. Thompson, F.L.S., Liverpool	Copepoda and other surface animals.
..	Prof. Herdman, Liverpool	Tunicata and general.
...	J. A. Clubb, University College, Liverpool...	General.
July.	J. Lomas, Liverpool.....	Polyzoa.
...	Prof. Herdman, Liverpool	Tunicata, &c.
..	R. J. Harvey Gibson, Liverpool.....	Algæ.
...	J. A. Clubb, University College, Liverpool ...	General.
August.	J. W. Gregory, F.G.S., British Museum	Annelids, &c.
..	Dr. R. Hanitsch, University College, Liverpool.	Mollusca, &c.
..	Alfred Leicester, Liverpool	Mollusca and Rotifera.
...	J. A. Clubb, University College, Liverpool ...	General.
Sept.	J. W. Gregory, F.G.S., British Museum	Annelids, &c.
...	Dr. R. Hanitsch, University College, Liverpool.	Mollusca, &c.
...	Alfred Leicester, Liverpool.....	Mollusca and Rotifera.
...	I. C. Thompson, F.L.S., Liverpool	Copepoda, &c.
...	A. O. Walker, F.L.S., Chester	Amphipoda, &c.
...	Prof. Herdman, Liverpool	Tunicata, &c.
...	J. A. Clubb, University College, Liverpool ...	General.

[On September 3rd, a party of biologists, from the meeting of the British Association at Manchester, visited the station.]

Dec.	R. McMillan, Liverpool	General.
...	Prof. Herdman, Liverpool	Tunicata, &c.
1888.		
March.	R. J. Harvey Gibson, Liverpool.....	Algæ.
...	W. R. Melly, University College, Liverpool...	Hydroida.
...	Prof. R. W. Phillips, Bangor.....	Algæ.
...	W. H. Gardner, University College, Liverpool.	General.
...	Dr. R. Hanitsch, University College, Liverpool.	Odontophores of Gastropoda and general.
...	Prof. Herdman, Liverpool	Tunicata, &c.
April.	Prof. R. W. Phillips, Bangor, and two students from University College, Bangor	Algæ.
...	W. R. Melly, University College, Liverpool...	Hydroida.
...	Dr. R. Hanitsch, University College, Liverpool.	Odontophores of Gastropoda and general.
June.	I. C. Thompson, F.L.S., Liverpool	Copepoda, &c.
..	R. McMillan, Liverpool	General.

DATE. 1888.	NAME.	WORK.
June.	Prof. Herdman, Liverpool	Tunicata.
...	Dr. Thomas, Llandudno	General.
July.	F. Victor Dutton, Chester	Algæ.
...	C. Timmins, Runcorn	Dredging.
...	C. Herbert Hurst, Owens College, Manchester.	Polyzoa, Nudibranchs, and general.
...	Prof. Herdman, Liverpool	Tunicata and general.
August.	C. Herbert Hurst, Owens College, Manchester.	Polyzoa, Nudibranchs, and general.
...	S. Nowell, University College, Liverpool	General.
...	J. A. Clubb, University College, Liverpool	General.
...	Prof. Reginald Phillips, Bangor	Algæ.
Sept.	C. Herbert Hurst, Owens College, Manchester.	Polyzoa, Nudibranchs, and general.
...	Prof. Herdman, Liverpool	Tunicata and general.
...	A. O. Walker, F.L.S., Chester	Amphipoda, &c.
...	H. Horrocks, Owens College, Manchester	General.
...	J. A. Clubb, University College, Liverpool	General.
...	Prof. Reginald Phillips, Bangor	Algæ.
...	A. T. Allen, Owens College, Manchester	General.

There are two important functions which a biological station like ours may be expected to perform. The first is to afford opportunity to the younger biologists and students of the neighbourhood of making themselves acquainted with marine animals and plants, alive and in their natural conditions, and of learning how to investigate a fauna, and how to conduct research work in general. Looked at from this point of view, although the Puffin Island Station has been fairly successful during the past year, there is room for considerable improvement. We have had a few students from University College, Liverpool, a couple from the Owens College, Manchester, a couple from the North Wales College at Bangor, and one from the Grosvenor Museum, Chester; but still, during a considerable part of the fine weather of summer, the best time of the year for work at such an institution, there was frequently accommodation for

more workers, and sometimes the laboratory was unoccupied. The committee would be glad to see the station taken advantage of to the fullest extent by the students of the neighbouring colleges.*

The second important function of such a biological station is to procure supplies of specimens of the various groups of animals required by the specialists who are engaged in working up the Fauna and Flora of Liverpool Bay. And it is in this direction that the Puffin Island institution has done most service to science. It is a singular and most encouraging circumstance that on, I believe, every visit of members of the L.M.B. Committee to the island their dredging and tow-netting operations have been rewarded by the capture of one or more species new to the district, and in many cases new to the British Seas; while several species new to science have been found during the past year.

Mr. A. O. Walker, F.L.S., who has charge of the higher Crustacea of the district, and who is now engaged upon a report which we shall have before us at a future meeting of the society, informs me that twenty-two species new to our fauna have been added in his department, including one or two new to the British seas, two Amphipods probably new to science, and three species of Cumacea, all new to our district.

Mr. I. C. Thompson, F.L.S., reports, in regard to the Copepoda, that since his last paper (written in November, 1887) in our recently published volume of Proceedings, the tow-net gatherings made by members of the committee, or by the curator of the station, Mr. Rutherford,

* Students of any of the above-mentioned colleges are offered lodging and the use of the laboratory at the station at the rate of ten shillings per week. Four simple meals—breakfast, dinner, tea, and supper—are provided by the curator at about cost price, averaging three shillings a day.

have yielded—two species new to science, one (*Pontella kroyeri*) new to British seas, and eight other species new to the district. Of the two new to science, the one is a Lernæan, while the other belongs to the interesting new family of the Cymbasomatidæ which has been lately established by Mr. Thompson. The first known species of *Cymbasoma* was *C. rigidum*, found at the Canary Islands in 1887 by Mr. Thompson, and shortly afterwards in the Mediterranean by Dr. Bruce, of Malta. Then a second species of the same genus, *Cymbasoma herdmani*, was described last year by Mr. Thompson from specimens found round Puffin Island. Since then this species has been found in large numbers by Mr. Sinel at Jersey, and by Mr. W. S. McMillan at Torbay. Lastly, a recent tow-net gathering sent by Mr. Rutherford from Puffin Island contains a specimen of what must be regarded as a third species of the genus *Cymbasoma*. For all of these discoveries and additions to our fauna we are indebted to the Puffin Island Biological Station.

The chief events of the year have been as follows:—The small steam launch, which was referred to in our last Report as having been acquired for the station, has, unfortunately, proved a total failure. It was taken down to Puffin Island early in the year, but met with a series of mishaps, such as running on a reef of rock, filling, and sinking near the lighthouse on Penmon Point, and finally developed a leak in the fire hole, which would have rendered extensive repairs necessary. It soon became evident to the committee that on account of the numerous reefs and sand-banks around the island, the strong currents, and the total absence of any shelter along the coast line, the launch was quite unsuitable for the situation and beyond the powers of the very limited staff and appliances at the station. She has now been taken up to Beaumaris,

and the committee are endeavouring to dispose of her, with the view of obtaining in her place a small sailing boat.

During the gale of last week the station met with a serious mishap in the total loss of the very useful rowing boat, which has been in constant service since June, 1887. The boat was carried away from her anchorage on the night of 1st November, and was washed ashore in pieces at Penmon Point on the following day. Although the very limited amount of the funds in the Treasurer's hands did not warrant any such expenditure, still on an island a boat is, of course, indispensible, so a new one has been purchased and sent down to the station.

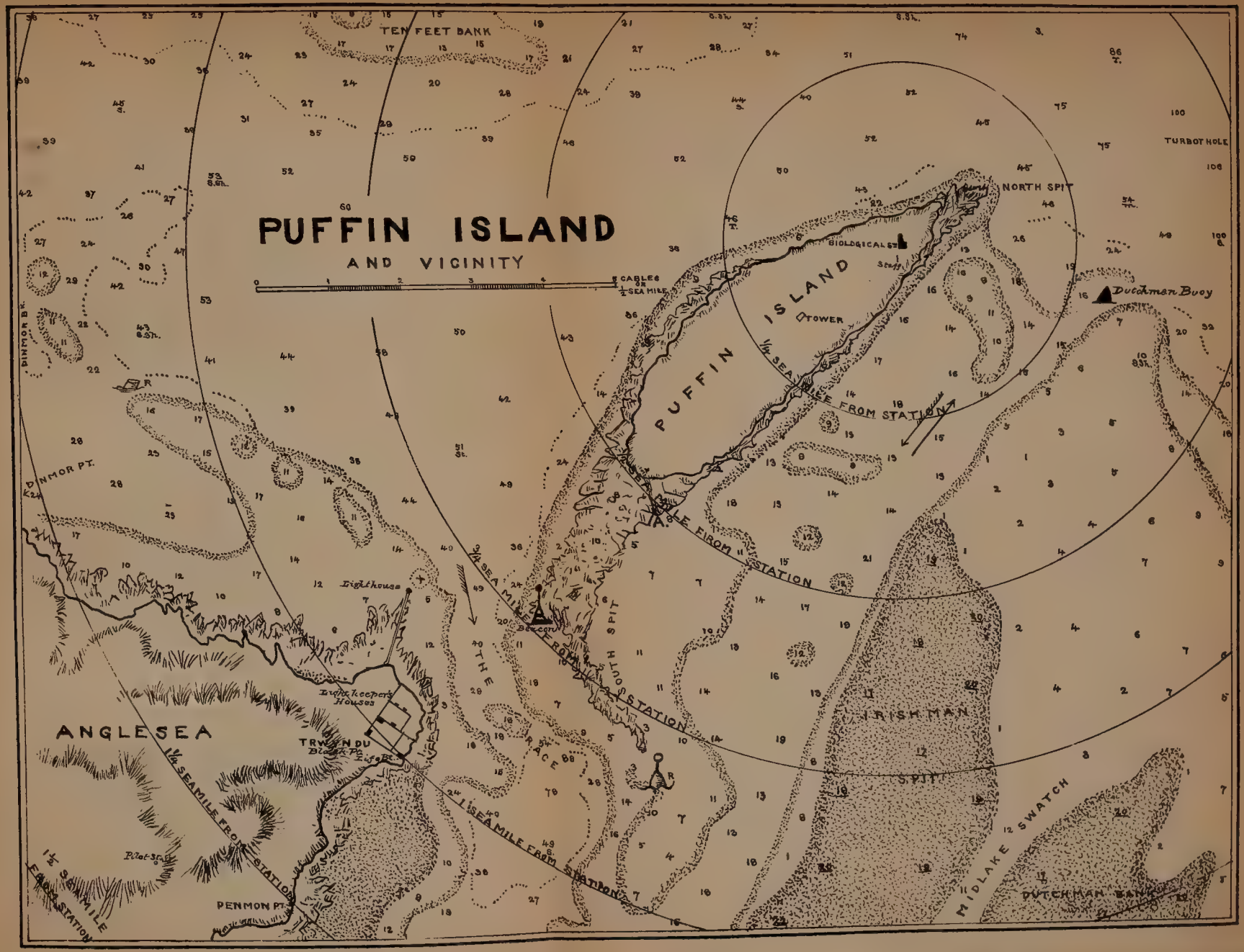
Turning now to the more scientific part of the year's record, we find that, during Easter, Mr. Harvey Gibson, Dr. Hanitsch, Mr. W. R. Melly and Professor Herdman visited the station, and although they were occasionally driven into the laboratory from the rocks by a biting north-east wind and showers of sleet, and on one day had the whole island covered by a layer of snow, still a good deal of shore and laboratory work was carried on, and one good day's dredging off the north end of the island (see chart,* Turbot Hole) was obtained, which yielded, amongst other things, twenty-one species of Amphipoda and Isopoda, of which seven are new to our fauna.

In June, Mr. Thompson, Mr. McMillan and Professor Herdman visited the station, and collected, amongst other things, *Calliopius norvegicus*, an Amphipod which is new to the British lists.

At the end of July, Mr. Hurst, of Owens College, Mr. Dutton, of Chester, and Professor Herdman did a good deal of collecting, and obtained *Calliopius norvegicus* again, an undetermined *Lysianassa*, and other species

* The chart of Puffin Island and the neighbourhood which accompanies this report was very kindly drawn for me by Mr. S. Nowell, Junr.

NORTH SPIT
TURBOT HOLE
Dutchman Buoy
DINMOR BK.
DINMOR PT.
STATION
ANGLESEA
SHMAN
SPIT
1½ SEAMILE
1½ SEAMILE
FROM STATION
MIDLAKE SWATCH
DUTCHMAN BANK


PUFFIN ISLAND
AND VICINITY
TEN FEET BANK
NORTH SPIT
TURBOT HOLE
BIOLOGICAL ST.
Ducatmen Buoy
TOWER
PUFFIN ISLAND
1/4 SEA MILE FROM STATION
1/4 SEA MILE FROM STATION
1/4 SEA MILE FROM STATION
1 SEA MILE FROM STATION
1 1/2 SEA MILE FROM STATION
DINMOR PT.
DINMOR BK.
Lighthouse
Lighthouse Keepers Houses
Beacon
THE RACE
SOUTH SPIT
IRISH MAN
SPIT
ANGLESEA
TRWYN DU
Black Pt.
Pilot-Sta.
PENMON PT.
MIDLAKE SWATCH
DUTCHMAN BANK

not yet worked out. Mr. Hurst continued his work at the station during the greater part of August.

During the very low tides of September, Mr. Walker joined Mr. Hurst and Professor Herdman at the island, and a large amount of material was collected on the long South Spit and the Beacon Rocks (see chart). On this occasion a considerable area not usually uncovered at low tides was exposed, and many magnificent Compound Ascidians which have not yet been identified were obtained, along with fourteen species of Amphipoda, five of which are new to our fauna.

The attempt was made during September, with what success is not yet known, to introduce at Puffin Island the large Nudibranch *Dendronotus arborescens*, which is sometimes so abundant at Hilbre Island. The first batch of specimens was collected at low tide on Hilbre by Mr. Clubb, and sent down to me at Puffin Island. They were unpacked at once, but were all apparently dead or dying, having probably been asphyxiated on the journey. However, they were immediately placed in pools on the two sides of the South Spit at low tide, and possibly some of them may have recovered. A second supply of specimens from Hilbre was brought down to Puffin on the 22nd September, by Mr. Clubb, and, as they were carefully looked after during the journey, they arrived in good condition, and were set free, along with some of their spawn, close to the landing place (A, on chart) at the south end of the island. They have not been seen since, and Mr. Rutherford reports that he looked for them at low tides recently without success. Still they may very possibly have migrated out into deeper water, and will appear on the shore again later on when spawning.

During the summer the committee commenced a system of daily observations upon the weather and the tem-

perature of the sea, to be taken by the curator of the station and recorded in a series of weekly reports, which give, in addition, a statement of the work being carried on from day to day. These reports have been made with regularity: a specimen week is shown on the opposite page.

It is interesting to be able to record that the American Clam (*Venus mercenaria*) specimens of which, it will be remembered, were laid down nearly twenty years ago, and then again in 1883, by Mr. F. Archer and Mr. T. J. Moore,* on several spots in Liverpool Bay, and have not since been heard of in the neighbourhood, has turned up this summer living near Beaumaris. Mr. C. H. Chadwick, of Manchester, found a living specimen, and reports that dead shells are not uncommon.

On an excursion of the Biological Society last June to Hilbre Island, while crossing the great stretch of wet sand which lies in the estuary of the Dee, it was pointed out by Mr. F. Archer that the surface of the sand was covered in some places with vast numbers of the small mollusc *Hydrobia ulvæ*. Some of these were brought back to the laboratory in their wet sand; and, on being put into a dish of sea-water, the molluscs were found next day to have crawled out of the sand, and I then noticed that nearly every specimen had several little rounded excrescences scattered over the surface of its shell. On examining these under the microscope it was found that each was a little mass of small sand-grains in the centre of which was a clear jelly containing several segmenting ova or young embryos. These were undoubtedly molluscan eggs, as I kept them alive until one or two had reached a "veliger" stage, but did they belong to the *Hydrobia* or to some other mollusc? No other mollusc was, however,

* See Mr. Moore's paper in the First Report of the Fauna of Liverpool Bay, 1886, p. 368.

PUFFIN ISLAND BIOLOGICAL STATION.

RECORD OF WORK FOR THE WEEK ENDING 15TH SEPTEMBER, 1888.

Days.	Wind.	Weather.	Sea.	Temperature of Sea.	Workers at Station.	Work done.	Remarks.
SEPTEMBER, 1888. 9th, Sunday.....	East, then North, then East; strong breeze.	Dull and cold.	Rough.	57.5° F.	Mr. C. H. Hurst. Mr. H. Horrocks. Mr. A. O. Walker. Prof. W. A. Herdman.	Laboratory work. Dredging off south end. Shore collecting on Spit, at low tide, until dusk.	Obtained large numbers of Compound Ascidians near Beacon rocks.
10th, Monday.....	East; fresh breeze.	Bright.	Moderate.	57° F.	Mr. C. H. Hurst. Mr. H. Horrocks. Mr. A. O. Walker. Prof. W. A. Herdman.	Laboratory work.	Prof. Herdman took several bottles of specimens (chiefly Ascidians) up to Liverpool.
11th, Tuesday.....	West; fresh breeze.	Dull.	Moderate.	57.5° F.	Mr. C. H. Hurst. Mr. H. Horrocks.	Boat to Beaumaris with Mr. Hurst, and for coal and stores.	.....
12th, Wednesday.	South-west; light breeze.	Fine.	Smooth.	57° F.	.....	Tow-netted off West Spit for Mr. I. C. Thompson (No. 29).	.....
13th, Thursday...	North-east; light breeze.	Fine.	Smooth.	57° F.	Mr. A. F. Allen.	Took night tow-netting in "race," for Mr. I. C. Thompson (No. 30).	Large numbers of Ctenophora in tow-net.
14th, Friday	East; fresh breeze.	Bright.	Moderate.	57.5° F.	Prof. R. W. Phillips.	Miscellaneous station work.	.....
15th, Saturday...	East; light breeze.	Bright.	Smooth.	58° F.	.....	Miscellaneous station work.	.....

(Signed) ALEX. RUTHERFORD, *Curator.*

noticed in any abundance in the neighbourhood. Has, then, the *Hydrobia* in this locality acquired the habit of laying its eggs upon its neighbours' shells as being the only comparatively stable objects to be found in the fine shifting sands around it? A short note on the subject published in "Nature" caught the attention of Professor G. Lindstrom, of Stockholm, who has written to me, saying:— . . . "I think there cannot be the least doubt that they [the egg-masses] really belong to that mollusc [*Hydrobia ulvæ*]. Many years ago I isolated a number of them to see how they spawned and succeeded in finding oothecæ such as you describe fixed on stones, on seaweeds, on dead shells, etc., not only on the shells of *Hydrobia*." He refers me to a paper* in which he had figured an egg-mass surrounded by sand-grains very similar to those we found here. Consequently the explanation which I have suggested above may probably be regarded as correct. It is an interesting instance of local conditions giving rise to a peculiar habit.

Another case of curious distribution of young molluscs is to be seen in the myriads of young mussels (*Mytilus edulis*), about 1 mm. or less in length, which are sometimes found on Caldy Blacks and some parts of Hilbre Island in such abundance that all projecting objects such as shells, zoophytes, seaweeds, &c., are almost blackened by the adhering masses of molluscs. Very few of these reach maturity—in fact most of them disappear very soon, being probably eaten by larger animals. The interesting point is that the minute free-swimming larvæ, derived probably from the mussel beds on the Leasowe shore, are ready to settle down in large numbers upon any object projecting from or more stable than the surrounding

* "Om Gotlands nutida Mollusker," Wisby, 1868.

sands. Would it not be worth while to establish artificial mussel beds in the neighbourhood of Hilbre Island?

The Liverpool Salvage Association, with their usual liberality, placed their famous old steamer, the "Hyæna," once more at the service of the committee at Whitsuntide, for a three days dredging expedition. During the three former biological cruises of the "Hyæna," in 1885, 1886 and 1887, the region explored has been the southern part of the L. M. B. C. district around the coasts of North Wales and Anglesey. (See fig. 1, over page.)

On the present occasion the committee decided to run a couple of lines of soundings and dredgings between the Mersey and the Isle of Man, and to spend some time dredging round the southern end of that island, the general objects being (1) to get some knowledge of the depths, bottom, and animals, across the eastern half of the Irish Sea, and (2) to investigate the rich fauna living around the "Calf" and south end of the Isle of Man.

About seven a.m. on Saturday morning, 19th May, the "Hyæna" left the Liverpool Landing Stage with a party of nearly twenty biologists on board, including Mr. I. C. Thompson, Mr. W. S. McMillan, Mr. A. Leicester, Mr. J. Lomas, Mr. A. O. Walker, Dr. R. Hanitsch, Mr. J. A. Clubb, Dr. F. C. Larkin, Mr. C. H. Hurst, Mr. Hill, Mr. R. McMillan, Professor Denny, Mr. Watson, Professor Miall, Mr. N. Caine, Professor Herdman, and Captain Young, of the Salvage Association; and provided with dredges, trawls, tow-nets, sounding line, deep-sea reversing thermometer,* microscopes, and the other necessary instruments, dishes, bottles and reagents.

After the well-known sand-banks round the mouth of the Mersey had been passed, soundings and bottom

* This very important instrument was kindly presented to the committee by Mr. Isaac Roberts, of Maghull.

temperatures were taken occasionally, and several times during the day a stop was made for trawling, dredging and tow-netting.

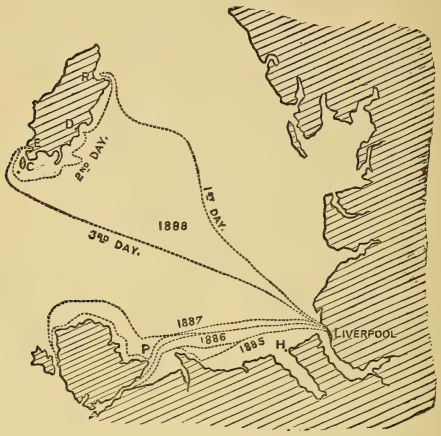


Fig. 1. Map* of the L.M.B.C. district, showing the course of the "Hyæna" in the cruises of 1885, 1886, 1887, and 1888. H, Hilbre Island; P, Puffin Island; R, Ramsey; D, Douglas; E, Port Erin; C, Calf of Man.

A fair amount of material, including *Ceratium tripos*, various Copepoda, and some interesting larval forms, was obtained, and for the most part preserved for further examination. No greater depth than 23 fathoms, with a bottom temperature of 47° F., was, however, met with. There was nothing specially noteworthy amongst the animals dredged; and although the shrimp trawl was used, it was probably very little on the ground owing to the strong tide running, consequently, with the exception of a

* For the use of this cut, which appeared in "Nature" for June 7th, 1888, in illustration of my article on the Cruise of the "Hyæna," I am indebted to the courtesy of Messrs. Macmillan and Co.

large colony of *Alcyonium digitatum*, and a few Amphipods, nothing was obtained.

It had been intended to anchor for the night in Douglas Bay, but during the dredging and trawling the vessel had drifted so far out of her course that when evening came it was found advisable to run for Ramsey. Here half the party went on shore for the night, the rest staying on board for the electric-light experiments, which will be described further on.

On the following morning an early start for the south was made, the rest of the party was picked up at Douglas, and then the work of the day commenced. The "Hyæna" steamed slowly round the east and south coasts of the island to Port Erin (see map, fig. 1, second day), dredging and tow-netting at intervals, with very good results. When a stop was made for collecting the fullest advantage was taken of it. The sounding-line and the deep-sea thermometer were over amidships, and two dredges, a large bottom tow-net, and one or more surface nets were put out astern. The deep tow-net, devised and worked by Mr. W. S. McMillan, was so weighted and buoyed as to work steadily at a distance of a foot or so above the sea-bottom, and it yielded a large amount of material, which was in some cases conspicuously different from the contents of the surface-nets, worked by Mr. I. C. Thompson, during the same time. The latter supplied very large numbers of *Anomalocera patersonii*, a Copepod which Mr. Thompson reports had been taken very rarely before, and never since, in our district. Some of these surface animals apparently exist in local shoals. This Copepod, although very abundant along the south-eastern coast of the Isle of Man, was not present in tow-nettings taken off Puffin Island during the same day.

A large area of the sea-bottom between Port Soderick and Port St. Mary is apparently covered by masses of *Melobesia calcarea*, and the numerous dead valves of *Pectunculus glycimeris;* and incrusting Polyzoa are especially abundant both upon the nullipore and the shells. Mr. J. Lomas, who has charge of the Polyzoa, informs me that amongst a number of other rare forms he has identified *Stomatopora johnstoni*,* and *S. incrassata*,* *Tubulipora lobulata*, and *T. flabellaris*, *Lichenopora hispida*, *Cellepora dichotoma*, *Membranipora aurita*, *M. craticula*, and *M. dumerilii*, *Schizoporella unicornis*,* *Hippothoa flagellum*,* *Diastopora suborbicularis*, and a peculiar variety of *Cellaria fistulosa*. Of these, the four species marked with an asterisk are new to our fauna. A single valve of *Pecten maximus* brought up in the dredge has been found by Mr. Lomas to be incrusted by colonies of no less than eleven species of Polyzoa, some of them rare forms; while a dead shell of *Buccinum undatum* similarly affords attachment to nine distinct species.

Towards evening three very successful hauls of the dredge were made, which covered practically all the ground in a line from the southern end of the "Calf" to the northern side of Port Erin Bay, just under Bradda Head. Amongst the material obtained in these hauls the following species were noticed:—*Asterias glacialis*, *Solaster endeca*, *Stichaster roseus*, *Porania pulvillus*, *Luidia fragilissima*, *Antedon rosaceus*, *Stenorhynchus longirostris*, *S. phalangium*, *Inachus dorsettensis*, *Hyas coarctatus*, *Eurynome aspera*, *Xantho rivulosa* var. *tuberculata*, *Pinnotheres pisum*, *Ebalia tuberosa*, *Corystes cassivellaunus*, *Eupagurus cuanensis*, *Anapagurus hyndmanni*,* *A. lævis*, *Galathea intermedia*, *Munida rondeletii*,* *Caridion gordoni*,* *Pandalus brevirostris*, *P. annulicornis*, *Virbius varians*, *Pleuro-*

* Those species marked with an asterisk are new to the fauna.

branchus membranaceus, Ascidia venosa, A. plebeia, Corella parallelogramma, Polycarpa sp., *Leptoclinum* sp., and other Compound Ascidians.

In Port Erin Bay after dark the electric light was again used successfully in the bottom and surface tow-nets.

On the third day an early start was again made, with the object of leaving time to run down into the deep water lying to the south of the Isle of Man. Unfortunately, however, a thick fog was encountered, which hampered our movements during the morning and changed all the plans for the day. After passing the Chicken Rock, the "Hyæna" steamed slowly for Liverpool, and reached the Mersey about one a.m. on Tuesday. A few hauls of the trawl and dredge were taken on the way home with no great results, and the tow-nets both bottom and surface, were worked whenever practicable. It is noteworthy that although we passed not far south of where the great quantities of *Anomalocera patersonii* had been captured on the previous day, not a single specimen of that Copepod was obtained either on the surface or with the deep tow-net.

The important feature of this cruise, however, was the use which was made of the electric light for collecting after dark. On the first night, in Ramsey Bay, after the shore party had left and the ship was anchored for the night, an electric light of 1000 candle power was hoisted a few feet above deck, and this allowed work to be carried on almost as comfortably as during the day. Captain Young, of the Liverpool Salvage Association, who was in command of the "Hyæna," then kindly arranged for us a 60 candle power Edison-Swan submarine incandescent lamp in the mouth of a tow-net. This illuminated net was let down to a depth of three fathoms, and allowed to remain there for half an hour. At the same time, another

tow-net without any light was let down to the same depth over the other side of the ship. When the nets were being hauled in, as the one with the electric light approached the surface numerous small animals (Crustacea probably) were noticed accompanying it, and darting about in the bright light. This tow-net when emptied into a glass jar of sea-water was found to contain an abundant gathering, consisting mainly of Crustaceans; while the net in the dark on the other side of the ship had practically nothing.

The two nets were then put out again. The one had the electric light in its former position, but this time it was let down to the bottom at a depth of six fathoms; while the other net was placed in the dark at the ship's stern, and also reached the bottom. The tow-nets remained stationary, but were kept distended by the tide. The outline of the illuminated net could be made out indistinctly at a depth of six fathoms. After being out for three-quarters of an hour, both nets were hauled in, with the same result as before. The illuminated net contained abundance of Amphipoda (*Ampelisca lævigata*, and *Dexamine vedlomensis*) and some Cumacea (young males of *Cuma scorpioides?*), while the dark net again contained practically nothing.

These two experiments showed pretty conclusively the effect of the brilliant light in attracting the free-swimming animals, the difference between the contents of the two nets being on both occasions most marked. Consequently, on the second night, in Port Erin Bay, *both* nets were illuminated, and while the one was let down close to the bottom at a depth of five fathoms, the other was kept at the surface of the sea on the opposite side of the ship. This experiment was tried three times, with the same result each time: both the nets were found to contain

abundance of animals, but the bottom and surface gatherings differed greatly in appearance and in constitution. The net from the bottom contained mainly large Amphipoda, and some Cumacea, while the gathering from the surface was characterised by the abundance of Copepoda.

Mr. A. O. Walker has supplied me with the following list of Crustacea from the bottom net.

CUMACEA :—*Iphinoë trispinosa*,* *Cuma scorpioides*, and *Pseudocuma cercaria* (many).*

AMPHIPODA :—*Anonyx* sp.,* *Monoculodes grubei*,* *Pontocrates norvegicus*, *Phoxus holbolli*, *Metopa* sp., *Dexamine vedlomensis*, *Bathyporeia pilosa*, and a remarkable undescribed species provisionally named by Dr. Norman as *Megalonoura agilis*.

At first sight it seemed that the Amphipods from the illuminated deep nets were all red-eyed species, such as *Ampelisca lævigata* and *Bathyporeia pilosa*, and this suggested that possibly there might be a relation between the colour of the eyes and sensitiveness to the electric light. A detailed examination of the material has shown, however, that this will not hold good strictly as, although the red-eyed specimens are the most abundant and conspicuous, still others are present.

Mr. Walker points out that all the Cumacea taken both at Ramsey Bay and Port Erin were males, and that the probable reason is that the males of all the three species represented are provided with pleopoda (or swimming legs), while the females are not, and that consequently the males are no doubt more active swimmers, and therefore more likely to rise from the sea-bottom where they live.

Mr. Thompson has identified the following species of Copepoda from the illuminated surface nets :—*Calanus finmarchicus*, *Pseudocalanus elongatus*, *Dias longiremis*,

* New to fauna.

Idya furcata, Centropages hamatus, Anomalocera patersonii, Isias clavipes, Oithona spinifrons, Harpacticus chelifer and *Harpacticus fulvus.* The specimens of the last two species are remarkable for their unusually large size and their abundance. It has been suggested that as the Harpacticidæ are well known to be foul feeders and to act the part of scavengers in clearing away decaying matters from our shores, they may have possibly been attracted in numbers to the tow-net by mistaking the electric light for the phosphorescent glow of decomposing animal matters.

Apart from the considerable number of rare species added to our lists by this expedition, the "Hyæna" cruise of May, 1888, will stand out as a notable occasion on account of the successful application of the electric light to marine biology, as a bait or attraction in the tow-net worked after dark. The obvious extension of this illumination method to deep-water tow-netting and trawling during the day-time we hope, thanks to the kindness of the Salvage Association, to be able to experiment upon in a future expedition.

The committee have decided that so much new material has been collected during this last year, and so many supplementary reports have either been prepared or are now in course of preparation, that they are justified in proposing to issue the second volume of the Fauna of Liverpool Bay during the present winter. Mr. S. Nowell, who gained some familiarity with the fauna at Puffin Island during August, is at present occupied, along with some other gentlemen, in the zoological laboratory of the college, in examining the various store bottles from Puffin Island and elsewhere, recording their contents, and sorting out the various groups of animals to be sent to specialists for further examination. When these

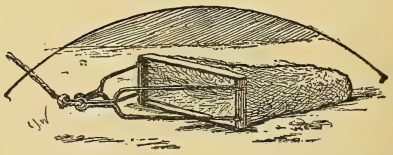
specimens have been investigated the final reports for the proposed volume will be collected and published.

This second volume of the "Fauna" will contain supplementary reports by Mr. Thompson, Mr. Walker, Mr. Lomas, and others upon the groups they discussed in the former volume, and also a report upon the Fishes of the district by Mr. Moore, on the Diatomaceæ by Dr. Stolterfoth, on the other Algæ by Mr. Harvey Gibson and by Prof. Phillips, on the Ostracoda by Mr. W. S. McMillan, on the Echinodermata by Mr. Chadwick, on the Sponges by Dr. Hanitsch, and on various smaller groups by other authors.

The appended list of subscriptions and donations for the year, and the treasurer's balance sheet, show that although the Puffin Island institution is managed in a very economical manner, increased support will be necessary in order to keep the station in an efficient condition even on the present modest scale. In last year's report it was stated that a fixed income of £100 would be required to meet the necessary expenses. Our subscription list for the year falls short of that amount, and even with the strictest economy the expenditure has exceeded the income. The biological station is so useful, has shown such good results during its short existence and is so modest in its demands upon the general public, that the committee believe that they need only point out this unsatisfactory state of the finances in order to elicit a somewhat increased measure of support from those who are interested in the biological investigation of Liverpool Bay.

Applications to be allowed to work at the Biological Station, or for Specimens (living or preserved) for Museums, Laboratory Work, and Aquaria, should be addressed to Professor Herdman, University College, Liverpool.

Subscriptions and Donations should be sent to Mr. I. C. Thompson, F.L.S., 19, Waverley Road, Liverpool.



SUBSCRIPTIONS AND DONATIONS.

	Subscriptions.			Donations.		
	£	s.	d.	£	s.	d.
Bangor University College Students		—		0	5	0
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Bickersteth, Dr., 2, Rodney-street	2	2	0		—	
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McMillan, R., 20, Aubrey-street		—		0	12	0

	Subscriptions. £ s. d.	Donations. £ s. d.
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LIVERPOOL MARINE BIOLOGY COMMITTEE,

Dr. IN ACCOUNT WITH ISAAC C. THOMPSON, HON. TREASURER. Cr.

1888.	£	s.	d.
To Salaries of Curator and Boy	57	5	0
,, Repairs, paint, sail, oars, &c. of Launch and Boat	11	11	3
,, New Boat	8	0	0
,, Coal	6	13	4
,, Oil	2	0	3
,, Repairs to Dredge and Tow-nets	0	8	4
,, Carriage of Specimens, &c.	3	0	2
,, Printing and Stationery	8	10	0
,, Postages	3	10	3
,, Sundries	0	17	0
	£101	15	7
By Balance due Treasurer	£2	1	1

1888.	£	s.	d.
By Balance, 31st Dec., 1887	8	14	0
,, Subscriptions, as per list	73	17	0
,, Donations	17	3	6
,, Balance due Treasurer	2	1	1
	£101	15	7

ISAAC C. THOMPSON,
HON. TREASURER.

Audited and found correct,
ALFRED LEICESTER.

LIVERPOOL, 31*st December* 1888.

The COLEOPTEROUS FAUNA of the LIVERPOOL DISTRICT.

By John W. Ellis, L.R.C.P.E., F.E.S.

[Continued from Proceedings, Liverpool Biological Society, Vol. II., p. 220.]

Trichopterygidæ.

Trichopteryx atomaria, De G. Eastham and Spital, abundant.

Trichopteryx grandicollis, Mann. Abundant in dung near Spital, in August, 1884.

Trichopteryx fascicularis, Herbst. Prenton, on the edge of a pond, in April, 1883.

Trichopteryx bovina, Mots. A few specimens captured along with the preceding species at Prenton.

Ptenidium punctatum, Gyll. Abundant on Bidston Marsh, among flood refuse, September, 1884.

Ptenidium nitidum, Heer, = *pusillum*, Er. Taken commonly at Liscard.

Ptenidium evanescens, Marsh., = *apicale*, Er. Abundant.

Ptenidium formicetorum, Kr. Common about West Derby. I have taken a dark form of this species, which has not hitherto been noticed (returned to me as such by the Rev. Canon Fowler), at Prenton, where it was abundant in April, 1883.

Phalacridæ.

Phalacrus caricis, Sturm. Taken abundantly by sweeping a species of *Carex* near Ellesmere Port, in May, 1888 (J.W.E.).

Olibrus consimilis, Marsh. A single specimen taken at Wallasey, last September (J.W.E.).

COCCINELLIDÆ.

Hippodamia mutabilis, Scrib. Abundant on the coast sandhills.

Coccinella obliterata, L. Occasional on species of *Pinus* at Eastham, Bidston, and Storeton.

Coccinella bipunctata, L. Abundant.

Coccinella variabilis, F. Very abundant on oak at Eastham, on firs at Bidston and Storeton, and on birch on Simmonswood Moss.

Coccinella 11-punctata, L. Abundant, especially on the coast sandhills.

Coccinella hieroglyphica, L. Occurs sparingly on Simmonswood and other mosses.

Coccinella 7-punctata, L. Used to be common in the neighbourhood, but during the last ten years or so I have not seen a dozen specimens.

Coccinella oblongoguttata, L. Abundant on *Pinus sylvestris* at Storeton, in March and April.

Coccinella ocellata, L. Found sparingly with the last mentioned species.

Coccinella 18-guttata, L. Common at Bidston and Storeton on fir.

Coccinella 14-guttata, L. I took a specimen, some years ago, I believe by beating fir at Bidston.

Coccinella 22-punctata, L. Frequent by sweeping roadside herbage.

Micraspis 12-punctata, L. Thurstaston (J.H.S.); I have taken it at Bidston, among dead leaves of heather.

Chilochorus renipustulatus, Scriba. I have once taken this species at Bidston, on fir.

Chilochorus bipustulatus, L. A few specimens beaten from fir at Bidston (J.W.E.); Hightown (F. Archer).

Scymnus frontalis, F. Hightown, on the bank of the

Alt, among flood refuse, and at Crosby (J.W.E.). New Brighton (B. Cooke).

Scymnus discoideus, Ill. Common on (and flying around) firs at Storeton, Bidston, and Simmonswood Moss. In moss on old walls about Storeton during the winter.

Rhizobius litura, F. Abundant.

Coccidula rufa, Herbst. Common in damp places.

Colydiidæ.

Sarrotrium clavicorne, L. Found occasionally crawling on the bare sandhills at Crosby and Hightown.

Histeridæ.

Hister unicolor, L. This large and distinct species has occurred at Eastham and Wallasey.

Hister cadaverinus, Hoff. Abundant.

Hister carbonarius, Ill. Two specimens captured at Bromborough, in June, 1879 (J.W.E.).

Hister stercorarius, Hoff. I have a specimen that was taken in this neighbourhood by Mr. E. R. Curzon.

Hister bimaculatus, L. Used to be taken in dung about Kirkdale, by Mr. Kinder.

Hister 12-striatus, Sch. One specimen at Hightown (J.H.S.) and one at Wallasey (R.W.).

Saprinus nitidulus, Payk. Frequent on the sandhills.

Saprinus æneus, F. Abundant on the sandhills.

Saprinus quadristriatus, Hoff. Frequent on the sandhills on both sides of the river.

Saprinus maritimus, Steph. I took a few specimens under a dead rabbit, on the Crosby shore, in the spring of 1875, but have not seen any since.

Onthophilus striatus, F. Occasionally found in dung on the Wallasey sandhills.

Micropeplidæ.

Micropeplus porcatus, F. One taken on the bank of the Alt at Hightown and one at Crosby (J.W.E.).

Micropeplus margaritæ, Duv. Mrs. Ellis once took this species commonly on a wall at Liscard, in October. I have met with single specimens occasionally in the district.

Nitidulidæ.

Brachypterus pubescens, Er.

Brachypterus urticæ, F. Both these species are abundant on nettles and roadside herbage during the summer.

Meligethes rufipes, Gyll. Abundant on hawthorn flowers.

Meligethes æneus. Abundant everywhere, especially in hawthorn blossom.

Meligethes viridescens, F. Common in hawthorn blossom at Wallasey, and recorded by Mr. Archer from Rock Ferry.

Meligethes picipes, Sturm. Abundant.

Meligethes brunnicornis, Sturm. Occasionally by sweeping.

Meligethes lugubris, Sturm. A scarce species, of which I have taken two specimens by sweeping, among *Mentha*, at Hightown.

Epuræa æstiva, L. Abundant in flowers of hawthorn and mountain ash.

Epuræa angustula, Er. I took a specimen of this very rare species under the bark of an oak, at Eastham, in February, 1883.

Epuræa florea, Er. I have a specimen taken among *æstiva*, probably at Bromborough.

Nitidula bipustulata, L. Occasionally found on dead animals on the Crosby shore and at Aigburth.

Omosita colon, L. Common on carrion.

Omosita discoidea, F. With the preceding species, but not nearly so common.

Soronia punctatissima, Ill. I took a specimen on the Aigburth shore in June, 1875.

Rhizophagus depressus, F. Under bark of fir at Bidston, in March, 1883 (J.W.E.).

Rhizophagus perforatus, Er. Mrs. Ellis found two specimens in my own garden (Brougham Terrace) last May.

Rhizophagus dispar, Payk. Eastham Wood, under oak bark.

Rhizophagus bipustulatus, F. Abundant under bark of oak at Eastham during autumn and winter.

Rhizophagus cœruleipennis, Sahlb. Has been recorded as taken by Mr. Taylor at Crosby. If correct, this is a singular locality for an insect which is one of the rarest of British beetles, only three specimens having occurred, at Matlock.

TROGOSITIDÆ.

Tenebrioides (Trogosita) mauritanica, L. Occasional on the Crosby shore, under matting, &c., and common in bakehouses. Introduced.

MONOTOMIDÆ.

Monotoma picipes, Payk. Occasionally found flying in town.

LATHRIDIIDÆ.

Lathridius lardarius, De G. Common.

Coninomus nodifer, West. Abundant, especially on the Wallasey sandhills.

Enicmus minutus, L. Abundant.

Enicmus testaceus, Steph. I took a specimen of this usually uncommon species at Eastham, in June, 1885.

Enicmus transversus, Ol. Abundant in moss, &c., during the winter.

Corticaria punctulata, Marsh. Two specimens taken in haystack refuse at Moreton.

Corticaria crenulata, Gyll. Taken abundantly by sweeping at Lydiate, in September, 1887, and occasionally elsewhere.

Corticaria denticulata, Gyll. Frequent.

Corticaria serrata, Payk. Occasional; usually taken flying.

Corticaria fulva, Chev. Abundant.

Melanophthalma gibbosa, Herbst. In moss from a wall at Bromborough, in January, 1880 (J.W.E.).

Melanophthalma fuscula, Gyll. Abundant, especially in moss during the winter.

Cucujidæ.

Silvanus surinamensis, L. Common in grain warehouses. Introduced.

Læmophlæus ferrugineus, Steph. Mr. Kinder used to take this species in warehouses about the north docks.

Cryptophagidæ.

Telmatophilus caricis, Ol. Bidston Marsh and Spital (J.W.E.).

Antherophagus nigricornis, F. A single specimen in Eastham Wood, in September, 1885 (J.W.E.).

Cryptophagus pubescens, Sturm. A very scarce species, at once recognised by its two-jointed antennal club, of which I took a specimen at New Ferry some years ago.

Cryptophagus lycoperdi. Herbst. Abundant in the puff-ball fungus (*Lycoperdon*) in Eastham Wood.

Cryptophagus pilosus, Gyll. Fairly common.

Var. *punctipennis*, Bris. I have taken this very distinct variety at Bidston.

Cryptophagus saginatus, Sturm. Frequent.

Cryptophagus umbratus, Er. A specimen taken at Wallasey, in May, 1883 (J.W.E.).

Cryptophagus scanicus, L. Occasional.

Cryptophagus cellaris, Scop. Common.

Cryptophagus acutangulus, Gyll. I have a specimen taken somewhere in the district.

Cryptophagus dentatus, Herbst. The commonest of the genus in this district.

Cryptophagus vini, Panz. Very abundant on gorse, at Bidston and Prenton, in spring.

Paramecosoma melanocephala, Herbst. A single specimen taken at Spital (J.W.E.).

Atomaria fuscipes, Gyll. Spital and Wallasey, by sweeping.

Atomaria pusilla, Payk. Wallasey, Storeton, Eastham Wood, and Caldy (J.W.E.).

Atomaria atricapilla, Steph. Common.

Atomaria berolinensis, Kr. Taken sparingly at Bidston and Wallasey.

Atomaria fuscata, Steph. A specimen from Hightown (J.W.E.).

Atomaria mesomelas, Herbst. I have a specimen taken somewhere in the district.

Atomaria ruficornis, Marsh. Two specimens taken at Spital.

Ephistemus globosus, Waltl. Frequent in moss, &c.

Ephistemus gyrinoides, Marsh. Common.

Mycetophagidæ.

Typhœa fumata, L. Common.

Byturus sambuci, Scop. Occasional among the next species. Recorded by Mr. Archer from flowers of *Caltha palustris*, at Rock Ferry.

Byturus tomentosus, F. Common on bramble, &c.

Dermestidæ.

Dermestes vulpinus, F. Mr. Kinder used to take this destructive species frequently in skin-yards about Kirkdale; Mr. Wilding has met with a specimen at Wallasey.

Dermestes murinus, L. Common at Hightown in a dead bird on a single occasion (J.W.E.); Crosby (R.W.).

Dermestes lardarius, L. Abundant in provision warehouses, &c.

BYRRHIDÆ.

Byrrhus pilula, L. Common on dusty roads in spring and early summer.

Cytilus varius, F. Stanley Park (R.W.); Bidston Marsh (F.A.); Wallasey sandhills, Leasowe, and about West Derby (J.W.E.).

Simplocaria semistriata, F. Not uncommon in moss on old walls.

GEORYSSIDÆ.

Georyssus pygmæus, F. In a shallow pool at Crosby, in September, 1862 (F.A.); in damp places among the Hightown and Birkdale sandhills (J.W.E.).

PARNIDÆ.

Limnius tuberculatus, Müll. A single specimen taken in a damp place at Spital, in July, 1886 (J.W.E.).

Parnus prolifericornis, F. Two specimens are all I have seen in the district; one on the Hightown sandhills, in September, 1885, and one recently in a pit at Moreton.

Parnus auriculatus, Panz. Abundant on the Crosby and Hightown sandhills, and under stones behind the Leasowe Embankment.

HETEROCERIDÆ.

Heterocerus marginatus. F. Hightown, on the bank of the Alt (J.H.S., J.W.E.).

LAMELLICORNIA.

LUCANIDÆ.

Sinodendron cylindricum, L. Usually a common species, especially frequenting decaying ash trees, but recorded from this district only by Mr. Archer, from Childwall.

SCARABÆIDÆ.

Onthophagus fracticornis, Preys. Common on the sandhills on the Lancashire side of the Mersey, and very occasionally at Wallasey.

Aphodius subterraneus, L. Common on the Wallasey sandhills in summer.

Aphodius fossor, F. Common about Wallasey and Spital.

Aphodius hæmorrhoidalis, L. Frequent on the Wallasey sandhills in dung. Most of the specimens I have taken there are the var. *sanguinolentus*, Herbst, which has a distinct red humeral spot.

Aphodius scybalarius, F. Abundant throughout the year on the Wallasey sandhills. The form known as *conflagratus*, F., is commoner than the type; and the dark variety (*nigricans*, Muls.) is not uncommon.

Aphodius fœtens, L. Common at Wallasey in July.

Aphodius fimitarius, L. Abundant.

Aphodius ater, De G. Both the type form and the dull red *terrenus*, Kirby, are common in the fields near the Wallasey sandhills.

Aphodius granarius, L. Frequent at Wallasey and Crosby.

Aphodius sordidus, F. Occasionally common at Wallasey.

Aphodius rufescens, F. Usually common at Wallasey in July.

Aphodius nitidulus, F. Taken by Mr. Wilding and myself at Wallasey.

Aphodius plagiatus, L. Not uncommon on the Wallasey sandhills. I have never found this species in dung, like the rest of the genus, but usually buried in the sand under "rejectamenta" at the margins of the "flashes." The type form, with the bright red streak on each elytron,

is very scarce, most of the specimens being the unicolorous black *niger*, Pz.

Aphodius inquinatus, F. Very abundant, and very variable, on the Lancashire and Cheshire coast sandhills. One of the earliest to appear in spring.

(*Aphodius melanostictus*, Schmidt. I have three specimens captured on our sandhills which have been referred to this species, but I have recently pointed out in a paper read before the Entomological Society of London* that the British specimens of (so called) *melanostictus*, Schmidt, are not that species, but varieties of *inquinatus*, in which by the coalescence of the elytral spots the dark markings have become band-like, forming in an extreme degree of this coalescence the variety *centrolineatus*, Panz.)

Aphodius conspurcatus, L. Common on the Wallasey sandhills in early spring.

Aphodius porcus, F. A very interesting species, said to inhabit the burrows of *Geotrupes*, about half a dozen specimens of which have been recently taken by Mr. Wilding at Wallasey.

Aphodius scrofa, F. A very scarce beetle, of which for many years the only veritable British example was one taken by Mr Sidebotham, at Southport, about 1865 or 1866 (Ent. Monthly Mag., vol. v., p. 100).

Aphodius pusillus, Herbst. Common on the coast sandhills.

Aphodius merdarius, F. Abundant on the Wallasey sandhills.

Aphodius prodromus, Brahm. Common throughout the district.

Aphodius punctatosulcatus, Sturm. Abundant everywhere throughout the whole year. I have taken some peculiar dark specimens at Leasowe.

* Proceedings, Ent. Soc. Lond., 1888, p. 15.

Aphodius contaminatus, Herbst. A late species, appearing usually about August or September, and though uncertain in its appearance, generally common on the Wallasey sandhills and Bidston Hill.

Aphodius obliteratus, Panz. I took several specimens of this species some years ago in Patrick Wood, near Bromborough. They occurred in the dung of tame zebus, in October.

Aphodius rufipes, L. Very abundant. Mr. Wilding has observed this species flying round gas-lamps at night.

Aphodius luridus, F. A specimen brought me from Hale, some years ago, is all I have seen in the district. Recorded from Crosby by Mr. Archer.

Aphodius depressus, Kug. Taken commonly on the Wallasey sandhills, a few years ago, by Mr. Wilding.

Oxyomus villosus, Gyll. An exceedingly scarce British insect, of which Mr. B. Cooke took a specimen at Southport, on 19th June, 1858 (Ent. Monthly Mag., vol. v., p. 44). Mr. Wilding has been fortunate in taking a single specimen at Wallasey.

Oxyomus porcatus, F. A few specimens in dry dung on the Crosby shore (J.W.E.).

Psammobius sulcicollis, Ill. Occasional on the Crosby and Hightown sandhills.

Ægialia sabuleti, Pk. Taken by Mr. Archer at New Brighton, in May, 1863.

Ægialia rufa, F. The only known British locality for this species is Wallasey, from whence it was first recorded as British by Mr. Archer (Liverpool Naturalists' Scrap Book, p. 186), who took the species in June, 1862. No more specimens seem to have occurred until 1883, when Mr. Wilding took two, but during 1885 and 1886 it occurred freely.

Ægialia arenaria, F. Abundant on the sandhills in spring.

Geotrupes typhœus, L. Taken by Mr. Willoughby Gardner at Caldy and Storeton.

Geotrupes stercorarius, L. Abundant.

Geotrupes spiniger, Marsh., = *mesoleius*, Thoms. Abundant.

Geotrupes sylvaticus, Panz. Common about Eastham and Spital.

Serica brunnea, L. Common in woods at the roots of bracken; and frequently seen flying round gas-lamps at Mossley Hill, &c., when they may be easily mistaken for *Noctuæ*.

Melolontha vulgaris, F. Generally distributed throughout the district, but not very common.

Phyllopertha horticola, L. Common about Eastham, on mountain ash. In June, 1883, it was exceedingly abundant in flowers of *Rosa spinosissima* on the Wallasey sandhills, and Mr. Smedley was fortunate in capturing a perfectly black specimen. Mr. Archer took a similar specimen at Rock Ferry, in June, 1862.

Anomala Frischii, F. Common on the sandhills on hot days in July and August.

(*Oxytherea stictica*, previously recorded as captured by Messrs. Edleston and Sidebotham on the Lancashire coast, was not taken in our district, but at Grange.)

Cetonia aurata, L. The Rev. H. H. Higgins informs me that he has seen this species in the garden of the Rainhill Asylum, but not within very recent years.

SERRICORNIA.

Elateridæ.

Lacon murinus, L. Not uncommon on the Wallasey sandhills.

Elater balteatus, L. Frequent on Simmonswood Moss, on birch, in June and July.

Cryptohypnus riparius, F. Common and generally distributed.

Cryptohypnus quadripustulatus, F. A single specimen captured by sweeping low herbage on the canal bank at Maghull (J.W.E.).

Melanotus rufipes, Herbst. A specimen taken in Eastham Wood, February, 1884, is all I have seen in the district.

Limonius cylindricus, Payk. Common on the coast sandhills in early summer.

Athous niger, L. Taken by Mr. Smedley, at Tranmere, flying round an old tree.

Athous hæmorrhoidalis, F. Common throughout the district, especially on oak.

(From the frequent occurrence of *Corymbites pectinicornis*, L., *C. cupreus*, F., and *C. quercus*, Gyll. (with the variety *ochropterus*, Steph., of the latter) on Chat Moss, I feel sure that all three will be found on Simmonswood Moss.)

Agriotes sputator, L. Common.

Agriotes lineatus, L. Occasional.

Agriotes obscurus, L. Abundant.

Agriotes pallidulus, Ill. Abundant on nettles and other roadside herbage.

Dolopius marginatus, L. Common on oaks in Eastham Wood.

Adrastus limbatus, F. Frequent on low herbage.

Campylus linearis, L. Frequent on Simmonswood Moss in June, the males flying in the sunshine.

Dascillidæ.

Helodes minutus, L. A pair taken on Simmonswood Moss (J.W.E.).

Helodes marginatus, F. Recorded from the Liverpool district in Stephens's "Manual of British Beetles," I know not on whose authority.

Cyphon coarctatus, Pk. Rock Ferry (F. Archer); Spital (J.W.E.).

Cyphon nitidulus, Thoms. Common in damp places.

Cyphon variabilis, Thunb. Common among reeds.

LAMPYRIDÆ.

Lampyris noctiluca, L. Local and not common. Mr. W. Gardner informs me that he has seen the female glow-worm between Hooton and Willaston; and Mr. Gregson tells me he has frequently found it on the clay banks on the New Ferry shore of the Mersey.

TELEPHORIDÆ.

Telephorus fuscus, L. Occasional.

Telephorus rusticus, Fall. Common.

Telephorus lividus, L. Common.

Telephorus lituratus, Fall. Common.

Telephorus pellucidus, F. West Derby (R.W.).

Telephorus nigricans, Müll. Occasional.

Telephorus bicolor, F. Abundant.

Telephorus hæmorrhoidalis, F. Taken by Mr. W. Gardner at Denhall.

Telephorus thoracicus, Gyll. Abundant on the banks of the Alt at Hightown.

Telephorus flavilabris, Fall. Taken with the preceding species.

Telephorus fuscicornis, Ol. Taken at Tranmere by Mr. Gardner.

Telephorus fulvus, Scop. Abundant.

Telephorus testaceus, L., and the var. *limbatus*, Thoms. Common.

Telephorus pallidus, F. Frequent.

Malthinus punctatus, Fourc. Spital, in July, 1886 (J.W.E).

Malthodes marginatus, Latr. Taken in Eastham Wood by Mr. Wilding and myself.

Melyridæ.

Malachius bipustulatus, L. Bromborough, in flowers of *Cardamine pratensis* (R.W.).

Cleridæ.

Necrobia violacea, L. I once took several specimens of this infrequent species in a dead bird on the Aigburth shore.

Necrobia rufipes, F. Common in decaying animal matter.

Cissidæ.

Cis boleti, Scop. Abundant.

Cis villosulus, Marsh. Near Childwall, in November, 1862 (F. Archer).

Octotemnus glabriculus, Gyll. Abundant in fungi in the neighbourhood of Prenton.

Ptinidæ.

Rhizopertha pusilla, F. Mr. Kinder used to take this species commonly in warehouses at the north end of Liverpool.

Priobium castaneum, F. Eastham Wood, in a dead tree, on a single occasion (R.W.).

Anobium domesticum, Fourc. Common in the woodwork of old houses and in old furniture.

Anobium paniceum, L. Common in druggists' shops, where it sometimes does much damage by feeding on dried roots, &c. No matter how poisonous—aconite, belladonna, hellebore, for instance—no root comes amiss to this marauder.

Niptus hololeucus, Fald. Common in cupboards, generally

in glass vessels into which it has fallen, and frequently mistaken for a golden-haired spider.

Ptinus sexpunctatus, Panz. Taken at Tranmere by Mr. Willoughby Gardner.

Ptinus fur, L. Taken by myself on a single occasion, among garden rubbish, at Wallasey.

LONGICORNIA.

Cerambicidæ.

Aromia moschata, L. The musk-beetle used to occur freely on willows between Waterloo and Crosby, and it still may be found about Hightown. Mr. Gregson informs me that it occurs in lanes about Wallasey, and I have heard of its being taken about Garston.

Clytus arietis, L. Occasionally found sunning itself on gate-posts, &c., in which it has lived in its larval state. I have a specimen taken in Stanley Street, Liverpool.

Lamiidæ.

Leiopus nebulosus, L. Eastham Wood, single specimens having been taken there by Mr. Wilding and myself.

Pogonocherus pilosus, F., = *hispidus*, Fourc. Eastham Wood, a single specimen, in May, 1883 (J.W.E.).

Lepturidæ.

Rhagium inquisitor, L. Frequent in Eastham Wood and in the fir-plantations about Bidston and Storeton.

Rhagium bifasciatum, F. In similar localities to the preceding species.

Strangalia armata, Herbst. Taken by Mr. Gardner at Raby Mere.

Grammoptera ruficornis, F. Captured on hawthorn blossom at Rock Ferry and Eastham, in June, 1862, by Mr. Archer.

MONILICORNIA.

Chrysomelidæ.

Donacia bidens, Ol. I once took this species in profusion in a pond between Liscard and Wallasey, on leaves of *Potamogeton natans*.

Donacia sagittariæ, F. I swept a specimen from a ditch side between Crosby and Hightown some years ago.

Donacia lemnæ, F. A single specimen from Moreton last April.

Donacia sericea, L. Rock Ferry (F. Archer).

Zeugophora subspinosa, F. Common on poplars and aspens around Formby.

Lema cyanella, F. Frequently taken by roadside sweeping about Spital.

Lema melanopa, L. In similar situations to the preceding species, but not quite so frequent.

Cryptocephalus aureolus, Schiff. Taken on the flowers of *Hieraceum pilosella* and *Taraxacum* on the Wallasey sandhills, in May and June, by Mr. Archer; also found there by Mr. Wilding.

Chrysomela staphylæa, L. Common among flood refuse on the Hightown and Aigburth shores; also at Eastham, under stones.

Chrysomela Goettingensis, L. This fine species has been taken in some numbers at Burton by Mr. Gardner.

Chrysomela hæmoptera, L. I have on several occasions picked up specimens of this species on Leasowe Marsh.

Chrysomela polita, L. Occasional.

Chrysomela hyperici, Forst. A single specimen taken (hibernating) at the foot of a tree in Eastham Wood (J.W.E.).

Gastrophysa polygoni, L. Common.

Gastrophysa raphani, F. Bidston Marsh and Moreton (J.W.E.).

Phædon tumidulum, Germ. Frequent.

Phædon cochleariæ, F. Common in moss growing on the bridges crossing the Fender, on Bidston Marsh, and occasionally obtained elsewhere by sweeping.

Phratora cavifrons, Thoms. Under bark at Bromborough, in December.

Phratora vitellinæ, L. Abundant on osiers about Formby.

Prasocuris marginella, L. Frequent in damp places about Liscard.

Prasocuris phellandrii, L. Common on water plants about Moreton and Liscard.

Prasocuris beccabunga, Ill. Taken on Bidston Marsh by Mr. Archer.

Adimonia tanaceti, L. Recorded from the New Brighton sandhills, in October, by Mr. Archer.

Adimonia suturalis, Thoms. Plentiful, on heather, on Oxton Heath and Bidston Hill.

Galeruca calmariensis, L. Taken in some numbers by sweeping willowherb, &c., at Lydiate, in August, 1887 (J.W.E.).

Agelastica halensis, L. Abundant, during autumn, on the Wallasey and Hoylake sandhills, among *Galium verum*.

Luperus betulinus, Fourc. Once taken by sweeping on the Wallasey sandhills, in July.

Halticidæ.

Haltica ericeti, All. Very abundant, in October, 1888, among heather on Oxton Heath.

Crepidodera transversa, Marsh. Frequent on marshy ground at the mouth of the Alt at Hightown (J.W.E.); taken by Mr. Archer at Crosby.

Crepidodera ferruginea, Scop. Abundant.

Crepidodera aurata, Marsh. Once taken by sweeping at Bromborough (J.W.E.).

Crepidodera modeeri, L. Crosby (R.W.) and Wallasey (J.W.E.).

Mantura rustica, L. Occasional at Wallasey and Crosby.

Phyllotreta undulata, Kuts. Abundant on roadside herbage.

Phyllotreta sinuata, Steph. Taken by myself at Leasowe and Bromborough.

Phyllotreta brassicæ, F. Among haystack refuse at Leasowe, in October (J.W.E.).

Plectroscelis concinna, Marsh. Common.

Thyamis lurida, Scop. Common on roadside herbage, &c.

Thyamis thoracica, Steph., var. *fuscicollis*, Steph. Common at Aigburth and Spital.

Thyamis tabida, Panz. Common on *Senecio Jacobœa* on the coast.

Thyamis ochroleuca, Marsh. I have taken two specimens in the district, one at Spital, the other at Hightown.

Psylliodes chrysocephala, L. Taken by myself at Crosby.

Psylliodes marcida, Ill. Wallasey sandhills on *Rumex*. Not uncommon.

Psylliodes cupronitens, Forst. Wallasey and Lydiate (J.W.E.).

Psylliodes affinis, Payk. Common on the Wallasey and Hightown sandhills.

Psylliodes picina, Marsh. Taken by myself at Formby and Hightown.

Apteropeda graminis, Panz. Once taken on Bidston Hill (J.W.E.).

Sphæroderma testacea, F. Not uncommon on thistles at Crosby and Hightown.

Cassididæ.

Cassida vibex, L. Taken at Hightown, in September, 1862, by Mr. Archer.

Cassida sanguinolenta, F. On the clay banks of the Mersey at Aigburth, and on the Wallasey sandhills (J.W.E.).

Cassida obsoleta, Ill. Taken at Southport, in September, 1864, by Benjamin Cooke.

HETEROMERA.

Tenebrionidæ.

Blaps mucronata, Latr. Abundant in cellars.

Blaps mortisaga, L. I have a specimen that was captured in Liverpool, and taken to Mr. Gregson as a "Colorado beetle."

Heliopathes gibbus, F. Abundant on the coast sandhills.

Opatrum sabulosum L. Recorded from New Brighton by Mr. Archer.

Microzoum tibiale, F. Common on the coast sandhills.

Tribolium ferrugineum, F. Occurs occasionally among provisions. Probably imported.

Gnathocerus cornutus, F. Mr. Kinder used to take this species freely in warehouses at the north end of Liverpool.

Palorus (Hypophlæus) depressus, F. Taken freely by Mr. Kinder.

Alphitobius piceus, Ol. Frequent in bakehouses and cellars.

Tenebrio obscurus, F. Frequent, but not so common as the following.

Tenebrio moliter, L. This, the common meal-worm beetle, is abundant in bakehouses, &c.

Helops pallidus, Curt. Taken at New Brighton, in September, 1858, by Benjamin Cooke.

Helops striatus, Fourc. Abundant under loose bark during the winter, especially about Bidston.

CISTELIDÆ.

Cistela murina, L. Common on the coast sandhills, being very partial to the flowers of *Rosa spinosissima*.

LAGRIIDÆ.

Lagria hirta, L. Occasionally common on the dwarf sallows on the Crosby and Wallasey sandhills, but very uncertain in its appearance.

MELANDRYIDÆ.

Phlœotrya Stephensi, Duv. Bred from decayed birch from Simmonswood Moss by Mr. G. A. Harker.

Melandrya caraboides, L. Crosby, in June, 1862 (F. Archer).

PYTHIDÆ.

Salpingus ater, Payk. Taken in some numbers in July, 1882, by sweeping near Bromborough (J.W.E.).

Rhinosimus viridipennis, Steph. West Derby (R.W.) and Aigburth (J.W.E.); in both cases under bark.

Rhinosimus planirostris, F. Common under bark.

PYROCHROIDÆ.

Pyrochroa serraticornis, Scop., = *rubens*, F. Bred freely by Mr. Smedley and myself from larvæ and pupæ found in a dead poplar on the borders of the Wallasey sandhills. We also captured the *imagines* in the same locality.

ANTHICIDÆ.

Notoxus monoceros, L. Frequent on the coast sandhills.

Anthicus bimaculatus, Ill. A very scarce British species, of which several specimens have occurred in our district. Mr. Chappell once took six specimens under a dead bird on the Southport shore; Mr. Broadhurst took a specimen in the same place, in June, 1867 (Ent. Monthly Mag., vol.

iv., p. 232); single specimens have occurred to Mr. Kinder, Mr. Wilding, and to myself, at Crosby; and to Mr. J. T. Harris at New Brighton, in 1873 (Ent. Monthly Mag., vol. xiv., p. 238).

Anthicus floralis, L. Frequent in flowers, &c.

Œdemeridæ.

Nacerdes melanura, L. On the shore of the Mersey at Aigburth and Bromborough Pool (J. W. E.); Mr. W. Johnson once sent me a large number taken under a workshop floor near the Liverpool docks.

Cantharidæ.

Meloe proscarabæus, L. Common in spring on dry sandy roadsides, where there are burrows of *Andrenidæ* (wild bees).

Meloe violaceus, Marsh. I have a single specimen, which I took on Bidston Hill.

Mordellidæ.

Anaspis frontalis, L. Common in flowers.

Anaspis ruficollis, F. Common.

Anaspis melanopa, Forst. Abundant, especially in the flowers of hawthorn and mountain ash.

Mordella fasciata, F. A specimen in the Liverpool Free Public Museum was taken by the Rev. H. H. Higgins at Rainhill.

RHYNCHOPHORA.

Rhynchitidæ.

Rhynchites germanicus, Herbst. Common on various plants.

Rhynchites nanus, Payk. Taken at Southport by Benjamin Cooke, and at Crosby and Hightown by myself.

APIONIDÆ.

Apion carduorum, Kirby. Common.

Apion onopordi, Kirby. Two specimens taken at Willaston, August, 1887 (J.W.E.).

Apion annulipes, Wenck. Of the three known British specimens of this species, I possess the only male, which I have taken, I believe, on the Wallasey sandhills.

Apion ulicis, Forst. Abundant on gorse at Bidston and Prenton, in spring.

Apion striatum, Kirby. Common.

Apion immune, Kirby. Bidston (J.W.E.).

Apion pubescens, Kirby. Willaston, August, 1887 (J.W.E.).

Apion seniculum, Kirby. I have taken three specimens in the district: one at Willaston, one at Wallasey, and one in haystack refuse at Moreton.

Apion viciæ, Payk. Bidston and Spital (J.W.E.).

Apion ononidis, Germ. Abundant on the Wallasey sandhills, among *Ononis arvensis*.

Apion flavipes, F. Spital (J.W.E.).

Apion nigritarse, Kirby. Spital and Eastham occasionally (J.W.E.).

Apion ebeninum, Kirby. Three specimens taken at Wallasey by sweeping (J.W.E.).

Apion virens, Herbst. Common in Wirral on roadside herbage during the summer, and (hibernating) in moss on walls during the winter.

Apion platalea, Germ. Spital, a single specimen in May, 1883 (J.W.E.).

Apion ervi, Kirby. Common.

Apion ononis, Kirby. Common at Wallasey, among *Ononis arvensis*.

Apion pisi, F. Common.

Apion scutellare, Kirby. Bidston, not uncommon.

Apion Spencei, Kirby. Common at Bidston and Wallasey.

Apion vorax, Herbst. Frequent.

Apion livescerum, Gyll. Bidston Hill on heather, July (J.W.E.).

Apion miniatum, Germ. Frequent.

Apion cruentatum, Walt. Occasional.

Apion frumentarium, L. Occasional.

Apion rubens, Steph. Taken at Lydiate in August, 1887 (R.W.).

Apion violaceum, Kirby. Abundant.

Apion marchicum, Herbst. Frequent at Bidston.

Apion humile, Germ. Abundant.

Otiorhynchidæ.

Tropiphorus mercurialis, F. Taken sparingly on the wall of Anfield Cemetery by Mr. Kinder.

Barynotus obscurus, F. Frequent.

Cneorhinus geminatus, F. Abundant on the coast sand-hills in spring.

Strophosomus coryli, F. Common in hedges.

Strophosomus limbatus, F. Common on heather on Bidston Hill and Oxton Common.

Platytarsus echinatus, Bons. I took a specimen of this hedgehog-like beetle by sweeping at Aigburth, in May, 1886.

Sciaphilus muricatus, F. Occasional.

Polydrosus planifrons, Gyll. I captured a single specimen of this rare species by sweeping at Lydiate, in August, 1887.

Polydrosus cervinus, L. Common on the dwarf sallows growing among the coast sandhills.

Polydrosus confluens, Steph. Occasionally swept from heather on Bidston Hill, in July.

Phyllobius alneti, F. Abundant among nettles during the early summer.

Phyllobius pyri, L. Common on oak at Eastham, July.

Phyllobius argentatus, L. Abundant on hawthorn hedges.

Phyllobius oblongus, L. Common on the dwarf sallows on the coast sandhills.

Phyllobius pomonæ, Ol. Very abundant in July on the coast sandhills. Probably feeds on *Rosa spinosissima*.

Phyllobius uniformis, Marsh. Common, by roadside sweeping, in Wirral.

Otiorhynchus scabrosus, Marsh. Mr. Wilding has taken a specimen at Wallasey, and I have one that I found at Aigburth.

Otiorhynchus ligneus, Ol. Occasional at Leasowe, Wallasey, and Bidston.

Otiorhynchus picipes, F. Very abundant on hawthorn hedges, &c.

Otiorhynchus sulcatus, F. Generally distributed throughout the district, but scarcely common.

Otiorhynchus ovatus, L. Common on the coast sandhills.

Sitones griseus, F. Abundant in spring on the coast sandhills. All our specimens are considerably darker than specimens in my collection from the south coast.

Sitones flavescens, Marsh. Common.

Sitones suturalis, Steph. Abundant.

Sitones sulcifrons, Thunb. Common.

Sitones tibialis, Herbst. Bidston, but not common there.

Sitones Regensteinensis, Herbst. Abundant on gorse during spring.

Sitones lineatus, L. Abundant.

Sitones hispidulus, F. Common.

Liosoma ovatulum, Clair. Common.

Cleonus sulcirostris, L. Common, sometimes in profusion, on the Crosby and Hightown sandhills among thistles.

Alophus triguttatus, F. Mr. Wilding has taken this

species at Heswall, and I have met with a few specimens under stones behind Leasowe Embankment.

Hypera punctata, F. Occurs very occasionally both inland and on the coast sandhills.

Hypera plantaginis, De G. Common, and at times abundant, on the coast sandhills.

Hypera murinus, L. A pair taken at Crosby by Mr. Chappell, at Easter.

Hypera variabilis, Herbst. Common on the Wallasey sandhills.

Hypera polygoni, L. Wallasey (R.W.) and on the Aigburth clay banks and at Formby (J.W.E.).

Hypera nigrirostris, F. Abundant on the coast sandhills.

Hypera trilineata, Marsh. Two specimens at Wallasey (J.W.E.).

Hylobius abietis, L. Common a few years ago in the fir plantations at Bidston.

Grypidius equiseti, F. Common on the Wallasey sandhills in spring.

Erirhinus bimaculatus, F. Occasionally found in flood refuse brought down the Alt; and Mrs. Ellis has found it behind Leasowe Embankment.

Erirhinus acridulus, L. Common among flood refuse and among water plants.

Mecinus pyraster, Herbst. Common.

Mecinus circulatus, Marsh. Taken on the Wallasey sandhills, in spring, by Mr. Chappell.

Tanysphyrus lemnæ, F. Common on *Lemna* in a pit at Moreton.

Hydronomus alismatis, Marsh. Taken abundantly by Mr. Kinder in pits about Kirkdale, and by Mr. Wilding and myself on *Alisma plantago* at Leasowe.

Anthonomus ulmi, De G. A single specimen taken some years ago at Wavertree (J.W.E.).

Anthonomus pomorum, L. Frequent on hawthorn blossom at Bromborough.

Anthonomus rubi, Herbst. Common.

Orchestes stigma, Germ. A single specimen at Simmonswood, in June, 1885 (J.W.E.).

Orchestes salicis, L. Frequent among sallows on the coast sandhills.

Rhamphus flavicornis, Clair. Common in spring on the sandhills, but much easier to see in the sweeping-net than to bottle.

Nanophyes lythri, F. Swept from *Lythrum salicaria* at Lydiate, in August, 1887; also taken at Spital (J.W.E.).

Cionus pulchellus, Herbst. Taken by Mr. Wilding at Burton, on *Verbascum*.

Orobitis cyaneus, L. Occasional on the coast sandhills, on *Viola*.

Cœliodes fuliginosus, Marsh. Wallasey, in March, 1887; a single specimen (J.W.E.).

Cœliodes quadrimaculatus, L. Very abundant on nettles.

Ceuthorrhynchus assimilis, Payk. Common on *Cruciferæ*.

Ceuthorrhynchus erysimi, F. Common.

Ceuthorrhynchus contractus, Marsh. Abundant.

Ceuthorrhynchus cochleariæ, Gyll. I took a few specimens of this species on the Aigburth shore, in May, 1883.

Ceuthorrhynchus ericæ, Gyll. Frequent on heather on Simmonswood Moss and Bidston Hill.

Ceuthorrhynchus litura, F. A single specimen, taken at Wavertree in 1874 (J.W.E.). Said to be found on thistles standing in the middle of fields.

Ceuthorrhynchus asperifoliarum, Gyll. Southport, May, 1858 (B. Cooke).

Ceuthorrhynchus arcuatus, Herbst. A rare species, taken at Southport by Mr. Prescott (as I am informed by Mr. Chappell).

Ceuthorrhynchus quadridens, Panz. I took a specimen at Wallasey, in May, 1884.

Ceuthorrhynchus pollinarius, Forst. Abundant.

Ceuthorrhynchus sulcicollis, Gyll. Southport, in September, 1864 (B. Cooke).

Ceuthorrhynchideus floralis, Payk. Common.

Ceuthorrhynchideus pyrrhorhynchus, Marsh. Freely in October by beating the nearly bare stalks of *Sisymbrium officinale* on the roadside between Wallasey and Leasowe (J.W. E.).

Ceuthorrhynchideus troglodytes, F. Frequently taken by roadside sweeping.

Rhinonchus pericarpius, F. Frequent.

Rhinonchus subfasciatus, Gyll. Generally distributed.

Rhinonchus castor, F. Crosby and Hightown, occasionally (J.W.E.).

Phytobius quadrituberculatus, F. Sparingly on the Hightown sandhills (J.W. E.).

Phytobius comari, Herbst. A specimen captured at Hale by Mr. J. Kidson Taylor (Ent. Monthly Mag., vol. v., p. 201).

Phytobius quadrinodosus, Gyll. Taken by Mr. Chappell on pieces of chip, &c., in pools behind Leasowe Embankment.

Litodactylus leucogaster, Marsh. Taken by Mr. Chappell under the same circumstances as the preceding; also at Liscard by Mr. Wilding, and on Bidston Marsh by Mr. Archer.

Eubrychius velatus, Beck. A single specimen taken at Wallasey (J.W.E.).

Poophagus sisymbrii, F. Common on water plants in pits at Moreton, in May.

Baris chlorizans, Germ. I have a specimen of this rare species that I took on Bidston Marsh, in March, 1883.

Balaninus glandium, Marsh. Frequent on oak in Eastham Wood. The larva feeds in acorns.

Calandridæ.

Calandra granaria, L. Common in grain warehouses.

Calandra orizæ, L. Taken by Mr. Wilding in rice mills in the city.

Scolytidæ.

Hylastes ater, Payk. Rock Ferry, May, 1862 (F. Archer).

Hylastes palliatus, Gyll. A single specimen taken on Leasowe Marsh, May, 1888.

Phlœopthorus rhododactylus, Marsh. Bidston Marsh, in April, 1862 (F. Archer); several specimens beaten from dead sticks of gorse at Bidston (J.W.E.).

Hylesinus crenatus, F. Mr. Wildiug has specimens taken in bark of ash at Knotty Ash.

Scolytus destructor, Ol. I have several times met with the work of this destructive insect, and dead specimens in the burrows, but have never found a living specimen.

Tomicus laricis, F. Mrs. Ellis found a specimen of this species blowing about on the Hightown sandhills, in September, 1885.

Cryphalus binodulus, Ratz. I found a single specimen on the Wallasey sandhills, in May, 1883.

Dryocœtes villosus, F. I once took a considerable number in a dead oak at Spital.

ADDENDA.

Additional Species.

Stenolophus vespertinus, Panz. A specimen captured on the Ince Marshes, 14th May, 1888 (J.W.E.).

Hydroporus vittula, Er. Common at Moreton; a specimen also from Wallasey.

Limnebius nitidus, Marsh. Several specimens taken at Moreton, in April and May, 1888.

Hydræna testacea, Curt. Liscard, in May last (R.W.).

Anisotoma macropus, Rye. A single specimen at Leasowe, October, 1886 (J.W.E.).

Anisotoma furva, Er. Taken by Mr. Wilding at Crosby, and at Wallasey by myself, last autumn.

Anisotoma ciliaris, Schm. Two specimens taken at Wallasey (R.W.).

Pselaphus Heisei, Herbst. A specimen found at Bromborough in grass at tree-roots, last November (J.W.E.).

Oligota inflata, Mann. Abundant in haystack refuse at Moreton, March, 1888.

Heterothops dissimilis, Grav. A specimen taken at Moreton, 31st March, 1888.

Bledius pallipes, Grav. A single specimen captured among *B. arenarius*, on the Birkdale shore, 12th May, 1888.

Homalium riparium, Thoms. Several specimens taken under seaweed on the Wallasey shore.

Additional Localities, &c.

Dyschirius nitidus, Dej. Puddington marshes, common (R.W.).

Dyschirius salinus, Schaum. Puddington (R.W.).

Bembidium normannum, Dej. Puddington (R.W.).

Bembidium varium, Ol. Taken commonly on the Dee shore about Puddington by Mr. W. E. Sharp.

Hydroporus lituratus, F. Common in pits at Moreton, April, 1888.

Hydroporus nigrita, F. Several specimens at Moreton, last March.

Ilybius obscurus, Marsh. Several specimens in a pit at Moreton, last spring.

Laccobius minutus, L. A specimen of the form *bipunctatus*, F., captured at Moreton.

Laccobius nigriceps var. *alutaceus*, Thoms. Abundant in ponds and ditches at Moreton.

Helophorus æneipennis, Thoms. Very abundant at Moreton in a ditch, on the right of the road leading from the station to Leasowe embankment.

Helophorus arvernicus, Muls. A second specimen, taken at Hightown last April.

Agathidium marginatum, Sturm. A specimen from Hightown last April.

Homalota elongatula, Grav. Several specimens taken at Moreton.

Homalota vicina, Steph. Ince marshes, May, 1884 (J.W.E.)

Homalota trinotata, Kr. Abundant in haystack refuse, at Moreton, last March.

Philonthus micans, Grav. A specimen captured at Wallasey last May.

Stenus foveiventris, Fairm. A few specimens on the bank of a pit at Moreton.

Stenus binotatus, Ljun. Common in the same situation as the preceding species.

Stenus cicindeloides, Grav. Mr. Rye remarks (Ent. Monthly Mag., vol. iii.) that the male of this species is very rare. I took a male at Leasowe last April.

Summary.

	British Species.*	Species recorded from the Liverpool District.
Geodephaga	300	163
Hydradephaga	133	66
Palpicornia	93	49
Brachelytra	768	250
Clavicornia	670	156
Lamellicornia	90	42
Serricornia	224	50
Longicornia	57	8
Monilicornia	251	51
Heteromera	124	31
Rhynchophora	517	124
Total	3227	990

Being 30 *per cent* of the British species.

* Fowler and Matthews's list, 1883.

REPORT on a Collection of TOW-NET GATHERINGS made by T. C. Ryley, Esq., on the WEST COAST of NORWAY, up to the North Cape, during June and July, 1888.

By Isaac C. Thompson, F.L.S., F.R.M.S.

[Read 11th January, 1889.]

The collection which furnished the material from which this report is drawn up was made by Mr. Ryley during a summer cruise of the steam yacht "Argo," belonging to Alfred Holt, Esq., of Liverpool.

Mr. Ryley was furnished with one of the very fine-meshed tow-nets of the "Challenger" pattern, and all the material kept was at once transferred to bottles containing a preservative solution composed of glycerine, water and alcohol, with boric acid as an antiseptic.

Thirteen bottles of material in all were obtained, each bottle being numbered and corresponding to a note entered at the time, with particulars as to date, time of day, locality, general atmospheric conditions, &c. The entire contents of every bottle I have examined under the microscope. As might be expected, the vast proportion of the material consists of Copepoda, sixteen species being obtained. The rest consists chiefly of quantities of the marine Cladoceran *Evadne nordmanni*, a few Amphipoda, Schizopoda, Cirripedia, various larval Crustacea, Annelids, Appendicularia, Medusæ, Peridineæ, and fish ova.

The various species may be classified as follows:—

PROTOZOA.

FLAGELLATA.

Ceratium tripos.

CŒLENTERATA.

Numbers of small Medusæ.

VERMES.

Two or three forms not identified.

ARTHROPODA.

CRUSTACEA.

CLADOCERA.

Evadne nordmanni, Lovén.

OSTRACODA.

A few isolated specimens.

COPEPODA.

Calanidæ.

Calanus finmarchicus, Günner.
Pseudocalanus elongatus, Boeck.
Scolocithrix minor, Brady.
Dias longiremis, Lilljeborg.
Acartia laxa, Dana.
Temora longicornis, Müller.
Centropages hamatus, Lilljeborg.
Isias clavipes, Boeck.

Pontellidæ.

Pontella inermis, Brady.

Cyclopidæ.

Oithona spinifrons, Boeck.
Oithona challengerii, Brady.

Harpacticidæ.

Dactylopus similis, Claus.
Idya furcata, Baird.
Zaus spinatus, Goodsir.
Harpacticus chelifer, Müller.
Harpacticus flexus, Brady and Robertson.

CIRRIPEDIA.

Quantities of larval *Balanus*.

AMPHIPODA.

Gammarus neglectus.

SCHIZOPODA.

Several forms not identified.

TUNICATA.

Appendicularia.

The tow-net was thrown over upon the "slowing" of the steamer at the various stopping places, and pulled along at or near the surface as specified for as long a time as the stopping of the engines allowed.

Of the thirteen localities referred to and numbered 1 to 13, the first and last are upon the west coast of Scotland, and are therefore not included in this report. The information regarding each locality was furnished by Mr. Ryley from his note-book, the results obtained being given with each.

The geographical distribution of the various species of Copepoda in our colder and warmer seas is very interesting, the former phase being remarkably illustrated by this collection. As we approach the north, number and size appear to compensate for diversity of species. It has been long known that the large and widely spread pelagic Copepod *Calanus finmarchicus*, Günner, forms the chief food of the Greenland whale, and it will be noticed that in some of the localities about the North Cape at which Mr. Ryley collected, this species forms almost the entire mass in the tow-net. Its profusion here enables us to clear up a most interesting question. It has been often remarked that in this, as in some other species of Copepoda, the precise manner of ovi-position is mysterious, in as much

as females with ovisacs have never been noticed though carefully looked for. Their absence has recently led an eminent naturalist to throw out the theory that *Calanus finmarchicus* may be only the larval form of another species, the *Euchæta norvegica*, which is usually found only at great depths. It has often struck me as probable that *Calanus finmarchicus* casts its ova directly into the sea just as fishes do, and its profusion in these northern localities has furnished the opportunity of establishing what seems to be a clear proof of the truth of this theory. For on examining many hundreds of them together, especially in the collection No. 4, made at Hammerfest, I find small quantities of specially granular ova scattered about, and in two instances as if just ejected from the animal, but entangled by the swimming feet as the animal met its doom. It is confirmatory of these being the ova of *Calanus* that they appear only in such other gatherings as contain in great abundance this species and of it almost exclusively. So the larval form theory of *Calanus* may, I venture to think, be considered disproved.

Of the sixteen species of Copepoda obtained, twelve are known in British waters, the other four being—

Scolocithrix minor.
Acartia laxa.
Pontella inermis.
Oithona challengerii.

The first of these, *Scolocithrix minor*, so far as I am aware, has heretofore only been found in the Indian Ocean,* and its presence near the Arctic regions is thus very interesting. The three latter are widely diffused, but none of them are common species.

* Brady's "Challenger" Report on the Copepoda, p. 58.

Localities at which the Tow-net was used, with List of the Captures at each.

No. 1, June 11, 1888, 9 p.m. Loch Eriboll, Pentland Frith, Scotland (not included in this report).

No. 2, June 14, 1888, 9 p.m. Sogne Fiord, Norway. A cloudy, rainy and cold evening. Tow-net about five to ten minutes in the water, just below the surface.

Copepoda.

Calanus finmarchicus. Abundant.
Pseudocalanus elongatus. Several.
Temora longicornis. A few specimens.
Dias longiremis. Abundant.
Acartia laxa. Several.
Centropages hamatus. Several.
Oithona spinifrons. Several.
Oithona challengerii. Scarce.
Pontella inermis. One large male, the only specimen of the family Pontellidæ found in the collection.
Dactylopus similis. Scarce.
Idya furcata. Scarce.

The gathering contains multitudes of *Evadne nordmanni*, several Schizopods, larval Cirrepedes, minute Medusæ, *Ceratium tripos*, and fish ova.

No. 3, June 15, 1888, 12 noon. Skate Trommen, Nord Fiord. Bright sunshine, hot. Tow-net in water fifteen minutes, a foot below the surface.

Copepoda.

Calanus finmarchicus. Abundant.
Temora longicornis. Several.
Pseudocalanus elongatus. Several.

Dias longiremis. Abundant.
Isias clavipes. One specimen.
Oithona spinifrons. Several.
Oithona challengerii. Several.

Like No. 2 gathering, this one contained multitudes of *Evadne nordmanni*, fish ova, larval Cirripedes, and *Ceratium tripos*. It also contained several of the free swimming Tunicate, *Appendicularia*.

Nos. 4 and 5, June 19, 1888, 3 p.m. Hammerfest. A cold, dull day. Net let down while the steamer was at anchor opposite the town, and pulled a few times through the water, and left in it stationary. Water very clear. Tow-net contained as many again as are preserved in the two bottles collected here.

COPEPODA.

Calanus finmarchicus. Very large and red specimens of this species exclusively, and their ova scattered about.

No. 6, June 19, 1888, 11.30 p.m. Off North Cape, in Bay. Sky overcast. Ship at anchor. Tow-net drawn along the water a few times.

COPEPODA.

Calanus finmarchicus. Abundant.

In addition, this gathering contained quantities of larval Crustacea and some small but long Annelids.

No. 7, June 20, 1888, 4 a.m. Svaerholtsklubben, fifteen miles east of North Cape. Fine. Tow-net in the water five to ten minutes, on and below the surface. Far more were in the tow-net than are preserved in the bottle.

COPEPODA.

Calanus finmarchicus. This species again formed the

main bulk of the gathering. The specimens, however, all differed remarkably from those from the other localities, being distinguished by the presence of a very large oil globule in the body of each.

Pseudocalanus elongatus. Several.

Oithona spinifrons. One specimen.

Harpacticus chelifer. One specimen.

Harpacticus flexus. One specimen.

The gathering also contained a few Schizopods and larval Crustacea, and a mass of minute ova contained in a gelatinous membrane.

No. 8, June 21, 1888, 11.45 p.m. Tromsoe. Sun shining and bitterly cold. Ship at anchor. Strong current running, and tow-net suspended in the current, just below the Fiord opposite the town.

COPEPODA.

Calanus finmarchicus. Abundant.

Pseudocalanus elongatus. Several.

Dias longiremis. Abundant.

Acartia laxa. Several.

Scolocithrix minor. A few. The presence of this species here is very interesting, it having as before stated been previously recorded only in the Indian Ocean.

Oithona spinifrons. Several.

Harpacticus chelifer. One specimen.

Zaus spinosa. One specimen.

This gathering, like Nos. 2 and 3, contained multitudes of *Evadne nordmanni*, also several Zoea of Crab, a few other large larval Crustacea, and one mutilated Amphipod.

No. 9, June 23, 1888, 8 a.m. Lödingen, West Fiord, Luffoden Islands. Cold, dull morning. Ship at anchor. Tow-net a foot below surface for less than five minutes.

COPEPODA.

Calanus finmarchicus. Very few.

Nothing else was found in this sparse gathering.

No. 10, June 27, 1888, 10 a.m. Open sea, two miles from shore, twenty-four miles north of Molde. Thick fog. Tow-net a foot below the surface for ten minutes. Ship at anchor. Collected just by the force of the drift of the small waves on the surface.

COPEPODA.

Calanus finmarchicus. Several.

Pseudocalanus elongatus. One specimen.

Dias longiremis. Several.

Here there seemed to be a shoal of *Evadne nordmanni*, the gathering being almost composed of them.

No. 11, June 29, 1888, 3 p.m. Geiranger Fiord, considerably inland. Water had a good deal of fresh in it. Bright sunshine. Tow-net on the surface for some time.

This gathering I looked forward to with some interest, it being the only one of the collection taken at any considerable distance up a Norwegian fiord, and the water being brackish it was likely to contain some forms peculiar to that condition. The tow-net was also immersed for a longer period than on any other occasion, and the bright sunshine would be favourable in attracting the animal life to the surface.

But in spite of these favourable conditions the result is almost nil. One amphipod, probably *Gammarus neglecta*, (possibly entangled in the tow-net and belonging to a previous gathering,) and an Ichneumon fly, accidentally submerged, being the only organisms found in it.

No. 12, July 4, 1888, 8 a.m. Near entrance to Sogne Fiord. Bright sunshine. Ship at anchor close to shore. Tow-net in water fifteen minutes, two or three feet below surface and on surface, caught by drift from wavelets.

COPEPODA.

Dias longiremis. A few specimens.

Very little material resulted, and, strange to say, no specimens of *Calanus*; *Evadne nordmanni* and several larval Crustacea, together with a number of fish ova, constituted the gathering.

No. 13, July 7, 1888, 2 p.m. West of Rum, Scotland (not included in report).

In conclusion I must express my own cordial thanks and that of the Society to our colleague Mr. Ryley for furnishing us with this interesting and valuable collection.

If others who may have the advantage of yachting, or other sea voyages, would take charge of a tow-net to use as occasion allows, they will find an additional zest imparted to their pleasure, and sometimes, possibly, a relief to monotony, and may be largely instrumental in adding to the scientific knowledge of our marine surface fauna.

On the PINEAL EYE of the YOUNG and ADULT *ANGUIS FRAGILIS*.

By Richard Hanitsch, Ph.D.,
demonstrator of zoology in university college, liverpool.

With Plate I.

[Read 9th November, 1888.]

Amongst other animals which I collected in the forests of Thuringia and brought over to England, towards the end of September last, were several blindworms. Only a few days after my arrival here, one of them gave birth to nine young ones. Two of the latter died shortly after birth, the one being still inside the egg-membranes, the other having broken them, but still carrying the yolk-sack. Having thus a number of both old and young blindworms, and wishing to see for myself actual preparations of the pineal eye, which was known to me only by diagrams, I resolved to make some sections of that organ, hoping at the same time to be able to throw some light upon the development of the pineal eye in *Anguis fragilis*. From an examination of these preparations I was led to conclusions which differed in some ways from the existing opinions about that organ, and these I intend to bring forward in this paper.

In publishing these notes, I must apologize to those authors who have lately written on the pineal eye and whose works I do not mention here, for the simple reason that I have not been able to see the original papers. If my results differ from those given in papers which I have not seen, I hope they will give rise to further investigations. If they agree with them, then this paper must be regarded simply as a confirmation of known facts.

My work has been carried on in the zoological laboratory in University College, Liverpool.

The Adult *Anguis fragilis*.

In Spencer's paper* the pineal eye is figured as a hollow sphere, in which the dorsal portion has been pressed in. In my sections, which are vertical and longitudinal like Spencer's, the organ is distinctly pear-shaped, the narrower end of it being directed ventrally and posteriorly (see fig. 1, Plate I.). Further both De Graaf and Spencer affirm, that in *Anguis fragilis* the pineal eye is separated off from the epiphysis. "The epiphysis," says Spencer, "was remarkable for running forward until very close to the eye, whilst its distal rounded extremity was invested by pigment cells." And he continues: "As described by De Graaf, the eye is separated off from the epiphysis." But according to my preparations that is not the case. On the contrary, from the ventral side of the distal portion of the epiphysis a small stalk is given off which goes to the eye and spreads out to form the retina.

Spencer does not agree with De Graaf, who had described the lens as being completely separated off from the retina, and he states, that the lens is directly continuous with the retina. In his figure the connecting part between lens and retina is almost as thick as those organs themselves. But this does not appear to be the case in my specimens. I find only very small portions of connective tissue which join the lens to the retina. In the retina I find essentially the same layers as Spencer, although I must remark, that his figure, being a low power view, does not show all details, and is not quite easy to under-

* "On the Presence and Structure of the Pineal Eye in Lacertilia." Quar. Journ. of Micr. Science for October, 1886.

stand, if one has not the actual specimen at hand. Those layers are: firstly, a layer of pigment cells; secondly, a nuclear layer; thirdly, a molecular layer; fourthly, a second nuclear layer; fifthly, a capsule of connective tissue which encloses the whole. De Graaf had figured the retina as having a layer of unpigmented cells ("Cyllinder-cellenlaag") lying internally to the pigmented rods. Spencer objects to this statement, and says, that he has not found a trace of either of those layers, and he supposes that De Graaf has taken the dried up remains of the contents of the vesicle for cells. I have not found De Graaf's "Cyllinder-cellenlaag," but I do not doubt that what De Graaf calls the pigmented rods are merely the pigmented cells which I also show in my figure. The pigment forms a very dense layer, with only small interruptions, and I have not been able to make out whether the pigment lies inside cylindrical cells, or whether there are special pigment cells which have been pushed between a layer of cells corresponding to the rods and cones of the paired eye.

The lens is pretty flat, its ventral surface being more convex than the dorsal one. It is for the greater part composed of fusiform cells, only in the centre of its dorsal portion we find a few rounded cells. In regard to this point I shall add a few remarks when treating of the lens of the young blindworm. Taken all together, I find the pineal eye of the adult *Anguis fragilis* rather more highly developed than I could have expected to find it from Spencer's description and figure.

The Young *Anguis fragilis*.

The two specimens which I used for examination were both about six days old, and about 7·5 cm. in length. Of the one I made longitudinal, of the other transverse sections. I shall not describe the latter, however, as they

present no features of special interest. From even quite a superficial examination of the sections striking differences from the adult *Anguis* can be noticed. We see that the pineal eye of the young form is very flattened, and that the cavity between lens and retina has not yet made its appearance. Another difference, although of secondary importance, is at once visible, the parietal bones are not yet developed. Notwithstanding these differences one great similarity is noticeable, namely the complete connection of pineal eye and brain by means of the epiphysis. There is, as in the adult, a short thin stalk springing from the distal end of the epiphysis and spreading out to form the retina. By closer examination we find that the cells of the retina have not yet been differentiated to form the various layers which are present in the adult state. Instead of the one molecular and the two nuclear layers there is here only a single layer present, in which the cells are of rather embryonic character, and of the same nature as those of the epiphysis; they are small and rounded and have a rather large nucleus. The pigment layer resembles that of the adult *Anguis*, the only difference is, that in the young one the pigment cells are still more crowded so as to form an almost continuous layer of pigment. The retina is continuous with the circumference of the lens, without a definite boundary, and there is at that stage very little difference between the cells forming lens and retina. Only a few of the cells in the lens have become fusiform and resemble those of the adult *Anguis*, whilst the remainder are still more or less rounded. No doubt we ought to expect that all those cells would have become fusiform in the adult, but that process of differentiation seems to be rather slow. For, as I mentioned in describing the lens of the adult, I found there some cells which differed from the remainder, and were not fusiform, but

round, and therefore of embryonic character. Perhaps the reason is that I examined the smallest of the adult blindworms which I possessed. It measured only 23 cm., whereas the mother of the young blindworms was 35 cm. in length. If I had examined such a large and quite mature specimen, possibly all the cells of the lens would have been found to be fusiform.

I have mentioned already, that in the young *Anguis* the lens lies close on the pigment layer of the retina, or in other words, that the cavity of the vesicle, as it is commonly called, has not yet made its appearance. This arrangement furnishes an argument against the usual opinion in regard to the formation of the vesicle of the pineal eye. Spencer supposes that the epiphysis and its eye is an outgrowth from the central nervous system, and that the cavity of the vesicle is derived from that of the neural canal. There can be no doubt about the first point, and there is also ample proof that the cavities of the epiphysis proper are derived from the neural canal, but my preparations of the young *Anguis* show, that the theory does not hold good for the cavity of the vesicle. I am of opinion that that cavity is formed by splitting, perhaps by the operation of a fluid which is secreted by the surrounding tissue pushing apart the two layers of cells. This fluid, lying between lens and retina, would then be analogous to the vitreous humour of the paired eye.

In the tissue separating the pineal eye from the outer world, and placed between a layer of connective tissue and the epidermis, there is a molecular mass apparently of semi-fluid nature, with very few cells scattered in it. Some of those cells are elongated and pointed, and have quite the appearance of sensory cells. This structure is not present in the adult, and I have no satisfactory explanation of it to offer. Perhaps we might say, that the structure is

analogous to the aqueous humour of the paired eye, whilst, as pointed out above, we can compare the fluid of the vesicle with the vitreous humour.

Pineal Eye of the Embryonic *Pelias berus*.

In the last of his "conclusions" Spencer says, that the pineal eye "is found amongst living forms only in Lacertilia," and, as far as I know, no author has described a pineal eye in the Ophidia. On examining an embryonic adder, *Pelias berus*, in the Zoological Museum of the College, and brought by Professor Herdman from the island of Arran, I found an organ which I have no doubt is the pineal eye. The lens is remarkable for its conical form, the broad base of the cone being directed dorsally, and for the large mass of pigment which lies in its centre. This arrangement of the pigment in the centre of the lens of the pineal eye, is not quite unknown. The same has been found by Spencer in *Varanus*, one of the Lacertilia. I was not able to make out other histological details about the pineal eye of the adder, as the specimen examined was not in a satisfactory condition, having been for a long time in rather weak spirit.

Perhaps I may now be permitted to make some speculations on the pineal eye of *Anguis fragilis*. That organ is generally said to be rudimentary, and to have been an organ of sight in former periods. I cannot agree with these views, and in my arguments against the same, I start from the fact, that the pineal eye is far more highly developed in the adult than in the young *Anguis;* and therefore it cannot be a rudimentary organ. We must suppose, then, that the pineal eye is still in function, and I have no doubt that it is in some way of use as a seeing organ. But certainly the function of seeing is here only

of quite secondary signification. For the image which it perceives from the outer world must be quite a dim one as compared with that of the paired eye; firstly, because its retina is not at all so highly differentiated as in the paired eye; secondly, because some parts of the retina are quite shut up by the overlying pigment; thirdly, because the connective tissue which lies on the top of the lens is by no means so clear and transparent as the cornea of the paired eye. So the pineal eye would be of very little use in guarding against enemies, and as for looking for food, an eye on the top of the head cannot be of any use whatever. And these two functions, searching for food and guarding against enemies, are the most important which the eyes of a blindworm have to perform. Besides this, the paired eyes of *Anguis* being placed on the sides of the head, may be able to see a good deal of what is going on above the head of the animal. Thus we find that an imperfect seeing organ on the dorsal surface of the head of *Anguis* would be of very little or no use to the animal.

It is much more probable, I think, that the pineal eye is an organ for feeling temperature, and certainly its structure seems perfectly suitable for that purpose. Rays of light can easily penetrate down to the pigmented layer, for in the living animal we can see the pigment layer shining through the skin. Rays of heat, of course, as being essentially the same as rays of light, could easily penetrate the ectoderm and the thin layer of connective tissue, and then they would be concentrated by the lens and thrown upon the pigmented layer. Here they would be absorbed and their action transferred by the "retina," the stalk of the eye and the epiphysis proper to the brain, to produce there the sensation of heat.

Therefore, if the facts which I have brought forward, and the conclusions drawn from them, are right, then we

have in *Anguis fragilis*, or perhaps in Lacertilia generally, a specialized organ for feeling temperature, up to now an institution without parallel in the whole animal kingdom. And no doubt it would be of great use for such animals with a thick and scaly skin, like the Lizards, to have such an organ, in addition to the general sense for temperature. Certainly such an organ would be of greater use than a third and imperfect eye alongside two perfect ones.

I know quite well, how venturesome it is to bring forward speculations on the function of an organ without having proved them by physiological experiments, and I should have preferred to postpone the publication of this paper till I was able to complete it by an account of such experiments. Still more I should have liked to examine some more of the Ophidia, and to see whether in other genera also traces of a pineal eye could be found as in *Pelias berus*. But being pressed for time by having undertaken another research, I am forced to postpone the completion of this work for some months.

I conclude by giving my chief results.

1. There is in *Anguis fragilis* a continuous connection between the pineal eye and the epiphysis, and therefore with the brain.

2. The cavity of the vesicle is not derived from the cavity of the neural canal, but is formed by splitting.

3. The pineal eye (at least in *Anguis fragilis*) is an organ for feeling temperature, and is still functional.

4. There are also traces of the pineal eye in the Ophidia, as for example in the embryonic *Pelias berus*.

Explanation of Plate I.

c.c. Capsule of connective tissue.
c.s. Clear substance of unknown character.
c.t. Connective tissue.
ep. Epiphysis.
l. Lens.
m.l. Molecular layer.
n.[1] *l.* First nuclear layer.
n.[2] *l.* Second nuclear layer.
pa. Parietal bone.
p.l. Pigment layer.
r. Retina.
s.c. Sensory cells.

N.B.—The anterior end of both figures is at the right hand side.

Fig. 1. Vertical longitudinal section through pineal eye of the adult *Anguis fragilis*. Zeiss, Obj. D, Oc. 2.

[The section from which this figure has been taken, showed the epiphysis only down to †. The complete connection of pineal eye and brain by the epiphysis could, however, easily be traced in other sections of the series.]

Fig. 2. Vertical longitudinal section through pineal eye of the young *Anguis fragilis* (six days old). Zeiss Obj. D, Oc. 2.

[A larger portion of the epiphysis in proximal direction is shown in this figure.]

On EMBRYONIC FISSION in PLANTS.

By R. J. Harvey Gibson, M.A., F.R.S.E., F.L.S.,
LECTURER ON BOTANY IN UNIVERSITY COLLEGE, LIVERPOOL.

With Plate II.

[Read 11th January, 1889.]

I am not aware that any one has hitherto suggested the possibility of the very general occurrence of embryonic fission amongst the Thallophyta, and although I have already drawn attention to this point in a paper published in a previous volume of this Society's proceedings,* I think that the matter is of sufficient importance to warrant further consideration.

The phenomena of alternation of generation in plants are too well known to need detailed restatement here; it may be noted, however, that where true alternation of generations occurs, the embryo, or product of the union of the ovum and the sperm, produces *directly* a plant which reproduces itself asexually, whilst the asexually produced spore arising from the sporophyte stage produces a gamophyte at once, or after *n* sporophyte generations have intervened.

In *Ædogonium* fertilization is effected by a sperm fusing with an ovum (oosphere). The fertilized ovum or embryo (oospore) then undergoes segmentation like the ovum of an animal; but the segments, instead of uniting to form a single organism, separate from each other, and each of them gives rise to a new individual (swarm-spore) which after a period of free life becomes fixed and grows into the

* On the Terminology of the Reproductive Organs of Plants. Proc. Biol. Soc., L'pool, vol. ii.

adult *Ædogonium*. In *Coleochæta* fertilization is effected as in *Ædogonium*, but the cells into which the embryo segments remain united and form a cellular mass, which is generally considered as a parasitic sporophyte.* The parenchymatous mass of cells, however, which results from the segmentation of the embryo of *Coleochæta*, after a time bursts from its capsule, formed by a filamentous outgrowth from the parent plant, and each cell by rejuvenescence gives rise to a motile cell, which is capable of producing on germination a sporophyte.†

I fail entirely to see wherein the difference between the life-histories of *Ædogonium* and *Coleochæta* lies, save that in the latter the formation of the motile cells is postponed. The parenchymatous mass formed by segmentation of the embryo of *Coleochæta* is, in my opinion, in no sense an individual, any more than the collection of motile cells which originates from the embryo of *Ædogonium* is an individual. In the case of *Ædogonium* embryonic fission has taken place, by means of which the number of embryos has been greatly increased. That these are motile is easily accounted for by the aquatic habit of the plant, and by the fact that the life-cycle is usually completed in one season. If germination commences in the following spring the oospore rests during winter protected by a thick and often spiny cell-wall. In *Coleochæta*, on the other hand, we have to deal with a plant living in stagnant water and usually attached to the submerged parts of plants where manifestly the possibilities of diffusion are not so great, and moreover, incapable of completing its life-cycle in one season. The embryos, or products of embryonic fission,

* On the Alternation of Generation in the Thallophyta. Prof. S. H. Vines. Journal of Botany, Nov., 1879.

† Outlines of the Classification and Special Morphology of Plants. Goebel. p. 47.

require to be protected during the winter. It would be running a needless risk to produce motile embryos at the beginning of winter; hence the daughter-embryos remain enclosed within their protecting cell-walls and in the protective capsule formed round them by the mother plant until the following spring, when they emerge as flagellate embryos, ready to seek a resting place and develope into sporophytes.

Perfectly similar cases are found among the Rhodophyceæ, in fact the production of a number of embryos as the result of one impregnation is a characteristic feature of that group, although many modifications in the mode of production of these is exhibited by different members of the group. So too in many Fungi the "ascospores" and "carpospores" are simply products of embryonic fission, or, in some cases of embryonic gemmation, i.e. embryos, and in no sense spores, which are never produced as the result of sexual union.

When special cells are set apart for the production of new individuals it is an obvious economy to the organism to produce many embryos as the result of one impregnation, in addition to the multiplication of the chances of its remaining on the surface of the earth. Embryonic fission in fact occurs most markedly in those groups where we would expect it, i.e. where the sexual reproductive process is a complicated and elaborate one, and where there is a possible chance of extinction if a sufficiency of embryos be not produced, and margin allowed for loss. Hence the parasitic Fungi, and more especially the Ascomycetes, exhibit this peculiarity to a very marked degree. In other forms, such as *Ædogonium* extra provision is made for loss of embryos; in *Coleochæta* and the Rhodophyceæ we have to consider as well the time of year at which the embryos are produced and the necessity

for protecting these embryos from injury during unfavourable conditions of the environment.

When embryonic fission is absent the power of reproduction by spores, as for example among the vascular Cryptogams, or by some other method, is especially developed instead.

NOTE.—*Coleochæta* is usually spelt *Coleochæte*, which is however wrong, both according to etymology and the British Association rules of nomenclature.

EXPLANATION OF PLATE.

I., II. Semi-diagramatic representation of the process of embryonic fission in *Ædogonium* and *Coleochæta*.

III., IV. Embryonic gemmation in *Spermothamium* and *Eurotium*.

A. the ovum (oosphere); B. ultimate result of fertilization; C. non-motile stage; D. motile stage.

On a DEEP SEA TOW-NET for OPENING and SHUTTING UNDER WATER.

By William E. Hoyle, M.A. (Oxon.), F.R.S.E.

(Communicated by Professor Herdman.)

With Plate III.

[Read 9th November, 1888.]

Introduction.

A conical net of muslin or other fine-meshed material has long been a favourite instrument for collecting the smaller denizens of the surface and sub-surface water, but, so far as I am aware, this apparatus was first used systematically at any considerable depth by the naturalists of the "Challenger" Expedition. The more extensive the observations made with it, the greater became the desire to know with certainty at what depth the animals captured in it had been obtained.

As the investigation of the deep sea became more frequent, attempts were from time to time made to construct an apparatus which could be lowered shut to a given stratum of water, then opened and towed for a time in that condition and finally closed before being again brought up. The earliest of these is, I believe, the "gravitating trap" of Captain Sigsbee.* It consists of a cylinder which slides down a rope, and is constructed to descend open through a stratum of water of any desired thickness, and then to close before being hauled up. Its

* Sigsbee, *Bull. Mus. Comp. Zool.*, vol. vi., pp. 155—158, pl., 1880; see also Agassiz, Cruises of the "Blake," *Bull. Mus. Comp. Zool.*, vol. xiv., p. 36, 1888.

disadvantage is that the stretch of water examined can only be extended vertically not horizontally.

Another invention is that of Mr. Alexander Turbyne,* captain of the steam yacht "Medusa," belonging to the Scottish Marine Station. A net of the ordinary type can be constricted by a rope passing round it a little behind the metal hoop. It is let down thus, and then the constricting cord is slackened, to be tightened again before being drawn up. The disadvantage of this apparatus is that it requires two ropes, which are liable to become entangled with each other.

Still another apparatus was contrived by Professor Pavesi,† for his researches into the abyssal fauna of the Italian lakes, which worked by means of a sliding weight, but it could only be opened when it reached the required depth and not closed again. An improvement, in which this drawback has been overcome, is described by MM. Pouchet and Chabry,‡ but I confess that I was unable from their very brief description to understand its action, even when aided by the wood-cuts, which accompany an article in the same journal by the Prince of Monaco.§

Captain Palumbo, of the Italian corvette "Vettor Pisani," devised an automatic net which was let down with the thermometer, and is said to have worked satisfactorily.‖

All these (except perhaps the last, regarding which I have no detailed information) depend upon the action of a "messenger," or perforated weight which runs down the cord to which the net is attached—the principle adopted

* The Scottish Marine Station for Scientific Research; its Work and Prospects. Edinburgh, 1885, 8vo.

† *Atti Soc. Ven.-Trent. Padova*, vol. viii., pp. 341—343, pl. viii., 1883.

‡ *Comptes rendus soc. biol.*, sér. 8, t. iv., pp. 602—604, 1887.

§ *Tom. cit.*, pp. 661—664, cuts.

‖ *Nature*, vol. xxx., p. 365, 1884.

in the apparatus to be described in the sequel. A different system has however, been utilised by Professor Chun.* His net is, in its essence, similar to my own, but it is opened and then closed again by the action of a fan which revolves as the apparatus is drawn through the water. Thus the whole has to be drawn for a certain distance before the net will open, and it will shut again after, and only after, a certain additional distance has been traversed. In the hands of its inventor this net has made valuable additions to our knowledge, but it is the operator who is dependent on the net and not the net on the operator.

During the past summer, when engaged in the Firth of Clyde in superintending the operations of dredging and trawling in the "Medusa," my attention was continually directed to the solution of this problem, and the results of my experiments are detailed in the present communication. I may add that at that period I was only acquainted with the apparatus of Professor Pavesi and of Mr. Turbyne.

Description of the Apparatus.

The apparatus, which is exhibited this evening, may be conveniently considered in three portions—(1) the net-frame, (2) the lock, (3) the messengers.

1. *The Net-Frame.*

The net itself is simply a conical bag either of muslin or of silk bolting cloth, which has the advantage of being very much more durable. It is attached to a brass ring (fig. 2, *a. b.*) which in the experimental apparatus is two feet in diameter, and consists of two semi-circles hinged together in such a manner that they can fold against another semi-circular piece, and so close the net. This

* *Bibliotheca Zoologica*, Heft 1, pp. 3—6, pl. i., 1888.

last piece (fig. 2, *c.*) is a quarter-inch thick and one inch broad, and is bevelled along its front margin, to diminish its resistance in passing through the water. At its middle is a ring (*j.*) by which the net can be dragged. About half way between this loop and the hinge is another small loop (*h.*) corresponding in position with similar ones (*g.*, *i.*) on the two halves of the net-frame. These are connected by cords of such a length that when they are extended the frame stands at right angles to the towing-hoop (as in fig. 1). Each half of the net-frame has also a loop in its centre (*d.*, *e.*), which serves in the first place to prevent it from swinging right through the towing-hoop when it is closed.

These two loops have, however, another function to discharge—a small rope, about a quarter-inch diameter, is attached to one of them and passed through the other (fig. 2, *d.*, *e.*). It will be obvious that when the net is in the water and traction is made upon this cord the net will close, hence it will be termed in the sequel the "closing cord;" whereas if the pull be applied to the ring on the towing-hoop, the resistance of the water will cause the net to open, hence the rope or rod attached here may be termed the "opening cord."

In practice it is found advantageous to employ links of quarter-inch brass rod instead of cord for attaching the net, as they are not liable to twist and become entangled with one another when wet. The arrangement adopted is as follows :—The closing cord itself is just over two feet long, so that when the net is open its extremity projects a few inches beyond the loop in the net-frame (fig. 2, *e.*). To this extremity is attached a brass link (*f.*) two feet long, and at the other end of this is a loop of wire by which the net can be hooked into the lock (fig. 1, *j.*). To this succeed two other links (*h.*, *i.*) eighteen inches long,

by which the closing cord is made fast to the lower part of the lock.

The opening cord consists of two links of brass (*c.*, *d.*) each two feet in length, at the end of which is a loop similar to that just mentioned (fig. 1, *j.*) for attachment to the lock. There is also a cord or chain (*n.*) of a little over three feet in length, the function of which is merely to prevent the links (*c.*, *d.*) from hanging loose when the net is brought up closed.

2. *The Lock.*

This portion of the apparatus is destined to enable the naturalist, by means of weights, known as "messengers," which slide down the line, to let go the closing and opening cords in succession. One half of it is shown from the median side in fig. 5, whilst a perspective view of the whole is given in fig. 6. It is seen to consist of two corresponding halves (*a.*, *a'.*), each of which is a solid brass casting of oblong shape, with a prominence at one end. Each portion has a groove (*f.*, *f.*) so arranged that when the two are applied to each other an oblique tunnel is produced, in which lies the rope by which the apparatus is towed. The rope having been laid in the groove of one of the pieces, is held in place by two bolts (fig. 7), the lower threaded portion being passed through the holes (*e.*, *e'.*) so that when a nut (like those in fig. 6, *i.*, *i'.*) is applied to the outside and screwed down, the hooks on the bolts grip the rope with the required degree of firmness. The other half of the lock is then placed over the rope and secured by similar nuts working upon the upper threaded portions. The lock can thus be made perfectly secure upon any part of the rope, and furthermore the thickness of the rope may vary within pretty wide limits.

In the left hand margin of each half of the lock is seen

a notch with parallel sides, and a pin (*b.*, *b′.*), which moves up and down in a hole, can pass across the notch or, rising up, leave it entirely free. A bell-crank lever (*c.*, *c′.*), pivoted at *d.*, *d′.*, the extremity of which passes through a slot in the upper end of the pin, is the means whereby it is moved up and down. Upon the other end of the lever impinges a rod (*g. g′.*) which runs in a hole parallel with the towing rope, the head of which is a curved piece of brass more or less embracing the rope, of the exact shape and disposition of which more will be said later on. Suffice it for the present to point out that pressure upon *g.* in a downward direction will withdraw the pin (*b.*) from the notch.

The screw (*j.*) is simply for the purpose of preventing the pin (*g′.*) from rotating on its axis.

3. *The Messengers.*

The controller of the net is able to exercise pressure upon the pins (*g.*, *g′.*) by means of perforated weights, which are allowed to slide down the rope by which the net is dragged. There are two of these, one for opening, the other for closing the net; they may be conveniently known as the "first" and "second."

1. The *first messenger* is represented in fig. 3. It is constructed upon the ingenious principle devised by Captain Rung, of the Danish Meteorological Institute,* in two halves, in such a manner that it can be put upon the rope at any point. The form of these two portions may perhaps be described by saying that the perforated weight is cut across transversely, except that a longitudinal slip, extending from centre to circumference, is cut out of the upper half and left attached to the lower, and *vice versa*.

* Den tekniske Forenings Tidsskrift, 1883; see also Mill, art. "Thermometer," Ency. Brit., 9th ed.

Fig. 3 A. represents the upper half; towards the left may be seen the slit into which the rope passes, whilst to the right and below is the slip which fills up the corresponding gap in the lower half, a front view of which may be seen in fig. 3 C. Fig. 3 B. shows a longitudinal section through the complete messenger. The top of this one is tapered so as to permit the other to slide over it without any danger of catching.

2. The *second messenger* (fig. 4) precisely resembles the first in principle, but to either portion is attached the half of a brass tube, divided longitudinally so that when it is put together a cavity is formed in the lower part, large enough to enclose the first messenger. Fig. 4 C. shows the appearance of the upper extremity of the messenger when put together.

The conditions which must obtain in regard to the form and disposition of the upper ends of the pins ($g.$, $g'.$) can now easily be seen. The pin ($g'.$) meant to be acted upon by the first messenger must lie near to the rope, and the upper curved part must embrace this so closely that the tube of the second messenger is sure to fall clear of it. The pin ($g.$) to be actuated by the second messenger must stand so far from the rope that the first cannot reach it, but so near that the second is sure to do so. These conditions are easy to secure provided the messengers fit the rope without too much play; but where ropes of very different sizes are used, it would be advisable to have a special set of messengers for each. The heads of the pins are curved round the rope as a centre so that an inclination of the rope obliquely to the surface of the lock shall not render it possible for the messengers to miss them.

For experimental purposes the messengers have been made of lead, but for permanent use it will be advisable to construct them of brass, and a ring fitting into a groove,

by which the two halves can be secured from any risk of coming apart during the descent, will be added.

Mode of Working.

The apparatus itself having been described, a few paragraphs may now be devoted to explaining the manner in which it is used. It is designed to act either at the end of a special rope or when attached at any point of a rope which is being used either for dredging or trawling. In this latter case it is of great advantage that a wire rope should be used, as its less flexibility makes the descent of the messengers full upon the heads of the pins more certain.

In fig. 1 the arrangement is shown when a special rope for the tow-net is used. This is passed through the channel between the two cheeks of the lock and made secure by means of the bolts. To its end a lead is attached, the weight of which depends upon the size of the net, the depth it is desired to reach and the speed of the vessel.

The loop (*j.*) on the closing line is now placed in the notch on the nearer side of the instrument in fig. 6, and the pin (*b'.*) is pressed down through it. The loop (*e.*) on the opening line is similarly placed in the other notch and the pin (*b.*) passed through it. In this position of affairs, as explained above, the resistance of the net as it is dragged through the water will keep it shut.

A small lead of four or five pounds weight is attached to the lower margin of the net (fig. 1), and it is then carefully let down over the stern of the vessel whilst under weigh, care being taken to see that it is shut and that the weighted side is downwards. All being clear, the two series of links are payed out and lastly the lock and sinker. A fair amount of way (four to five knots) should be kept on the vessel whilst this is being done, and enough rope

should be payed out to allow the net to reach the required depth, when the boat is going at the working rate. The speed of the vessel is then reduced so that the net gradually sinks to the level which it is desired to investigate.

The first messenger is then allowed to descend, which striking upon the pin (*g'*.) raises the pin (*b'*.) and liberates the loop (*j*.) in the manner already described. The links (*h*. and *i*.) now stretch out, and thus the closing line is lengthened to the extent of some three feet. The strain of the net is thus borne by the links (*c*. and *d*.), and the pressure of the water, aided by the weight on its lower margin, opens the net. The present state of matters is that shown in fig. 1, and in this position the net is dragged so long as its controller thinks fit.

When this period has elapsed the second messenger is allowed to descend, which strikes upon the pin (*g*.) raises *b*. and liberates the loop (*e*.). The opening line is thus lengthened by the addition of the cord or chain (*n*.), in consequence of which the strain of dragging the net once more falls upon the closing line and the net shuts.

It is then drawn up to the surface, and the contents treated in the usual manner.

When the tow-net is to be worked in conjunction with the dredge or trawl, this latter is first put over, and the lock is made fast to the line at any desired distance above it, the two cheeks being separated so far as to allow the rope to pass in between them.

Futhermore it will be readily seen that by means of this apparatus several tow-nets can be worked at different depths on the same rope. The first and deepest is attached quite in the usual manner. Just below the lock of the next tow-net two messengers are placed upon the wire, the "first" of the pair below the "second." The former

is suspended by a loop of wire, which is passed over the loop (*j.*) before it is fixed in its notch. The latter is similarly suspended to the loop (*e.*). When this second net is opened by its first messenger the corresponding messenger just below it is liberated as soon as *j.* slips out of its notch and runs down to open the first tow-net. In the same manner the shutting of the second net also closes the first.

Advantages and Drawbacks.

The apparatus just described seems to me to present the following advantages over any which has hitherto been described:—

1. It will work equally well at any depth.
2. The times of opening and shutting are entirely under the control of the operator.
3. It will work either on a special rope or on one which is being used with a dredge or trawl.
4. A number of nets can be worked simultaneously on the same rope.

It cannot be denied, however, that it also has certain drawbacks. The first, and to my mind the most serious, is that any foreign body becoming attached to the rope, such for example as a piece of Alga or the trailing threads of a Siphonophore or Medusa, would check the descent of the messengers, and thus prevent the working of the net. This accident has never as yet occurred in my experience, but its possibility is obvious.

Again, when the speed of towing is at all high compared with the weight of the apparatus, the inclination of the towing rope to the horizontal is very small, especially near its lower extremity, and the friction of the water being considerable the descent of the messengers is slow,

and the time they occupy in reaching the lock at a depth even of eighty fathoms (the greatest at which I have experimented) is undesirably long, and if the net were used in really deep water would be a serious matter. I have, however, never found that they failed to actuate the levers in the lock.

Both these disadvantages can, I think, best be remedied by adapting to this tow-net the electrical apparatus which Professor Chrystal has applied with such success to the reversing of deep sea thermometers, and I hope to be able to carry out this plan during the coming summer. The apparatus required will be somewhat expensive, but no attachment of obstacles to the line will check the current and its action will be instantaneous.

In conclusion, I have to express my thanks to all those from whom I have received assistance during the conducting of experiments and devising apparatus:—To Mr. John Murray, for the use of the yacht "Medusa," and to Mr. Alexander Turbyne, for his willing and skilful co-operation in the numerous, often futile trials. To Messrs. Jas. Duff and Sons, of Greenock, for their care and attention in constructing the net-frame and the first form of lock for preliminary operations. To my friend, Mr. Leonard Massey, for his invaluable assistance in designing the improved lock here described, and to Messrs. B. and S. Massey, for constructing the same.

Explanation of the Plate.

Fig. 1. View of the net, open and at work. *a.* the net; *b.* the frame; *c. d.* the links forming the opening line; *e.* the loop by which it is fixed into the lock; *f.* the hempen portion of the closing line; *g. h. i.* brass links composing the remainder of it; *j.* loop for attachment to the lock; *k.* the rope for towing the net; *l.* the lock; *m.* the sinker; *n.* the cord or chain by which the opening line is attached to the lock.

Fig. 2. The net-frame seen open from the front. *a. b.* the two halves of the frame; *c.* the flat piece for towing by when open; *d.* loop to which the closing line is attached; *e.* loop through which it passes; *f.* end of brass link; *g. h. i.* loops for cords to prevent the net from opening too far; *j.* loop to which the opening line is attached; *k. k'.* the hinges; *l.* the hempen part of the closing line.

Fig, 3. The first messenger. A. the upper half, seen sideways; B. longitudinal section through the complete messenger; C. the lower half, seen from the front.

Fig. 4. The second messenger. A. B. the two halves, seen from the inner surface; C. the complete messenger from above.

Fig. 5. View of one cheek of the lock, seen from within. *a. a.* the brass cheek; *b.* the pin which moves into and out of the notch; *c.* the bell-crank lever actuating the pin; *d.* its pivot; *e. e'.* holes for the bolts (fig. 7) to hold the cheeks together and to the rope; *f. f.* groove in which the towing rope lies;

g. pin pressed down by the messenger which actuates the bell-crank lever (*c*.).

Fig. 6. View of the lock put together. Letters as in fig. 5; also *h*. *h'*. ends of the bolts; *i*. *i'*. thumb-screws working on them; *j*. screw to prevent the pin (*g'*.) rotating on its axis.

Fig. 7. Bolt by which the cheeks of the lock are held together and to the rope.

Abstract of Communication, "On the VARIATIONS PRODUCED in the ELECTRICAL CONDITION of the VISCERA by STIMULATION of ADJACENT CUTANEOUS NERVES."

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[Read 11th January, 1889.]

In studying the electric phenomena of nerve and muscle, it is well known that a change in the electrical state—the negative variation or current of action—occurs during frictional activity, and that in all nerves other than motor and secretory ones it forms the only objective phenomenon by which the transit of a nerve impulse can be recognised.

Having a definite object in view relating to practical medicine, I was wishful to ascertain whether stimulation of the cutaneous nerves of the trunk had any influence on the nerves of the internal organs.

The only mode of ascertaining this was to find out if a negative variation in the electrical condition of these nerves or of the organ to which they are distributed occurs at the instant when the stimulation of the cutaneous surface takes place. The following experiment was therefore performed, and frequently repeated. A frog was rapidly and painlessly killed by destroying its brain; a small quantity of woorain was then injected into a lymph sac, to prevent reflex spasm; a small coil of intestine was withdrawn through an opening in the left flank, and two non-polarisable electrodes were so arranged as to bring this coil of intestine into the circuit of a sensitive galvanometer. The needle at once showed a certain amount of deflection. This being

noted, the skin of the abdomen was stimulated either by heat, by an induced electrical current, by a chemical irritant, or mechanically by pinching or otherwise, and coincidently a negative variation was shown by the galvanometer, indicating that a nerve impulse had travelled round by the intercostal nerves, and had produced an active condition of the nerves of the intestine.

This experiment is one of some difficulty, and cannot reasonably be expected to succeed always; it has, however, succeeded so frequently that little doubt can be entertained of the fact it was intended to demonstrate.

A SIMPLE SCHEMA of the LYMPHATIC CIRCULATION.

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With Plate IV.

[Read 8th February, 1889.]

It has been my experience, and I believe the experience of many other teachers, that students have great difficulty in comprehending the nature of the lymph and the forces concerned in its circulation. This was, I thought, due to the want of some simple model illustrating the fundamental principle of the lymphatic circulation—that is, the relation of the lymphatics and blood vessels to one another through the tissue interspaces.

With the object of making the relationship clear, I constructed, some four years ago, the little schema that I now describe, and which has assisted me greatly in explaining, and my students assure me it has assisted them in understanding easily what was otherwise very difficult.

The apparatus illustrates four chief points :—

1. That the lymph is the transudation, exudation, or filtration fluid from the capillaries.

2. That it exudes first into the tissue interspaces.

3. That the lymphatics commence freely in these interspaces.

4. That the force that propels the lymph onwards in the lymphatics is fundamentally the same as that which causes the flow of blood in the blood vessels.

The apparatus, a rough sketch of which is seen in Plate IV., consists of the following parts :—

An elastic ball-syringe *a*, with valves arranged so that

fluid ejected from it passes into *b*, a strong, wide rubber tube; with this is connected a manometer *c*, and a length of thinner rubber tube *d*. These, as in the ordinary blood schema, represent the heart and arteries. The tube *d*, is connected with the glass tube *e*, which passes through the cork of the wide-mouthed bottle, and is connected at its other end with the narrow rubber tube *f*; this is perforated by numerous pin-holes so as to render it permeable. The other end of *f*, is connected with the glass tube *g*, which is either narrower than *e*, or constricted at its lower end; in this way it offers a slight resistance to the onward flow. *g*, ends in a piece of rubber tube *h*. *f*, stands for the capillaries, and *g*, *h*, for the veins.

Opening freely into the bottle by its lower end is the tube *i*, which is attached above to the glass tube *k*. This perforates the cork and ends in the rubber tube *l*. *i*, *k*, *l*, represent the lymphatics.

Perforating the cork also is the manometer tube *m*, for measuring the pressure in the bottle—the lymph pressure, or extra-vascular blood pressure.

When fluid is driven intermittently into the system by squeezing the ball *a*, the tubes *b*, and *d*, become distended, the manometers show a rise in pressure in the system, and a continuous flow of fluid comes from *h*, and *l*, rapidly from *h*, slowly from *l*.

When the fluid in its passage reaches *f*, the artificial permeable capillary, some will pass through its walls into the cavity of the bottle, representing the tissue interspaces. It there causes a rise of pressure, which is recorded by the manometer *m*. The fluid as a consequence of this rises up the tube *i*, *k*, *l*, and flows out at *l*.

In order to better represent the cells and tissue interspaces, I have sometimes filled the bottle with pebbles or coarse sand.

REPORT on the MARINE DIATOMACEÆ of the L.M.B.C. DISTRICT.

By Dr. H. Stolterfoth, M.A.

[Read 8th February, 1889.]

In the present condition of our knowledge of the Diatomaceæ, it is impossible to give a scientific arrangement of the genera and species. All the attempts that have hitherto been made are based on artificial systems, that must some day be superseded, and so I have thought it best in this catalogue, which I have prepared for the Liverpool Marine Biology Committee, to do what most of the recent writers on the subject have done, viz. place the genera and species in alphabetical order. This makes the list easy to consult, and in no way precludes its being used by those who adopt an artificial system of reference. One of the best of the artificial systems is that proposed by Professor H. L. Smith, and which will be found in Dr. Van Heurck's "Synopsis of the Diatomaceæ," p. 37 of the text.

The great difficulty that surrounds the study of the Diatomaceæ, is that so many writers seem to look upon it as necessary to give new names to even the commonest species, and the transference of well known forms from one genus to another, adds not a little to the complication. Different localities and conditions give rise to variations, which in many cases have been made to constitute new species. I have endeavoured to avoid this, and I hope that the following list will be of some use to those who are working at this subject. Very few lists of the Diatomaceæ of particular districts in this country have been published. They are as follows—

1. "New Forms of Marine Diatomaceæ of the Firth of

Clyde and Loch Fyne," by William Gregory, M.D. Transactions of Royal Society, Edinburgh, 1857.

2. Mr. Comber's "List of Diatomaceæ Found in the Neighbourhood of Liverpool." Transactions of Historic Society of Lancashire and Cheshire, vol. xi., 1859.

3. "The Diatomaceæ of Hull," by Mr. George Norman. Published by himself, 1865. This is a most admirable list, and little has been added to it up to the present day.

4. "List of Diatomaceæ Found in the Neighbourhood of Chester," by Dr. H. Stolterfoth, M.A. Published in the Proceedings of the Chester Society of Natural Science, 1874.

In the following list I shall confine myself to those forms of Diatomaceæ that are found in salt and brackish water affected by the tide. Mr. Comber's list, referred to above, contains 137 salt and brackish water species; to these I have been able to add 47, making 184 species in all. A large portion of my gatherings have been made in the estuary of the Dee, but they also extend along the coast of North Wales, and I have made a few gatherings in the Isle of Man. I have no surface gatherings of more than a few miles from the shore, and it is here that my list will, perhaps, be most deficient. I have examined many gatherings from the Bristol Channel, estuary of the Thames, the coast of Devonshire, and Northumberland, Tay in Scotland, &c. The general character of the forms found on the east and west side of England are much the same, but the frequency with which they recur varies considerably, and certain forms may be said to mark particular localities. This is what would be expected in an examination of this lowly order of the Flora.

For the growth of the Diatomaceæ heat and sunlight are essential, and on these factors depends the development of the siliceous skeleton, which is the characteristic of this order. As might have been expected in most specimens

found in this neighbourhood the siliceous skeleton is but poorly developed.

No department of Botany has been more fully illustrated than the Diatoms. A very good Bibliography is found in Dr. Van Heurck's "Synopsis," ch. iii., p. 43, and it is hardly necessary in the list that follows to give more than the authority upon which the names of genera and species rest. I have not considered it necessary to give the authorities in full, as the abbreviations are well known to those who study the subject.

The localities mentioned in the list are those in which the form was first observed.

Very rare means that only a very few forms have been seen.

Rare, that the form has only been seen in a very few gatherings, but may have been abundant in them.

Common, that the form has appeared in many gatherings.

Very common, that the form is present in most of the gatherings and is abundant.

List.

Achnanthes (Bory, 1822) *brevipes*, Ag. Surface of Dee, common.

A. longipes, Ag. Hoylake, common.

A. subsessilis, Ehr. Ince Marsh, rare.

Actinocyclus (Ehr.) *crassus*, W. Sm. Surface of Dee, rare.

A. ralfsii, W. Sm. Parkgate, rare.

Actinoptychus (Ehr.) *splendens* (Shad), Ralfs. Surface of Dee, rare.

A. undulatus, Ehr. Queen's Ferry, very common.

Amphiprora (Kutz.) *alata*, Kutz. Mostyn, very common.

A. paludosa, Greg. Mostyn, common.

A. plicata, Greg. Rhyl, rare.
A. pusilla, Greg. Bangor, rare.
A. vitrea, Greg. Hoylake, rare.

Amphora (Ehr.) *affinis*, Kutz. Queen's Ferry, common.
A. binodis, Greg. Ince Marsh, rare.
A. hyalina, Kutz. Mostyn, very common.
A. commutata, Grun. Burton Marsh, rare.
A. complexa, Greg. Mostyn, rare.
A. lævis, Greg. Ince Marsh, rare.
A. litoralis, Dn. Rhyl, rare.
A. membranacea, W. Sm. Holywell, rare.
A. minutissima, Gray. Helsby Marsh, rare.
A. salina, W. Sm. Connah's Quay, common.
A. spectabilis, Greg. Mostyn, rare.
A. ventricosa, Greg. Ince Marsh, rare.

Asterionella (Hassal) *bleakleyii*, W. Sm. Surface of the Dee, common.
A. ralfsii, W. Sm. Surface of the Dee, rare.
These forms are often very abundant in the summer.
A. bleakleyii grows in long continuous filaments like a corkscrew.*

Atheya (West) *decora*, West. Surface of the Dee, very rare. This form was described by Mr. West in the Trans. Micro. Soc., vol. viii., 1860, and I do not know of its having been seen by any one since. I found it on the Dee in 1874 for the first time, and have seen it two or three times since in surface gatherings.

Bacteriastrum (Lauder) *varians*, Lauder. Surface of Dee, common.

Berkleya (Grev.) *obtusa*, Grev. Puddington Marsh, rare.

* *Vide* Trans. of Micro. Soc., vol. viii., 1860, Mr. West's paper.

Biddulphia (Gray) *aurita*, Breb. Connah's Quay, common.
B. baileyi, W. Sm. Surface of Dee, very common.
B. granulata, Roper. Surface of Dee, rare.
B. obtusa, Kutz. Connah's Quay, rare.
B. radiatus, Greg. Parkgate, rare.
B. rhombus, W. Sm. Parkgate, common.
B. suborbicularis, Grun. Surface of Dee, rare.
B. turgida, W. Sm. Parkgate, rare.

The form *B. aurita* is not so common on this coast as about the Thames and south coast, where it is found abundantly associated with *Actinoptychus splendens* and *Eupodiscus argus*.

Campylodiscus (Ehr.) *bicostatus*, W. Sm. Mostyn, rare.
C. cribrosus, W. Sm. Mostyn, rare.

Cestodiscus (Grev.) *johnsonianum*, Greg. Mostyn, rare.

Chætoceros (Ehr.) *armatum*, West. Surface of Dee, rare.
C. boreale, Bail. Connah's Quay, rare.
C. paradoxum, Cleve. Surface of Dee.
C. wighamii, Brightw. Surface of Dee, rare.

Cocconeis (Ehr.) *scutellum*, Ehr. Hilbre Island, common.
C. britannica, Nægeli. Isle of Man, common.
C. eccentrica, Dn. New Brighton sands, Comber.

Coscinodiscus (Ehr.) *asteromphalus*, Grun. Surface of Dee, common.
C. concinnus, W. Sm. Parkgate, common.
C. eccentricus, Ehr. Parkgate, common.
C. fimbriatus, Ehr. Surface of Dee, rare.
C. obscurus, Schmidt. Surface of Dee, rare.
C. radiatus, Ehr. Connah's Quay, rare.

Cymbella (Ag.) *scotica*, W. Sm. Mostyn, rare.

Dickeia (Berk.) *ulvoides*, Berk. Colwyn Bay, rare.

Dimeregramma (Ralfs) *nanum*, Greg. Surface of Dee, rare.

Epithemia (Kutz) *constricta*, Greg. Mostyn, common.

E. gibba, Kutz. Helsby Marsh, common.

E. turgida, W. Sm. Frodsham Marsh, very common.

This genus seems to flourish equally well in fresh and brackish water, but is not found in the open tidal water of the Dee.

Eucampia (Ehr.) *zodiacus*, Ehr. Surface of Dee and Mersey, common.

E. striata, Stolt. Surface of Dee, rare.

This last form was described in the Journal of the Royal Microscopical Society by me in 1879. It has been placed by Mons. H. Peragello in his "Diatomies de la Baii de Villefranche," 1888, in the genus *Rhizosolenia*, because it has a terminal spine, which I have figured in my paper. I am doubtful if Mons. Peragello has ever seen my figure. This is the first notice I have seen of the form described in Europe. In Castracane's "Challenger Diatoms" a single valve is figured, but not named. I still think that from the mode of growth this form is allied to *Eucampia*, or perhaps to *Hemiaulus*.

Eupodiscus (Ehr.) *argus*, Ehr. Connah's Quay, doubtful. This form is abundant in the estuary of the Thames, Kiel harbour, &c., but on the west side of England it is hardly known.

Gomphonema (Ag.) *marinum*, W. Sm. Wepre Brook, rare.

Grammatophora (Ehr.) *marina*, Kutz. Colwyn Bay, rare.

G. serpentaria, Kutz. New Brighton, in Comber's list.

Hantzschia (Grun.) *virgata*, Grun. Colwyn Bay, very rare.

Hyalodiscus (Ehr.) *stelligis*, Bail. Surface of Dee, rare.
H. scoticus, Grun. Mostyn, common.

Licmophora (Ag.) *gracilis*, Grun. Mostyn, rare.
L. anglica, Grun. Rhyl, rare.
L. dalmatica, Kutz. Dingle Bay, Comber's list.

Lauderia (Cleve.) *delicatula*, Peragello. Surface of Dee, rare. This form I found with *Eucampia striata*, in 1879, and thought it a stage of growth of that form, but I think Peragello is right in placing it in the genus *Lauderia*.

Mastogloia (Theo.) *lanceolata*, Th. Puddington Marsh, rare.
M. smithii, Th. Mostyn, common.

Melosira (Ag.) *borreri*, Grev. Rhyl, rare.
M. nummuloides, Bory. Helsby Marsh, common.
M. sulcata, Ehr. Surface of Dee, rare.
M. westii, W. Sm. Connah's Quay, rare.

Navicula (Dn.) *abrupta*, Greg. Surface of Dee, very rare.
N. æstiva, Dn. Colwyn Bay, rare.
N. affinis, Ehr. Helsby Marsh, rare.
N. aspera, Ehr. Colwyn Bay, common.
N. boeckii, Herberg, Burton Marsh, rare.
N. bombus, Ehr. Mostyn, common.
N. carassius, Ehr. Mostyn, rare.
N. clepsydra, Ehr. Colwyn Bay, rare.
N. crabro, Ehr. Connah's Quay, common.
N. cyprinus, Ehr. Mostyn, rare.
N. didyma, Ehr. Bagilt, rare.
N. distans, W. Sm. Helsby Marsh, rare.
N. fortis, Greg. Mostyn, rare.
N. fusca, Greg. Mostyn, rare.
N. fusiformis, Grun. Mostyn, very rare.
N. granulata, Breb. Rhyl, rare.

N. interrupta, Kutz. Mostyn, common.
N. johnsonii, Greg. Colwyn Bay, rare.
N. litoralis, Dn. Colwyn Bay, rare.
N. lyra, Ehr. Surface of Dee, very rare.
N. marina, Greg. Colwyn Bay, common.
N. northumbrica, Dn. Colwyn Bay, rare.
N. numerosa, Dn. Hoylake, rare.
N. palpebralis, Breb. Connah's Quay, common.
N. peregrina, Dn. Mostyn, common.
N. pusilla, W. Sm. Connah's Quay, common.
N. pygmæa, Kutz. Mostyn, common.
N. rectangulata, Greg. Colwyn Bay, very rare.
N. rostrata, Ehr. Mostyn, very rare.
N. semiplena, Greg. Connah's Quay, rare.
N. suborbicularis, Greg. Mostyn, very rare.
N. subsalina, Dn. Helsby Marsh, common.
N. venata, Kutz. Chester cop, common.
N. westii, Greg. Queen's Ferry, common.

Nitzschia (Hassal) *bilobata*, W. Sm. Queen's Ferry, rare.
N. birostrata, W. Sm. Mostyn, rare.
N. closterium, W. Sm. Ince Marsh, very rare.
N. distans, Greg. Colwyn Bay, rare.
N. granulata, W. Sm. Mostyn, rare.
N. lanceolata, W. Sm. Mostyn, rare.
N. notabilis, Grun. Surface of Dee, rare.
N. obtusa, W. Sm. Helsby Marsh, rare.
N. panduriformis, Greg. Surface of Dee, rare.
N. paradoxa (Bacillaria paradoxa), Gmel. Surface of Dee, common.
N. plana, W. Sm. Ince Marsh, very rare.
N. punctata, Grun. Mostyn, rare.
N. reversa, W. Sm. Helsby Marsh, rare.
N. sigma, W. Sm. Mostyn, very common.
N. scalaris, W. Sm. Holywell, rare.

N. tænia, W. Sm. Connah's Quay, very common.

N. tryblionella, Hantz. Helsby Marsh, common.

Plagiogramma (Grev.) *gregorianum*, Grev. Surface of Dee, rare.

P. van-heurckii, Grun. Surface of Dee, rare.

Pleurosigma (W. Sm.) *æstuarii*, W. Sm. Surface of Dee, common.

P. angulatum, W. Sm. Mostyn, very common.

P. balticum, W. Sm. Connah's Quay, very common.

P. delicatulum, W. Sm. Mostyn, common.

P. distortum, W. Sm. Connah's Quay, common.

P. elongatum, W. Sm. Mostyn, common.

P. fasciola, W. Sm. Mostyn, very common.

P. formosum, W. Sm. Bangor, rare.

P. hippocampus, W. Sm. Connah's Quay, very common.

P. litorale, W. Sm. Mostyn, rare.

P. marinum, W. Sm. Rhyl, rare.

P. prolongatum, W. Sm. Mostyn, common.

P. obscurum, W. Sm. Connah's Quay, rare.

P. scalprum, W. Sm. Queen's Ferry, rare.

P. strigilis, W. Sm. Bangor, rare.

P. strigosum, W. Sm. Mostyn, rare.

P. tenuissimum, Greg. Colwyn Bay, rare.

P. transversale, Roper. Surface of Dee, rare.

Most of the British forms of *Pleurosigma* have been found in this district. Mostyn and Connah's Quay may be noted as particularly rich in this genus.

Rhabdonema (Kutz.) *arcuatum*, Kutz. Holywell, rare.

R. minutum, Kutz. Hilbre Island, rare.

Rhaphoneis (Ehr.) *amphiceros*, Ehr. Connah's Quay, common. Many varieties of this form are found in the district.

Rhizosolenia (Ehr.) *imbricata*, Brightw. Surface of Dee, rare.

R. setigera, Brightw. Connah's Quay, rare.

R. styliformis, Brightw. Connah's Quay, rare.

R. wighamii, Brightw. Surface of Dee, rare.

Schizonema (Agardh.) *crucigera*, W. Sm. Helsby Marsh, common.

S. eximium, Th. Mostyn, rare.

S. helmintosum, Greg. Helsby Marsh, rare.

S. vulgare, Th. Helsby Marsh, common.

Scoliopleura (Grun.) *latistriata*, Breb. Mostyn, common.

S. tumida, Breb. Mostyn, common.

Skeletonema (Grev.) *costatum*, Grun. Surface of Dee, rare.

Stauroneis (Ehr.) *acuta*, W. Sm. Queen's Ferry, very rare.

S. salina, W. Sm. Connah's Quay, rare.

S. linearis, W. Sm. Helsby Marsh, common.

Stephanopyxis (Ehr.) *turris*, Grev. Surface of Dee, rare.

Striatella (Kutz.) *unipunctata*, Ag. Helsby Marsh, very rare. It was a long time before I found this form, which is so common on the south coast.

Surirella (Turp.) *constricta*, W. Sm. Burton Marsh, rare.

S. crumena, Breb. Helsby Marsh, rare.

S. gemma, Ehr. Mostyn, very common.

S. fastuosa, Ehr. Mostyn, rare.

S. salina, W. Sm. Railway bridge, very common.

S. splendida, Kutz. Helsby Marsh, rare.

S. striatula, Turp. Mostyn, very common.

Synedra (Ehr.) *affinis*, Kutz. Hilbre Island, very common.

S. affinis, var. *arcus*, Kutz. Helsby Marsh, very common.

S. fulgens, W. Sm. Isle of Man, common.

S. gallionii, Ehr. Isle of Man, rare.

S. obtusa, W. Sm. Helsby Marsh, common.

S. pulchella, var. *acicularis*, Kutz. Mostyn, common.

Toxonidia (Dn.) *gregoriana*, Dn. Connah's Quay, rare.

T. insignis, Dn. Surface of Dee, rare.

Triceratium, (Ehr.) *brightwellii*, West. Surface of Dee, rare.

T. favus, Ehr. Connah's Quay, very rare.

T. striolatus, Ehr. Surface of Dee, rare.

T. favus, which is so common in the estuary of the Thames, is a very rare form in this district, and not common on the west side of England.

REPORT on the MARINE ALGÆ of the L.M.B.C. DISTRICT.

By R. J. Harvey Gibson, M.A., F.R.S.E., F.L.S.,
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[Read 8th March, 1889.]

In the First Report of the Liverpool Marine Biological Committee* a brief catalogue is given by Mr. A. Leicester of species of marine Algæ collected during the various expeditions undertaken by the committee. As stated by Mr. Leicester, "no particular search was made for Algæ, the primary object of the expeditions being to collect animals." Mr. Leicester notes the occurrence of twelve species of Phæophyceæ, fifteen species of Rhodophyceæ, and one species of Chlorophyceæ.

It has been thought desirable by the committee that the Second Report should include a more detailed and complete list of the marine Algæ of the district mapped out as the field of the committee's work. Although I have not as yet had many opportunities of investigating the Algæ of that district with anything approaching thoroughness, I feel that the occasion of the publication of the Second Report should not be allowed to slip past without incorporating in that volume a synopsis of the work already done in this department of Botany, together with a record of the additions to the list of the marine Flora which have been made during the past year. From the little I have been able to accomplish in that line, I feel convinced that the marine Algæ form a field for investigation scarcely the borders of which have as yet been explored. I think this

* *The First Report upon the Fauna of Liverpool Bay and the Neighbouring Seas.* Liverpool, 1886, p. 312.

is especially true of the minute parasitic forms among the Rhodophyceæ. I trust that ere the time arrives for the publication of the Third L.M.B.C. Report I may be able to justify that remark, and to largely increase the list which at present represents our knowledge on the subject.

Since the establishment of the Biological Station on Puffin Island, Anglesey, the opportunities of satisfactorily dealing with the many and interesting problems connected with the structure, distribution, and life-history of marine Algæ, have been enormously increased. The zone between high and low water marks abounds in forms belonging to all the main divisions of the group, and I feel sure that a thorough exploration of that zone (which I purpose making during the ensuing summer) will result in the discovery of many species new to the district, if indeed we are not fortunate enough to meet with species new to British seas.

So far as I can discover, the literature on the Algæ of the district includes only several short papers published by Mr. F. P. Marrat, of the Liverpool Free Public Museum, in the *Liverpool Naturalist's Scrap Book* (1863-1864); a list quoted by the Rev. H. H. Higgins in the First Report of the L.M.B. Committee,* indicating those species which were found on the shores of Puffin Island by Mr. Marrat during an expedition of the Liverpool Naturalists' Field Club, in June, 1865; a list of Algæ from Puffin Island, published by Mr. C. S. Gregson in the *Naturalist*, vol. ii.; and the list by Mr. Leicester, already referred to. I have incorporated these lists in the present report, not only because I am anxious to present as complete a catalogue as possible, but also because Mr. Marrat's lists are hidden in the pages of a long extinct periodical, very scarce and not easy of access. The copy I have consulted is in the Free Library of Liverpool.

* *Pioneers in Local Biology*, loc. cit. p. 24.

Mr. Marrat has been for many years engaged in the investigation of the Algæ of the district, both fresh water and marine, and with great generosity he has allowed me to make use of his extensive unpublished list. I desire also to acknowledge his kindness in placing his notes at my disposal, extracts from which I have freely incorporated in the following pages.

Among the more recent treatises on the subject, that of Dr. Ferdinand Hauck of Trieste,* in Rabenhorst's *Kryptogamenflora*, is one of the most complete and exhaustive. I have followed Hauck's nomenclature, both specific and classificatory, save that I have altered the family terminations. I have, however, noted the synonyms employed by Harvey in his *Phycologia Britannica*, a valuable work, which, though considerably behind date in microscopic matters, may still be looked upon as the standard work on the subject for British seas. Where a species has not been observed by Hauck I have adopted Harvey's specific nomenclature.

Mr. Marrat draws attention to the fact that "the Mersey district is much less productive now than it was in former years. In 1860 the seaweeds on our coast were cleaner, finer in colour, and more healthy in their general appearance than they are now." This degeneration is, I think, without doubt to be accounted for by the increasing amount of impurities in the rivers Mersey and Dee, derived from the chemical and other works whose refuse finds its way into them. "The Algæ of the Cheshire coast," as Marrat remarks, "are peculiar and marked in their character. In place of the beautiful well-grown plants found on Puffin Island, the coast of Wales, Anglesey, and the Isle of Man, we have many dwarfed and stunted specimens. Parasites coat and envelope some species of

* *Die Meeresalgen Deutschlands und Oestereiches*, Leipzig, 1885.

Ceramium and *Cladophora* almost from the time of their commencing to grow." Species belonging to "the genera *Ceramium* and *Callithamnion* are only about one-half the size of well-grown plants belonging to the same species found in the above named localities." I quite agree with Marrat in thinking that "the matted bases of close-growing and intertwined slender species would form a very prolific source of novelties." Marrat also calls attention to the "large mud-covered banks of Bromborough and Wallasey pools, upon the sides of which many beautiful but minute microscopic forms are exclusively found. Caves near the sea, only occasionally supplied with salt water, are fertile sources for the obtaining of the rarer species."

Whilst recently investigating the shores of Puffin Island, I was particularly struck by the fact, long ago pointed out by Forbes, namely, that the shore between high and low water mark could be divided into zones characterised by the luxuriant development of one or more especially prominent genus, as, for example, the *Laminaria* zone at extreme low water mark, the *Fucus* zone above, followed by other zones characterised by the presence of Rhodophyceæ and Chlorophyceæ. The association of various forms, such as, for example, certain species of *Polysiphonia* with certain species of *Fucus*, is also a point of some interest. I hope ere long to lay before the Biological Society some notes on the distribution of Algæ on the shores of Puffin Island, where these zones may be very readily studied.

Altogether 230 species of marine Algæ have been noted as occurring in the L.M.B.C. district, of which 59 belong to the Phæophyceæ, 115 to the Rhodophyceæ, 42 to the Chlorophyceæ, and 14 to the Cyanophyceæ. Of these 219 are recorded by Marrat in his published papers or are included in his private list. Of the 28 species noted by

Leicester, 24 are mentioned by Marrat. In the present report seven species are recorded as occurring in the district, though not included, so far as I am aware, in previous catalogues, published or unpublished.

Species recorded by Marrat, or mentioned in his lists as having been found by others, are distinguished by having (M) appended to them after the locality; those found by Leicester and by myself by (L) and (G) respectively.

Series A. **RHODOPHYCEÆ.**

Order I. FLORIDEÆ.

Family. PORPHYRIDÆ.

Bangia fusco-purpurea, Lyngb.

At the roots of *Polysiphonia* and *Ceramium* (M). Not uncommon at the north end of Puffin Island (G).

Porphyra laciniata, Ag.

P. vulgaris, Harvey.

Plentifully distributed (M). *P. laciniata* has been considered as a variety of *P. vulgaris*. Marrat, who records both *P. vulgaris* and *P. laciniata*, mentions having found the latter occasionally as much as half an inch wide. Puffin I., 1865 (M), 1889 (G).

Family. SQUAMARIDÆ.

Peyssonnelia dubyi. Crouan.

Locality not recorded (L).

Petrocelis pellita, J. Ag.

Cruoria pellita, Harvey.

South shore, Hilbre I. and New Brighton (M).

Family. WRANGELIDÆ.

Chantransia virgulata, Thur.

Callithamnion virgulatum, Harvey.

On *Ceramium rubrum*, Eastham (M). Puffin I. (G).

Monospora pedicellata, Sol.
Callithamnion pedicellatum, Harvey.
Locality not recorded (M), (L). Puffin I. (G).

Spermothamnion turneri, Aresch.
Callithamnion turneri, Harvey.
Locality not recorded (M).

Niccaria wigghi, Endl.
Isle of Man (M).

Family. HELMINTHOCLADIIDÆ.

Nemalion multifidum, J. Ag.
The coast generally (M).

Family. CERAMIIDÆ.

Rhodochorton rothii, Näg.
Callithamnion rothii, Harvey.
Common on the rocks and pier walls (M).

R. floridulum, Näg.
Callithamnion floridulum, Harvey.
Locality not recorded (M). Puffin I. (G).

Anthithamnion cruciatum, Näg.
Callithamnion cruciatum, Harvey.
In rock pools at Hilbre I., parasitic on *Cladostephus spongiosus* (M).

A. plumula, Thur., var. *genuinum*.
Callithamnion plumula, Harvey.
Isle of Man (M).

Callithamnion pluma, Ag.
Parasitic on stems of *Laminaria digitata* and other species, Puffin I. (G).

C. thuyoides, Ag.
Isle of Man (M).

C. polyspermum, Ag.
Many localities (M).

C. tetragonum, Ag., var. *genuinum*.
Coast generally (M). Puffin I. (G).

C. tetragonum, Ag., var. *brachiatum*.
Callithamnion brachiatum, Harvey.
Coast generally (M). Puffin I. (G).

C. corymbosum, Ag.
Locality not recorded (M). Rather plentiful at Puffin I. (G).

C. byssoideum, Arn.
Hilbre I. (M).

C. seirospermum, Griff.
Seirospora griffithsiana, Harvey.
Hilbre I., parasitic on *Sphacelaria scoparia* (M).

C. granulatum, Ag.
C. spongiosum, Harvey.
Coast generally (M).

C. brodiæi, Harv.
Isle of Man and coast generally (M).

C. roseum, Lyngb.
Not rare, but locally not recorded (M).

C. hookeri, Ag.
Not uncommon in pools at New Brighton (M).

C. davesii, Lyngb.
On *Ceramium rubrum* at Rock Ferry, and on *Cladostephus spongiosus* on North shore (M).

Pleonosporium borreri, Näg.
Callithamnion borreri, Harvey.
Common on the South shore, and at Hilbre I. and New Brighton (M). Puffin I. (G).

Griffithsia barbata, Ag.
New Brighton (M).

G. setacea, Ag.
Isle of Man and Puffin and Hilbre Is., at low water (M and G).

G. corallina, Ag.

Isle of Man (M); locality not recorded (L).

G. equisetifolia, Ag.

In drift on Lancashire and Cheshire coasts (M).

Ptilota elegans, Bonnem.

P. sericea, Harvey.

Common (M); abundant at Puffin I. (G).

P. plumosa, Ag.

Locality not recorded (M and L); Puffin I. (G).

Ceramium tenuissimum, J. Ag.

C. nodosum, Harvey.

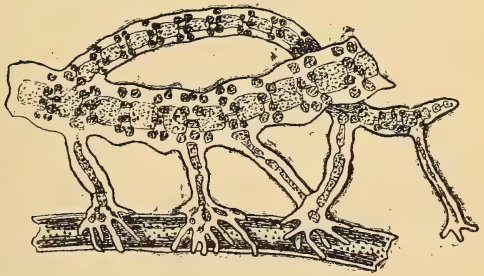
Hilbre I. (M); Puffin I. (G).

C. fastigiatum, Harv.

Hilbre I. (M).

C. deslongchampii, Chauv.

Hilbre I., New Brighton (M). Very abundant on Puffin I., parasitic on many species of Algæ (M and G). The figure shows a branch of *C. deslongchampii*



with twigs transformed into clasping organs. In this case the supporting plant was a stout filament of *Porphyra laciniata*, but I have found it with similar attachments to *Chylocladia articulata*, *Ceramium rubrum*, and other species. In some specimens

I fancied I detected an intercommunication of protoplasm between cells of the "host" and those of the "parasite," but I have not as yet succeeded in obtaining a specimen which shows this in such a manner as to leave no doubt as to the actual union of protoplasmic elements.

C. strictum, Grev. et Harv.

Common at Puffin I. (G).

C. diaphanum, Roth.

New Brighton and Hilbre I., parasitic or on rocks (M).

C. rubrum, Ag.

Very common at Hilbre I. and very variable, often parasitic (M). Extremely abundant at Puffin I. (M and G); locality not recorded (L).

C. rubrum, Ag., var. *decurrens*.

C. decurrens, Harvey.

Not uncommon at New Brighton and Hilbre I. (M).

C. ciliatum, Ducl.

Parasitic on *Chylocladia articulata*, at Puffin I. (M and G).

C. ciliatum, Ducl., var. *echinatum*.

New Brighton (M).

C. echionotum, J. Ag.

Puffin I. (M. and G.)

C. flabelligerum, J. Ag.

Locality not recorded (M); Puffin I. (G).

C. acanthonotum, Carm.

Purple forms at Hilbre I., white at Puffin I. (M). I found two specimens at Puffin I. which had the usual dark red colour.

C. botryocarpum, Griff.

Isle of Man (M).

Gloiosiphonia capillaris, Carm.

Isle of Man (M).

Family. SPYRIDIIDÆ.

Spyridia filamentosa, Harv.
Holyhead (M).

Family. CRYPTONEMIIDÆ.

Sarcophyllis edulis, J. Ag.

Iridæa edulis, Harvey.
Isle of Man and Puffin I. (M).

Fastigiaria furcellata, Stackh.

Furcellaria fastigiata, Harvey.
Hilbre I., Eastham, New Brighton, Rock Ferry (M).

Dumontia filiformis, Grev.
Shore near Little Hilbre I. (M); Puffin I. and Anglesey (M and G).

Family. GIGARTINIDÆ.

Chondrus crispus, Stackh.
Hilbre I., South shore, Eastham (M); locality not recorded (L); Puffin I. (M and G). Marrat notes the existence of an almost white variety near high water mark.

C. norvegicus, Lamour.
Rarely at Hilbre I. and Isle of Man (M).

Gigartina mammillosa, J. Ag.
Hilbre and Puffin Is., Anglesey, and I. of Man (M).

Gymnogongrus plicatus, Kütz.
Hilbre I. and I. of Man (M); Puffin I. (M and G).

G. griffithsiæ, Mart.
Isle of Man and rarely at New Brighton (M).

Phyllophora rubens, Grev.
Hilbre I., Isle of Man (M); Puffin I. (M and G).

P. membranifolia, J. Ag.
Hilbre I., Isle of Man, and Puffin I. (M).

Cystoclonium purpurascens, Kütz.

Hypnœa purpurascens, Harvey.

Hilbre and Puffin Is., New Brighton, and Isle of Man (M).

Family. RHODYMENIIDÆ.

Chylocladia articulata, Grev.

Hilbre I., Eastham, New Brighton, and I. of Man (M). Puffin I., very abundant (M and G).

C. claviformis (?).

Marrat also records a species under this name, without giving the authority, but I have not been able to find any mention of this species in the works I have had access to.

Rhodymenia palmetta, Grev.

Locality not recorded (L); Puffin I. (G).

R. palmata, Grev.

Plentiful at Hilbre I. (M); abundant at Puffin I. (G).

R. laciniata, Grev.

Not rare, but locality not stated (M).

R. bifida, Grev.

Rarely at Puffin I. (M).

R. ciliata, Kütz.

Isle of Man, Anglesey, and Puffin I. (M).

Plocamium coccineum, Lyngb.

Not uncommon at Isle of Man, Hilbre and Puffin Is. (M). I have found this species in abundance at Puffin I. Leicester records it, but does not state the locality. Also rarely at New Brighton, and cast ashore at Bootle and Southport (M).

Hydrolapathum sanguineum, Stackh.

Delesseria sanguinea, Harvey.

Isle of Man (M); Puffin I. (M and G).

Family. DELESSERIIDÆ.

Nitophyllum punctatum, Harv.
Rarely at New Brighton (M).

N. laceratum, Grev.
Generally (M).

Delesseria hypoglossum, Lamour.
Hilbre and Puffin Is., Isle of Man, Welsh coast (M).

D. ruscifolia, Lamour.
Isle of Man (M).

D. alata, Lamour.
Hilbre I., Hoylake, Isle of Man, and Anglesey (M). Very plentiful at Puffin I. (M and G). Marrat notes the finding of a green variety; but I have found many specimens with some fronds green and others intermediate between that and the natural colour on the same plant, the variation in the colouring being obviously due to decay, disease or bleaching.

D. sinuosa, Lamour.
Hilbre I. (M). Puffin I. (G).

Family. SPHÆROCOCCIDÆ.

Gracelaria confervoides, Grev.
Hilbre I., Welsh coast, Isle of Man (M). Puffin I. (M and G).

Sphærococcus coronopifolius, Stackh.
Isle of Man (M).

Family. SOLIERIIDÆ.

Catenella opuntia, Grev.
Hilbre I., Eastham, New Brighton, Puffin I., on the rocks very common (M). This species is also recorded by Leicester, although the locality is not stated. I searched for it at Puffin I., but was unable to find

any specimens. I fear that it is often confounded with *Chylocladia articulata*, which at first sight it closely resembles.

Family. GELIDIIDÆ.

Gelidium crinale, J. Ag.

G. corneum, var. *crinale*, Harvey.

Eastham (M).

G. corneum, Auct.

Marrat records the variety *latifolium* of this species from Hilbre I., and also a variety (unnamed) from the Isle of Man and from Hilbre I.

Family. SPONGIOCARPIDÆ.

Polyides lumbricalis, Grev.

P. rotundus, Harvey.

South shore, Hibre I. (M). Marrat marks this species with a query.

Lomentaria kaliformis, Gaill.

Chylocladia kaliformis, Gaill.

Isle of Man (M).

Family. RHODOMELIDÆ.

Odonthalia dentata, Lyngb.

Isle of Man, Hilbre and Puffin Is., and among drift Zoophytes at New Brighton (M).

Laurencia pinnatifida, Lamour.

Hilbre I. rarely (M). In abundance at Puffin I. (G).

L. cæspitosa, Lamour.

Locality not stated (M).

Rhodomela subfusca, Ag.

Hilbre and Puffin Is., occasionally (M); tolerably abundant at the latter (G).

R. lycopodioides, Ag.

Sparingly at Eastham and Hilbre I. (M).

Rytiphlœa thuyoides, Harv.

Occasionally at Puffin and Hilbre Is. (M). Marrat records this and the two succeeding species as members of the genus *Rhodomela*.

R. fructiculosa, Harv.

Occasionally at Puffin and Hilbre Is. (M).

R. pinnastroides, Ag.

Locality not stated (M).

Bonnemaisonia asparagoides, Ag.

Isle of Man (M).

Polysiphonia urceolata, Grev.

On rocks, at the roots of other Algæ (M and G).

P. pulvinata, Kütz.

Rarely at Eastham, New Brighton, and Hilbre I. (M); also occasionally at Puffin I. (M and G).

P. violacea, Grev.

Locality not recorded (M).

P. elongata, Harv.

Locality not recorded (M).

P. elongella, Harv.

Locality not recorded (M). In drift on Penmon Point, Anglesey (G).

P. variegata, Zanard.

Puffin I. (G).

P. brodiæi, Grev.

Locality not recorded (M); Puffin I. (G).

P. byssoides, Grev.

Locality not recorded (M); Puffin I. (G).

P. nigrescens, Grev.

Variable in colour, at New Brighton, Eastham, and Hilbre I.; common (M). Puffin I. (G).

P. fastigiata, Grev.

Common on species of *Fucus* (M). Extremely abundant at Puffin I., parasitic on *Ascophyllum nodosum* (G). Locality not recorded (L).

P. formosa, Suhr.

Locality not recorded (M and L); Puffin I. (G).

P. fibrata, Harv.

Hilbre and Puffin Is. (M and G).

P. fibrillosa, Grev.

Locality not recorded (L).

Dasya coccinea, Ag.

Marrat records two varieties, one a bright rose red, the other a dull purple, from the I. of Man, Hilbre and Puffin Is., and elsewhere. I found the rose red variety to be one of the commonest of the Rhodophyceæ on Puffin I. Marrat remarks that "the Hilbre Island plants are not like either the Manx or Devonshire forms." Locality not recorded (L).

Family. Corallinidæ.

Melobesia farinosa, Lamour.

General on the coast (M).

M. membranacea, Lamour.

General on the coast (M). Puffin I. (G).

M. pustulata, Lamour.

Parasitic on *Phyllophora rubens*, at Puffin I. (M); also on various other Rhodophyceæ at the same locality (G). I confess to having some doubts as to the advisibility of separating these two forms, *M. pustulata* and *M. membranacea*. Croall and Johnstone (*Nature Printed British Seaweeds*) consider the latter as an "imperfectly developed state" of the former.

M. verrucata, Lamour.

Locality not recorded (M); parasitic on various Rhodophyceæ at Puffin I. (G).

M. rubra, Meneg.

General (M). This species is not recorded in the works of Harvey or any other writer on British seaweeds. I have not had access to Meneghini's works, and so am unable to say whether it is represented by a synonym in other lists.

Lithothamnion calcareum, J. Ag.

Melobesia calcarea, Harvey.

A deep water species, dredged in large quantities in the "Hyæna" expedition of 1888. Prof. Herdman informs me that the bottom of the Irish Sea, round the eastern shores of the Isle of Man, seems in many places to be covered with this species.

L. polymorphum, Aresch.

Melobesia polymorpha, Harvey.

Isle of Man (M).

L. fasciculatum, Aresch.

Melobesia fasciculata, Harvey.

Puffin I. (M).

Lithophyllum lichenoides, Rosan.

Melobesia lichenoides, Harvey.

Puffin I. (M and G).

Corallina rubens, Linn.

Jania rubens, Harvey.

Puffin I. (M and G).

C. officinalis, Linn.

Very abundant in rock pools on the coast generally (M and G). Locality not recorded (L).

Series B. **PHÆOPHYCEÆ.**

Order II. FUCOIDEÆ.

Family. FUCIDÆ.

Sargassum linifolium, Ag.
Sargassum vulgare, Harvey.
Not unfrequently cast ashore (M).

Himanthalia lorea, Lyngb.
Abundant at the Isle of Man (M).

Ascophyllum nodosum, Le Jol.
Fucus nodosus, Harvey.
Very abundant at Puffin and Hilbre Is., and elsewhere (M and G). Locality not recorded (L).

A. nodosum, Le Jol., var. *scorpioides*.
Occasionally on the coast of Anglesey (G).

Fucus vesiculosus, Linn.
Abundant on the coast generally (M and G). Locality not recorded (L).

F. platycarpus, Thur.
Two or three patches on the rocks at the north end of Puffin I. (G).

F. serratus, Linn.
Extremely abundant on the coast generally (M and G). Locality not recorded (L).

F. canaliculatus, Linn.
Abundant at Hilbre I. (M). Also at Puffin I. (G).

Halidrys siliquosa, Lyngb.
Frequently cast up in drift (M and G). Locality not recorded (L).

Cystosira granulata, Ag.
Rarely at Hilbre I. (M).

Order III. DICTYOTEÆ.

Family. DICTYOTIDÆ.

Dictyota dichotoma, Lamour.
I. of Man, Puffin I. (M). Locality not recorded (L).

Order IV. PHÆOZOOSPOREÆ.

Family. ECTOCARPIDÆ.

Myrionema vulgare, Thur.
M. strangulans, Harvey.
Locality not recorded (M).

M. lechlancherii, Grev.
Hilbre I., on *Rhodymenia palmata* (M).

M. punctiforme, Harv.
On *Ceramium rubrum* and *C. deslongchampii* at Hilbre I. (M).

Ectocarpus velutinus, Kütz.
Elachista velutina, Harvey.
Parasitic on *Himanthalia lorea*, Isle of Man (M).

E. tomentosus, Lyngb.
Common on species of *Fucus* at Hilbre I. and New Brighton (M).

E. crinitus, Carm.
Marrat states that some plants of this species were found growing in the Aquarium in the Liverpool Museum, but does not state whence they were obtained.

E. confervoides, Le Jol.
E. siliculosus, Harvey.
The landing stage of New Brighton, and Eastham; also at Hilbre I. and elsewhere (M).

E. fasciculatus, Harv.
Occasionally at Hilbre I. (M).

E. granulosa, Ag.
New Brighton and Hilbre I. (M); Puffin I. (M and G).

E. littoralis, Lyngb.
On species of *Fucus* (M). One of the commonest species of *Ectocarpus* at Puffin I. (G).

E. hinksiæ, Harv.
The coast generally (M and G).

Myriotrichia clavæformis, Harv.
Generally on the coast (M).

M. filiformis, Harv.
Locality not recorded (M).

Sphacelaria radicans, Ag.
Not uncommon on the South shore and at New Brighton (M).

S. cirrhosa, Ag.
Common at Hilbre I., Eastham, and I. of Man (M); also at Puffin I. (G).

S. fusca, Ag.
Not rare at Puffin and Hilbre Is. (M).

S. scoparia, Lyngb.
Common at Hilbre (M), and at Puffin Is. (G).

Chætopteris plumosa, Kütz.
Sphacelaria plumosa, Harvey.
Hilbre and Puffin Is., rare (M); rather plentiful on the north-east end of Puffin I. (G). Locality not recorded (L).

Cladostephus verticillatus, Ag.
Puffin I. (M).

C. spongiosus, Ag.
Puffin and Hilbre Is., not rare (M). Plentiful at the former and tolerably abundant at low water at the latter locality (G). Locality not recorded (L).

Family. MESOGLŒIDÆ.

Elachista scutellata, Duby.
On the stems of *Himanthalia lorea*, near Port St. Mary, I. of Man (M).

E. flaccida, Aresch.
On *Cystosira fibrosa* (M).

E. fucicola, Fries.
Very common on species of *Fucus* (M and G).

Leathesia umbellata, Menegh.
L. tuberiformis, Harvey.
Hilbre I. (M).

Castagnea virescens, Thur.
Mesoglœa virescens, Harvey.
Locality not recorded (M).

Mesoglœa vermiculata, Le Jol.
M. vermicularis, Harvey.
Puffin and Hilbre Is., and shore generally (M and G).

M. verticillata, Ag.
Puffin I. (M).

Chordaria flagelliformis, Ag.
Hilbre I., Eastham, South shore, &c. (M). Puffin I. (G).

Family. PUNCTARIIDÆ.

Punctaria plantaginea, Grev.
Coast generally (M and G).

P. latifolia, Grev.
Locality not recorded (L).

Dictyosiphon fœniculaceus, Grev.
Hilbre I., Eastham (M). In drift at Penmon Pt. (G).

Striaria attenuata, Grev.
Coast generally (M).

Desmarestia viridis, Lamour.

Isle of Man (M). Puffin I. (M and G). Locality not recorded (L).

D. aculeata, Lamour.

Cast ashore frequently; abundant at the I. of Man (M), and at Puffin I. (M and G). Locality not recorded (L).

Litosiphon pusillus, Harv.

On *Chorda filum*, at Bangor and Hilbre I. (M).

L. laminariæ, Harv.

On *Chorda filum*, at Bangor and Hilbre I. (M).

Family. SPOROCHNIDÆ.

Asperococcus echinatus, Grev.

I. of Man and Hilbre I. (M); Puffin I. (M and G).

A. turneri, Hook.

Locality not recorded (M).

Family. SCYTOSIPHONIDÆ.

Phyllitis fascia, Kütz.

Laminaria fascia, Harvey.

Hilbre I., at extreme low water (M).

Scytosiphon lomentarius, J. Ag.

Chorda lomentaria, Harvey.

Hilbre and Puffin Is. and Isle of Man (M).

Family. LAMINARIIDÆ.

Chorda filum, Stackh.

Hilbre I., between the Great and the Little Eye (M). Puffin I., at extreme low water (G).

Laminaria digitata, Lamour.

Welsh coast and Isle of Man (M). Very abundant at extreme low water at Puffin I. (G). Locality not recorded (L).

L. saccharina, Lamour.

Port St. Mary, I. of Man (M). Puffin I. and Penmon Point (G). Locality not recorded (L).

L. saccharina, Lamour, var. *phyllitis*.

Laminaria phyllitis, Harvey.

On the life-boat, New Brighton (M).

Alaria esculenta, Grev.

I. of Man, Anglesey, and Hilbre I., at low water (M).

Ralfsia verrucosa, J. Ag.

Puffin I. (M and G).

Family. CUTLERIIDÆ.

Cutleria multifida, Grev.

Hilbre and Puffin Is., and Isle of Man (M).

Aglaozonia reptans, Kütz.

Zonaria parvula, Harvey.

Coast generally (M).

Series C. **CHLOROPHYCEÆ.**

Order V. OOSPOREÆ.

Family. VAUCHERIIDÆ.

Vaucheria marina, Ag.

New Brighton (M).

V. thuretii, Woron.

V. velutina, Harvey.

Forming velvety cushions on the mud near high water mark at Eastham (M).

Order VI. CHLOROZOOSPOREÆ.

Family. ULVIDÆ.

Monostroma grevillei, Wittr.

Ulva lactuca, Harvey.

Locality not recorded (M). Puffin I. (G).

Enteromorpha intestinalis, Link.
Not uncommon (M). Exceedingly abundant in pools near high water mark and beneath that point, at Puffin I. (G).

E. linza, J. Ag.
Ulva linza, Harvey.
Common (M and G).

E. compressa, Grev.
Not uncommon (M and G).

E. clathrata, T. Ag.
Eastham (M).

E. erecta, J. Ag.
Occasionally at New Brighton (M).

E. ramulosa, Hook.
Plentiful (M and G).

E. percursa, J. Ag.
Occasionally on mud at New Brighton (M).

E. ralfsii, Harv.
General on the coast (M and G).

E. granulosa, (——?).
Marrat records this species, without giving the authority, from New Brighton.

Ulva lactuca, Le Jol., var. *genuina*.
Ulva latissima, Harvey.
Common at Hilbre I. and New Brighton (M). Very abundant in pools at or near high water at Puffin I. (G). Locality not recorded (L).

Family. CONFERVIDÆ.

Chætomorpha melagonium, Kütz.
Conferva melagonium, Harvey.
The coast generally (M). Puffin I. (G).

C. crassa, Kütz.

Conferva linum, Harvey.

Locality not recorded (M). Puffin I. (G).

C. ærea, Kütz.

Conferva ærea, Harvey.

South shore and Eastham (M).

C. tortuosa, Kütz.

Conferva tortuosa, Harvey.

On the North slip, Prince's Pier (M).

Ulothrix flacca, Thur.

Lyngbya flacca, Harvey.

Isle of Man (M).

U. isogona, Thur.

Lyngbya speciosa, Harvey.

Common at Puffin I. (G), and generally (M).

Rhizoclonium tortuosum, Kütz.

Conferva implexa, Harvey,

Locality not recorded (M). Puffin I. (G).

R. riparium, Harv.

Bromborough and Wallasey Pools, Eastham, and Hilbre I. (M).

R. gasparyi, Harv.

Eastham (M).

Cladophora arcta, Kütz.

Bromborough and Wallasey Pools, Eastham, and Hilbre I. (M). Puffin I. (G).

C. lanosa, Kütz.

Isle of Man and Anglesey (M). Puffin I. (M and G).

Parasitic on *Fastigiaria furcellata*.

C. pellucida, Kütz.

In a cave at Hilbre I. (M).

C. rupestris, Kütz.

Very common (M and G).

C. hutchinsiæ, Kütz.
Isle of Man, New Brighton, and Hilbre I. (M). *C. diffusa*, Harv., recorded as from New Brighton by Marrat, is synonymous with *C. hutchinsiæ*.

C. utriculosa, Kütz., var. *lætevirens*.
C. lætevirens, Harvey.
Not uncommon at New Brighton (M). Puffin I. (G).

C. flexuosa, Harv.
New Brighton, Hilbre I., Eastham (M). Puffin I. (G).

C. rudolphiana, Harv.
Not uncommon at Hilbre I. (M).

C. gracilis, Kütz.
Occasionally at Hilbre I. (M).

C. albida, Kütz.
Eastham and Puffin I. (M).

C, glaucescens, Harv.
Puffin and Hilbre Is. (M and G).

C. fracta, Kütz.
C. flavescens, Harvey.
Bromborough Pool (M).

C. refracta, Kütz.
Puffin I. (M).

C. uncialis, Harv.
Puffin I. (M).

Family. BRYOPSIDÆ.

Bryopsis plumosa, Ag.
Isle of Man, Anglesey, Hilbre and Puffin Is., New Brighton (M).

B. hypnoides, Lamour.
Hilbre I. (M).

Conferva arenosa, Carm.
South shore (M).

C. litorea, Harv.
South shore and Eastham (M).

C. sutoria, Berk.
Hilbre I. (M).

C. youngana, Dilln.
Bromborough and Wallasey Pools, and the life-boat, New Brighton (M).

[The genus *Conferva* is one into which many dubious forms have been placed from time immemorial. I insert the above mentioned species here because they have been recorded by Marrat; and while they may be good species, there is the possibility that some of them may be merely varieties of one species under different conditions.]

Series D. **CYANOPHYCEÆ.**

Order VI. SCHIZOPHYCEÆ.

Family. NOSTOCIDÆ.

Calothrix confervicola, Ag.
Common on species of *Ceramium* (M).

C. scopulorum, Ag.
Generally distributed (M).

Rivularia plicata, Carm.
Generally distributed (M).

R. atra, Roth.
Generally distributed at Hilbre I. and South shore (M).

R. biasolettiana, Menegh.
Schizosiphon warreniæ, Harvey.
On mud-covered rocks (M).

Sphærozyga carmichœlii, Harv.
Eastham (M).

Lyngbya maguscula, Harv.
Not uncommon at Hilbre I., Eastham, and Wallasey (M).

L. semiplena, Ag.
Calothrix semiplena, Harvey.
Generally distributed (M).

L. æstuarii, Liebm.
L. ferruginea, Harvey.
Bromborough Pool and Hilbre I. (M).

Microcoleus chthonoplastes, Thur.
M. anguiformis, Harvey.
Generally distributed (M).

Oscillatoria littoralis, Carm.
North and South shores (M).

O. spiralis, Carm.
Eastham (M).

O. nigroviridis, Thwaites.
Eastham (M).

Family. CHROOCOCCIDÆ.

Gleocapsa crepidium, Thur.
On stones near high water mark, at Puffin I. (G).

SECOND REPORT on the *PORIFERA* of the L.M.B.C. DISTRICT.

By Richard Hanitsch, Ph.D.,
DEMONSTRATOR OF ZOOLOGY IN UNIVERSITY COLLEGE, LIVERPOOL.

With Plates V., VI. and VII.

[Read 8th February, 1889.]

Since the publication in 1886 of the "First Report upon the Porifera," by Mr. Thomas Higgin, F.L.S., in the first volume of "The Fauna of Liverpool Bay," several very important works upon the Sponges have appeared which have changed to a considerable extent the accepted views as to the classification of the group, and render a re-arrangement of the species dealt with in the former report absolutely necessary. I have found it convenient to arrange the Sponges in the following groups:—Myxospongiæ, Ceratosa, Monaxonida, Tetractinellidæ, Hexactinellidæ, and Calcarea. I regard these groups as orders, although I do not wish to state that they are all equivalent to each other. Every one of these orders, except the Myxospongiæ, has been treated of in a separate "Challenger" Report, and this fact justifies my classification sufficiently. In the further division of the orders I shall accept Ridley and Dendy's system for the Monaxonida, and Sollas's system for the Tetractinellidæ. In regard to the Calcarea, I shall follow Mr. Higgin's example and use Haeckel's classification, instead of that of Polejaeff. The Sponges in our district belonging to the remaining orders are so few in number that any further classification of them is unnecessary.

I will add an explanation, why I did not follow the latest classification of the sponges given by R. v. Lendenfeld,

in his "Catalogue of the Sponges in the Australian Museum, Sydney." This is the only work on sponges from that author which I have been able to see, and it would have been very difficult to identify even the genera by that catalogue, as figures of spicules and similar details necessary for identification are not given. Nor, perhaps, as v. Lendenfeld's work is a museum catalogue, should we expect to find illustrations of that kind in it. Finally, it did not seem advisable to me to re-arrange the species which I had identified chiefly by Bowerbank's "British Spongiadæ" and the "Challenger" Reports, according to the system of another author, especially as it has not yet been shown that v. Lendenfeld's classification is superior to that of the "Challenger" Reports.

The following list includes the Sponges recorded by Mr. Higgin in his "Report on the Porifera of the L.M.B.C. District." Those Sponges are marked in column "I." whilst the additions made in the present report are given in column "II." The nomenclature of this report differs in some cases from that of the first report, and I shall give the latter nomenclature in brackets. For the names of authors I use the following abbreviations:—

B. Bowerbank.	H. Haeckel.
C. Carter.	J. Johnston.
F. Fleming.	M. Montagu.
G. Gibson.	S. O. Schmidt.

I am able to add seven to the list of sponges recorded from this neighbourhood, of these is one (*Reniera semitubulosa*, S.) new to British seas, and one (*Seiriola compacta*) is new to science.

LIST of PORIFERA recorded from the L.M.B.C. DISTRICT.

Order I. MYXOSPONGIÆ.

Family.		I.	II.
HALISARCIDÆ	*Halisarca dujardinii*, J.	×	×

Order II. CERATOSA.

SPONGELIDÆ	*Dysidea fragilis*, J.	×	×

Order III. MONAXONIDA.

Subord. HALICHONDRINA.

HOMORRHAPHIDÆ.	*Halichondria panicea*, J. (*Amorphina panicea.*)	×	×
	Halichondria coccinea, B. (*Amorphina coccinea.*)	×	
	Halichondria albescens, J. (*Amorphina albescens.*)	×	
	Halichondria caruncula, B. (*Amorphina caruncula.*)	×	
	Reniera varians, B. (*Isodictya varians.*)	×	×
	Reniera elegans, B. (*Isodictya elegans.*)	×	
	Reniera simulans, J. (*Isodictya simulans.*)	×	
	Reniera fistulosa, B. (*Isodictya fistulosa.*)	×	×
	Reniera clava, B. (*Isodictya clava.*)	×	
	Reniera semitubulosa, S.		×
	Chalina oculata, J.	×	×
	Chalina limbata, M.	×	×
	Chalinula pallida, B. (*Isodictya pallida.*)	×	
	Chalinula densa, B. (*Isodictya densa.*)	×	

Family.		I.	II.
HETERORRHAPHIDÆ.	None.		
DESMACIDONIDÆ..	*Desmacidon incrustans*, J..... (*Halichondria incrustans.*)	×	
	Desmacidon fucorum, J..... (*Isodictya fucorum.*)	×	×
	Esperia ægagropila, C.....	×	
	Clathria seriata, J. ..... (*Ophlitaspongia seriata.*)	×	
	Plumohalichondria plumosa, C...	×	
AXINELLIDÆ.....	*Hymeniacidon sanguinea*, J.....	×	
	Raspailia viminalis, S.		×
	Raspailia stelligera, S. ..... (*Dictyocylindrus stuposus*, B.)	×	×
	Subord. CLAVULINA.		
SUBERITIDÆ.....	*Suberites carnosa*, J.	×	
	Suberites suberea, M.....	×	×
	Cliona celata, J.	×	×
	Papillina suberea, S. ..... (*Raphyrus griffithsia*, B.)	×	
	Polymastia mammillaris, J.....		×
	Polymastia robusta, B.		×
Order IV.	**TETRACTINELLIDÆ.**		
	Subord. CHORISTIDA.		
TETILLIDÆ.....	*Tethya lyncurium*, J.....		×
PACHASTRELLIDÆ.	*Dercitus niger*, C.	×	
SEIRIOLIDÆ.	*Seiriola compacta*, n. sp.		×
STELLETTIDÆ.	*Stelletta grubii*, S.	×	
	Ecionema ponderosa, B.....	×	×
GEODIIDÆ	*Pachymatisma johnstonia*, B. ...	×	×
	Subord. LITHISTIDÆ.		
	None.		

Order V. HEXACTINELLIDÆ.

None.

Order VI. CALCAREA.

Family.		I.	II.
Ascones	*Ascetta primordialis*, H.		×
	Ascetta coriacea, F.	×	
	Ascaltis botryoides, F.	×	
Leucones	*Leucandra fistulosa*, J.	×	
	Leucandra gossei, B.	×	
	Leucandra nivea, F.	×	
	Leucandra johnstonii, C.	×	
Sycones	*Sycandra ciliata*, F.	×	×
	Sycandra compressa, F.	×	×
	Aphroceras ramosa, C.	×	
	Sycortis aspera, G.	×	

Order I. MYXOSPONGIÆ.

Halisarca dujardinii, J.

Frequently met with by dredging and shore collecting at Puffin Island and other places. There seem to be two colours, grey and brownish.

Order II. CERATOSA.

Dysidea fragilis, J.

Dredged in Church Bay, near Holyhead, "Hyæna" Expedition, 1886. Collected on the Beacon Rocks, Puffin Island, 1st February, 1888.

Order III. MONAXONIDA.

Halichondria panicea, J.

Collected at Puffin Island, Hilbre Island, &c. on various occasions.

Reniera varians, B.

Collected at Hilbre Island, 20th March, 1886.

Reniera fistulosa, B.

Collected on "Hyæna" Expedition, 1888, off the south end of the Isle of Man, 20 fathoms.

Reniera semitubulosa, O. Schmidt.

Pellina semitubulosa, O. Schmidt.

Halichondria semitubulosa, Lieberkühn.

This Sponge was first described by Oscar Schmidt, in his "Spongien des Adriatischen Meeres." It had been found commonly near Venice, and formed an irregular base with numerous ascending branches, which were here and there fused together. The colour was greenish or whitish. One of the chief characteristics was that the dermal membrane could easily be separated from the underlying tissue. The oscula were found mostly on the extremities of the branches, but also on the other parts of the surface. The spicules were oxea. A few years afterwards O. Schmidt formed the new genus *Pellina*,* and gave the species which he formerly called *Reniera semitubulosa* as the type for it. In the same work he describes two other species of this genus: *Pellina bibula*, found in the Kattegat, and *Pellina profunditatis*, found near Florida.

Ridley and Dendy† do not agree with O. Schmidt's proposal to form a new genus for this sponge, not regarding the character of the separable dermal membrane as being of generic importance. They further remark, "The so-called dermal membrane is also a very distinct feature of *Halichondria panicea*, yet Schmidt keeps this species out of his genus *Pellina*, into which it ought certainly to fall

* Oscar Schmidt, "Spongienfauna d. Atl. Gebietes."

† Ridley and Dendy, "Report on the Monaxonida collected by H.M.S. *Challenger*," p. 15.

according to his definition, if such it can be called." For this reason I am also inclined to retain the generic name *Reniera* for this sponge.

A small specimen of it was found on the North Spit at Puffin Island, at low water, in September, 1887. The base of the specimen is about 2·5 cm. in height and 1 cm. in thickness. There are five branches arising from the base, three of which are broken off close to their origin, the two others are about 8 mm. in length by 3 mm. in diameter. The spicules are oxea, and measure about 0·3 mm. They are arranged in multispiculous triangular or quadrangular meshes.

Chalina oculata, J.

Dredged in Church Bay, near Holyhead, on the "Hyæna" Expedition, 1886.

Chalina limbata, M.

Two splendid specimens were obtained on the Beacon Rocks at Puffin Island, at low spring tide, 1st February, 1888.

Desmacidon fucorum, J.

Dredged in Church Bay, near Holyhead, on the "Hyæna" Expedition, 1886; also off the North side of Puffin Island, 12—15 fathoms, in February, 1888; and on 24th March, 1888; also off Calf of Man, 20 fathoms, "Hyæna" Expedition, 20th May, 1888.

Genus *Raspailia*, Nardo.

The genus *Raspailia* was founded first by Nardo, in the year 1833. The exact words of his definition are not known to me, but as Oscar Schmidt* states that he accepts Nardo's definition of the genus, giving it however in his own words, we may take it for granted that

* Oscar Schmidt, "Spongien des Adriatischen Meeres," p. 59.

Schmidt's definition agrees in general with that of Nardo. The characters are: from the narrow base of the sponges of the genus *Raspailia* branches are given off which may be simple or dichotomous. The spicules are arranged in two different ways—some lie in bundles in the vertical axis, the others are placed horizontally and project through the ectoderm. The bases of the spicules are imbedded in ceratose. The colour of the sponges is a dark yellow. Schmidt describes three species of this genus, two of which are of special interest to us: *Raspailia viminalis*, S. (with large and small styli and spined styli), and *Raspailia stelligera*, S. (with large and small styli and spherasters).

Bowerbank, when he published the first two volumes of his "British Spongiadæ," took no notice of Schmidt's researches, and so it came to pass that many species which had been already described by Schmidt, were re-described by Bowerbank as new species, and were christened once more. To those privileged sponges belonged the genus *Raspailia*, Nardo. Bowerbank's error was first pointed out by O. Schmidt, in his second supplement to the above mentioned work, and he stated that the sponges of the genus *Dictyocylindrus*, B., belong either to *Raspailia*, Nardo, or to *Axinella*, S., and that *Dictyocylindrus stuposus*, B., is identical with *Raspailia stelligera*, S. Consequently we find in Ridley and Dendy's classification the genera *Raspailia*, Nardo, and *Axinella*, S., instead of *Dictyocylindrus*, B. But their definition of *Raspailia* does not quite agree with that of Nardo and Schmidt, as they have added the negative character "no microsclera." Now *Raspailia stelligera*, S., could not come under the genus *Raspailia* as defined by Ridley and Dendy, for this species has microsclera. And it becomes still more difficult to find a place for *Raspailia stelligera*, S., in Ridley and Dendy's system, when we read on page xxi. of their "Introduction"

to the Report on the Monaxonida, that the only stellate forms of microsclera "which are certainly known to occur in the Monaxonida" are "spirulæ, discastra and amphiastra." According to this, *Raspailia stelligera*, S., as having spherastrous microscleres would not even belong to the Monaxonida. But there can be no doubt that *Raspailia stelligera* is a true monaxonid sponge, and I think even the presence of microsclera not important enough to remove it from the genus in which it had been placed by Schmidt. Therefore I would amend two points in Ridley and Dendy's Report. Firstly, spherasters should be mentioned as being a fourth form of stellate microsclera in the Monaxonida; and secondly, the limits of the genus *Raspailia* should be enlarged by leaving out the negative character "no microsclera," so as to reconstitute the older and wider genus defined by Nardo and Schmidt.

Raspailia viminalis, Schmidt (Pl. V., figs. 2—4).

Dictyocylindrus ventilabrum, Bowerbank.

Both the figures and the description of *Dictyocylindrus ventilabrum*, B., as given by Bowerbank, agree so fully with all the characters of *Raspailia viminalis*, S., as given by Schmidt, that I do not hesitate to consider those species as identical.

One specimen of this species was dredged on the "Hyæna" Expedition, 1886, in Church Bay, near Holyhead. Bowerbank records it from the British Channel and Brighton, and O. Schmidt from the Adriatic Sea. The colour of the living sponge is orange yellow.

Our specimen was apparently quite a young one, as it measured only 3·5 cm. in height. The stem is cylindrical, has a well pronounced expanded base, and bears distally two branches. The beginning of a third branch is just visible (see Pl. V., fig. 2). Bowerbank had much larger

specimens at his disposal. Of one of them he gives the following description:—"The pedicel is barely an inch in height; at an inch and a half from the base it has divided into four primary branches; within one inch from their origin these primary branches each divide dichotomously, and this mode of division continues, with a single exception of one branch dividing trichotomously, so that at four inches from the base there are as many as twenty-two, all nearly in the same plane, assuming a fan-shaped series of branches, eight inches in height by about the same extent in width. The branches are cylindrical," &c.

A transverse section through this sponge shows us that it consists of a solid mass without central cavity. The oscula are numerous, although visible only in those sections. Bowerbank has stated that the "oscula and pores are inconspicuous." The oscula open into irregular cavities, branching throughout the whole sponge. The spicules consist firstly of styli of two different sizes. The large styli measure from 1·2 mm. to 1·5 mm. by 0·013 mm.; the shorter ones from 0·42 mm. to 0·45 mm. by 0·004 mm. Besides that, we find spined styli, 0·124 mm. by 0·0055 mm. The ordinary styli are arranged either in bundles running parallel to the longitudinal axis of the sponge, or they form bundles standing at right angles to the longitudinal axis, and project for about two-thirds of their length through the ectoderm. This latter point had been noticed by Bowerbank,* who said that "in the dried condition of the sponge the fasciculi of radiating spicula project from the central cylinder of the skeleton to the extent of at least one-third of the whole diameter of the branch," but he adds, "it is probable that in a living state their apices would be barely visible beyond the dermal membrane." As I have stated already, sections through a well preserved

* Bowerbank, "British Spongiadæ," vol. ii., p. 101.

specimen of *Raspailia viminalis* do not leave any doubt that in a living state the spicules do project beyond the ectoderm. These projecting bundles of styli consist, in most cases, of one large stylus surrounded by a number of small ones. In some cases the bundles consist only of small styli, and lastly the large styli are also found singly. All those different arrangements are represented in the semi-diagrammatic figure (Pl. V., fig. 4). The spined styli are found scattered throughout the whole mass of the Choanosome.

Raspailia stelligera, Schmidt (Pl. V., fig. 1).

Dictyocylindrus stuposus, Bowerbank.

As Mr. Higgin states, this species has already been collected at Port Erin, Holyhead and Isle of Man. On the 16th and 17th of February last, Professor Herdman obtained a number of bright orange coloured sponges at extreme low tide, under one of the ledges of rock, on the north end of Puffin Island, near the Biological Station. The specimens showed a narrow base and an expanded distal portion with more or less numerous short branches. The whole mass was beset with rough ridges, and spicules were seen projecting through the ectoderm. The height of the sponge-masses varied between 2 cm. and 4 cm. Transverse and longitudinal sections through this sponge show that the arrangement of the megasclera is here the same as in *Raspailia viminalis*. The only remarkable point is the great masses of ceratose in which the bases of the spicules, especially of those in the interior, are imbedded. The bundles of the projecting spicules consist of styli, and the centre of these bundles is commonly formed by one or more shorter and stouter styli (0·92 mm. by 0·012 mm.), which are surrounded by long and thin styli (0·8—1·5 mm. by 0·0043 mm.). The spicules of the

interior are in most cases strongyla (0·54—0·85 mm. by 0·012 mm.), besides which there are found also styli of the above mentioned kind, and a very few oxea. The microsclera are spherasters, with about twelve rays, and measuring 0·02 mm. in diameter. Those spherasters are found only in the ectosome; they lie very close to the surface and are numerous, although they do not form a continuous layer.

Suberites suberea, M.

Collected at Puffin Island, on the North side, 14th January, 1888, and on the South Spit, March, 1888.

Cliona celata, J.

Raphyrus griffithsia, B.

Very common, boring in old shells and in the limestone rocks, at Puffin Island.

Polymastia mammillaris, Johnston (Pl. VI., figs. 1—3).

Spongia penicillus, Montagu.

Halichondria mammillaris, Johnston.

One small specimen of this Sponge was dredged in Church Bay, near Holyhead, on the "Hyæna" Expedition of 1886, and it is the first one which has been obtained in the L.M.B.C. district, although the species had previously been found at many points on the British coast. Johnston gives the following localities: coast of Devon, Scarborough and Strangford. Bowerbank mentions Larne Lough, Guernsey, Shetland, and the Orkney Islands. According to Vosmaer,* it is found in the Atlantic, Arctic, Mediterranean and Adriatic Seas generally. The specimen from Holyhead has a rounded basal mass of about 7 mm. in diameter, and had apparently been fixed to a small stone. Four papillæ are given off, the largest of which is 8 mm.

* Vosmaer, "Sponges of the Willem Barrents Expedition, 1880 and 1881," in "Bijdragen tot de Dierkunde."

in height. I do not think it necessary to figure this specimen, as figures of the entire *Polymastia mammillaris* have been given by Johnston, Bowerbank and Vosmaer. Vosmaer figures also a section through the basal mass and one of the papillæ. As the figure, however, is quite a low power view, it does not show some points of interest which I was able to make out in transverse and longitudinal sections through two of the papillæ. The papillæ have the form of tubes, in which the diameter of the central cavity is about as large as, or slightly larger than, the thickness of the wall. This central cavity gives off numerous recesses into the wall, which come so close to the surface that only a thin membrane, 0·02 mm. in thickness, is left separating the cavity from the outer world (see figs. 2 and 3, Pl. VI.). Seen from the surface those membranes are round or oval in outline, with a diameter of 0·08 to 0·14 mm. Oscula are not present either on the extremity of the papillæ or on their sides. The absence of oscula in the papillæ agrees with the generic characters of *Polymastia* given by Ridley and Dendy:*—"Genus *Polymastia*, Bowerbank. Suberitidæ of massive, sessile form, with more or less numerous mammiform processes on the upper surface, some of which may bear oscula at their summits, but usually without visible openings." Pores are most probably present in the above mentioned thin membranes (pore membranes), but I have not been able to see them satisfactorily.

The skeleton of *Polymastia mammillaris* has already been sufficiently described by the above mentioned authors. In the wall of the papillæ we find bundles of large and stout tylostyli (0·75—0·8 mm. by 0·01—0·012 mm.), running parallel to the long axis of the papillæ, and further bundles of short and thin tylostyli (0·15 mm. by

* Ridley and Dendy, "Report on the Monaxonida collected by H.M.S. *Challenger*," p. 210.

0·003 mm.) standing perpendicularly to the longitudinal axis and projecting for half their length through the ectoderm. One spicule of the former kind is given in fig. 1 *a*, Pl. VI.; one of the latter kind in fig. 1 *b*, Pl. VI. In regard to the arrangement of the spicules see figs. 2 and 3, Pl. VI.

Polymastia robusta, Bowerbank.

Dredged in Church Bay, near Holyhead, on the "Hyæna" Expedition of 1886. The largest of the three specimens has a flat basal mass, 5·5 cm. by 4 cm. in horizontal expansion and 1·5 cm. in thickness. On one side it bears between 30 and 40 papillæ, which in the natural condition probably are standing upright, but now have become pressed down upon the basal mass. These papillæ are laterally compressed and vary greatly in size. The largest measure 2 cm. in height and 7 mm. in breadth. They taper towards the extremities, but there are no oscula visible on their extremities. The dermal membrane can very readily be torn off from the basal mass. The colour of the specimens, which have been kept in spirit for nearly three years, is whitish. The skeleton consists of styli, which are of two different sizes: 0·6 mm. by 0·01 mm. and 0·17 mm. by 0·004 mm. The arrangement of the spicules is similar to that of *Polymastia mammillaris*.

According to Bowerbank, *Polymastia robusta* is found on the coast of Northumberland.

Order IV. **TETRACTINELLIDÆ.**

Tethya lyncurium, J.

Dredged in Church Bay, near Holyhead, on the "Hyæna" Expedition of 1886. This species had not previously been recorded in the L.M.B.C. district, although it is found, according to Bowerbank, at various localities on the British

coast: Plymouth, Torquay, Guernsey, Diamond Ground off Hastings. I may add the Chausey Islands, off the Normandy coast, from which locality there is one specimen, collected by Professor Herdman in 1882, in the Zoological Museum of University College, Liverpool. *Tethya lyncurium* has been found by Oscar Schmidt in the Adriatic Sea, and by Vosmaer in the Adriatic, Mediterranean, and Arctic Seas. A description of this well known sponge is not wanted.

Seiriolidæ, n. fam.

The tetractinellid sponge, described below under the name *Seiriola compacta*, appears so different from all described forms that I am obliged to found a new family for it, the "Seiriolidæ," called after St. Seiriol's Island, an older name for Puffin Island. This new family belongs clearly to the demus Streptastrosa, Sollas, since *Seiriola compacta* is an astrophorous sponge in which one of the microscleres is some form of spiraster. The three families of the demus Streptastrosa, Sollas, are now as follows:—

Fam. 1. Theneidæ: "The ectosome never forms a cortex; the mesoderm is a collenchyma; the flagellated chambers eurypylous" (Sollas).*

Fam. 2. Pachastrellidæ: "Streptastrosa, in which the chief megascleres are calthrops; triænes being absent. The microscleres may be spirasters, spherasters or microrabds. The choanosomal mesoderm is sarcenchymatous and the chamber system aphodal" (Sollas).

Fam. 3. Seiriolidæ: The ectosome forms a cortex. Chief megascleres triænes. The choanosomal mesoderm is cystenchymatous.

* Sollas, "Report on the Tetractinellidæ collected by H.M.S. *Challenger*," pp. 59 and 104.

*Seiriola,** n. gen.

Characterized by the tylostyles of the ectosome. This genus is formed for the single new species

Seiriola, compacta, n. sp. (Pl. VII., figs. 1 to 3).

This sponge was found by Mr. Rutherford, Curator of the Biological Station, Puffin Island, in June, 1888, in one of the caves on the N.W. side of the island which are exposed only at low spring tides.

The specimen forms a knob-like mass, like that of so many tetractinellid sponges, and measures horizontally 4 cm. by 1·5 cm., and vertically 1·3 cm. It is dark grey in colour and has a somewhat rough surface. A vertical section through this sponge shows that the cortex (which in this species is quite identical with the ectosome) is extraordinarily well marked off from the choanosome, and further examination shows that the ectosome is both in regard to skeleton and to histological structure, very different from the choanosome. The spicules of the ectosome are tylostyles, and their shape and arrangement reminded me at once of *Polymastia mammillaris*, which sponge, of course, belongs to quite a different group. These tylostyles measure from 0·1 to 0·38 mm. by 0·003 to 0·006 mm. They are arranged in bundles, and project for about one-half of their length through the ectoderm (see fig. 1, Pl. VII.).

The skeleton of the choanosome consists of megasclera and microsclera. The former show the following forms: dichotriæna, orthotriæna, oxea, styli, strongyla, tylota. The dichotriæna are very numerous, and are arranged immediately beneath the ectosome, with their cladomes directed towards the ectosome. The rhabdome measures from 0·36 to 0·42 mm., the protocladus from 0·06 to 0·09

* From Seiriol, an early Welsh saint, who is said to have had his cell on Puffin Island.

mm., and the deuterocladus from 0·037 to 0·045 mm. The orthotriæna are far less numerous and slightly smaller than the dichotriæna. They are also placed close to the ectosome. The oxea are the most numerous spicules, and are arranged in bundles, which take their origin in or immediately beneath the region of the triæna, and stretch vertically down through the whole depth of the choanosome. Those oxea measure 0·34 to 1·5 mm. by 0·009 to 0·026 mm. Amongst them we find a few stylote, strongylote and tylote spicules.

The microsclera are spherasters, 0·025 mm. in diameter, and spirasters 0·012 to 0·016 mm. in length. Besides those, I have found in some sections a third kind of microsclera, which looked like the fragments of the narrow blades of fret-saws, straight on one side, toothed on the other, and a few which were toothed on both sides (see fig. 2*c*, Pl. VII.). These spicules measure 0·08 mm. by 0·0014 mm., but I do not think I have seen a complete spicule of this kind. They were found in the choanosome immediately beneath the ectosome.

A great part of the choanosome, especially the portion in the neighbourhood of the ectosome, consists of a cystenchymatous tissue, also called vesicular connective tissue or bladder cells ("blasiges Bindegewebe" of German authors). It has been already remarked by other authors in various groups of the sponges, as by Vosmaer,* in *Polymastia hemisphærica*, by Sollas† in *Pachymatisma*, &c., and also in some of the Lithistidæ. A similar tissue is known to occur in many Molluscs and in Tunicata.‡

* Vosmaer, "Sponges of the Willem Barrents Expedition," 1880 and 1881. "Bijdragen tot de Dierkunde."

† Sollas, "Report on the Tetractinellidæ, collected by H.M.S. *Challenger*," p. xxxix.

‡ W. A. Herdman, "Report on the Tunicata, collected by H.M.S. *Challenger*," part i., p. 28—29.

I could not get a correct idea of the canal system of *Seiriola compacta*. The figure on Pl. VII. shows everything I could make out in regard to this point.

Ecionema ponderosa, Bowerbank.

Found in the caves on the N.W. side of Puffin Island, June, 1888.

Pachymatisma johnstonia, Bowerbank.

Found in the caves on the N.W. side of Puffin Island, June, 1888.

Order VI. CALCAREA.

Ascetta primordialis, Haeckel.

Collected at low tide at the south end of Puffin Island, on 8th September, 1888, by Professor Herdman.

The species is new to the district, although it is cosmopolitan, and has been recorded by Haeckel from nearly every part of the world.

Sycandra ciliata, Haeckel.

Collected at Isle of Man, August, 1886; common at Puffin Island.

Sycandra compressa. Haeckel.

Common at Puffin Island. Some very fine specimens were found hanging from the ledges of rock at the north end, below the Biological Station.

Explanation of the Plates.

bl. Bladder cells.
ch. Choanosome.
c.c. Ciliated chambers.
e. Ectosome.
l.s. Longitudinal bundles of spicules in transv. section.
o. Ova.
os. Osculum.
p. Pores.
p.m. Pore membrane.

Plate V.

Fig. 1. *Raspailia stelligera*, S., nat. size.
Fig. 2. *Raspailia viminalis*, S., nat. size.
Fig. 3. *a.*, *b.* and *c.* Stylote spicules of *Raspailia viminalis*, S. (x 55). *d.* Spined spicule of the same (x 235).
Fig. 4. Portion of a transverse section through the middle of the stem of *Raspailia viminalis* (x 40).

Plate VI.

Fig. 1. Tylostylote spicules of *Polymastia mammillaris*. *a.* (x 100); *b.* (x 235).
Fig. 2. Transverse section through one of the papillæ of *Polymastia mammillaris* (x 100).
Fig. 3. Longitudinal section through one of the papillæ of *Polymastia mammillaris* (x 60).

Plate VII.

Fig. 1. Vertical section through *Seiriola compacta*, n. sp. (x 100). [N.B. The third cladus of every triæna has been left out as standing nearly at right angles to the plane of the section.]
Fig. 2. Microscleres of *Seiriola compacta*, n. sp. *a.* (x 1000); *b.* (x 1000); *c.* (500).
Fig. 3. The cladome of a dichotriæna of *Seiriola compacta*, n. sp. (x 200). [N.B. The rhabdome must be imagined as standing vertically upon the centre of the cladome.]

SECOND REPORT on the ECHINODERMATA of the L.M.B.C. DISTRICT.

By Herbert C. Chadwick.

(Communicated by Professor Herdman.)

[Read 8th February, 1889.]

In the following pages I have incorporated with the results of the work of the L.M.B.C., during the years 1886–7–8, my own observations on the Echinodermata of Beaumaris Bay and the Menai Straits.

The total number of species obtained by the Committee up to the present time is thirty-five, the additions to the previous lists* consisting of five Asterids, viz., *Stichaster roseus*, *Asterias glacialis*, *Solaster endeca*, *Porania pulvillus*, and *Luidia savignii*, and one Holothurian, *Cucumaria planci*. The Anglesey coast, from Bangor eastwards, round by Puffin Island to Holyhead, and the deep waters off the southern end of the Isle of Man, have again yielded most of the forms obtained. Though none of the species, nor yet of the groups to which they are assigned, can be said to be peculiar to any part of the L.M.B.C. district, the Asteroidea appear, both as regards species and individuals, in greatest force in the latter locality, while the Menai Straits are largely inhabited by four out of the six Ophiurids recorded in our previous list.

The Echinoidea are more generally distributed; all the recorded species being well represented in both the above-mentioned localities; and the same remark applies fairly well to the Holothuroidea.

* "Report upon the Crinoidea, Asteroidea, Echinoidea, and Holothuroidea," by Professor Herdman; and "Report upon the Ophiuroidea, by H. C. Chadwick, in "Fauna of Liverpool Bay," vol. i., 1886.

My thanks are due to W. Percy Sladen, Esq., the Rev. Canon A. M. Norman, and Professor Jeffrey Bell, for their courteous assistance during the preparation of this report.

CRINOIDEA.

Family. Comatulidæ.

Antedon rosaceus, Linck (sp.).

Comatula rosacea, Fleming, "Hist. British Animals," p. 490, 1828; Forbes, "British Starfishes," p. 5. 1841.

This species was found to occur in large numbers, at a depth of 10 fathoms, off Cemmaes Bay, North Anglesey, during the "Hyæna" Expedition of 1886. It was also taken in May, 1888, from a depth of 20 fathoms, off Port Erin. It occurs, too, off Bull Bay, on the north coast of Anglesey.

OPHIUROIDEA.

The successive dredging expeditions of the committee have not resulted in the discovery of any new Ophiurids, nor are there any new localities to record. I may, however, mention a specimen of *Ophiothrix pentaphyllum*, which I dredged from the Menai Straits, off Bangor, in August, 1887, and which agrees most remarkably with Forbes's description of his *Ophiocoma minuta*. The disk measures 3 mm. in diameter, and is decidedly pentagonal. Its centre is occupied by a white pentagon, which during life was bordered by deep red. The remainder of its surface is covered with short trifid spines, amongst which are a very few spines of considerable length and resembling those of the rays. The latter measured nearly 3·5 cm. in length. Their colour was grey, mottled and belted with a rosy hue, and the spines which fringe them partook of the same colours. With this specimen only before me, I should be inclined to support Forbes in regarding its characters as

distinctive, but having examined a number of examples of the undoubted young of *O. pentaphyllum* in which considerable variation was displayed, I have no hesitation in referring our specimen to that variable species.

ASTEROIDEA.

Family. Asteriadæ.

Stichaster roseus, Müller (sp.).

Asterias rosea, Müller, "Zool. Dan. Prod.," p. 234, No. 2837. 1776.

Cribella rosea, Forbes, "British Starfishes," p. 106. 1841.

Asteracanthion roseus, Müller and Troschel, "Syst. der Asteriden," p. 17. 1842.

This is perhaps the rarest of the five additions to our list of Echinoderms in which the "Hyæna" expedition of 1888 resulted. It is a northern species, and an inhabitant of deep water. The specimens under notice were obtained off the south-eastern corner of the Isle of Man, from a depth of 20 fathoms.

Asterias rubens, Linn.

This species is very abundant at Beaumaris, and not uncommonly attains a very large size. I have seen at least a dozen specimens which measured from 12 to 15 inches in diameter. These approached *A. violacea* in the possession of numerous clavate spines, especially amongst those bordering the ambulacra. In the deeper parts of the Menai Straits, especially to the west of Garth Ferry, I have on two occasions dredged numbers of small Asterids, which, from the fact that they exhibit more or less markedly some of the characters of *A. hispida*, I have felt inclined to refer to that species; but, after carefully studying a number of examples from Puffin Island, in addition to those in my own collection, I have come to

the conclusion that I have before me simply a number of the young of the species under notice.

Asterias glacialis, Linn. (sp.).

Uraster glacialis, Forbes, "Brit. Starfishes," p. 78. 1841.

In this species we have a second addition to our list of Echinoderms. Specimens were obtained from a depth of 20 fathoms, between the Calf of Man and Port Erin Bay, on 20th May, 1888, during the cruise of the "Hyæna."

Family. SOLASTERIDÆ.

Cribrella sanguinolenta, Müller (sp.).

Asterias sanguinolenta, Müller, "Zool., Dan. Prod.," p. 234, No. 2836. 1776.

Asterias oculata, Pennant, "Brit. Zool." vol. iv., p. 61, No. 46. Pl. xxx., figs. 5, 6. 1777.

Cribella oculata, Forbes, "Brit. Starfishes," p. 100. 1841.

Echinaster oculatus, Müller and Troschel, "Syst. der Asteriden," p. 24. 1842.

I have frequently taken three or four specimens of this species during an evening's ramble on the beach at Beaumaris. The roots of *Laminaria*, at extreme low water mark, seem to be its favourite haunt. I do not remember having taken it in the dredge. My largest specimen measures rather more than five inches in diameter, but specimens of this size are not common.

Solaster endeca, Linn. (sp.).

In this species we have another addition to our list of Echinoderms. It was taken on 20th May, 1888, from a depth of 20 fathoms, off the south-eastern corner of the Isle of Man, during the cruise of the "Hyæna."

Solaster papposa, Linn. (sp.).

This well known species occurs in considerable numbers at extreme low water mark, at Beaumaris, where I have

taken several specimens measuring eight inches in diameter. Almost every specimen forms a habitat for a great number of examples of the Caprellid *Podalirius typicus*, which cling tenaciously to the paxillæ by means of the fourth pair of thoracic limbs, the fifth pair being spread out behind, the sharp pointed terminal joints giving a very firm hold.

Porania pulvillus, Müller (sp.).

Asterias pulvillus, Müller, "Zool. Dan.," vol. i., p. 19, Pl. xix., figs, 1, 2. 1788.

Goniaster Templetoni, Forbes, "Mem. Wern. Soc.," vol. viii., p. 118, Pl. iv., fig. 2. 1839.

Asteropsis pulvillus, Müller and Troschel, "Syst. der Asteriden, p. 14. 1842.

In this species we have the fourth addition to our list made during the "Hyæna" expedition of 1888. It was taken, with the three previously mentioned, from a depth of 20 fathoms off the south-eastern corner of the Isle of Man, and with them and the subjoined *Luidia savignii* serves to show how rich and varied is the Echinoderm fauna of that district.

Family. ASTROPECTINIDÆ.

Astropecten irregularis, Pennant (sp.).

Asterias irregularis, Pennant, "Brit. Zool." vol. iv., p. 61, No. 47. 1777.

Asterias aurantiaca, Müller, "Zool. Dan. Prod.," p. 234, No. 2831 (but not of Linnæus). 1776; Forbes, "Brit. Starfishes," p. 130. 1841.

I have taken this species in the dredge from a depth of about ten fathoms in the Menai Straits, close to the training ship "Clio." I have also found it cast ashore at Southport.

It does not seem to be generally known that in the genera *Astropecten* and *Luidia*, a *pair* of "Tiedemann's bodies" are present at the point of junction of the stone canal with the circum-oral water vessel, where in *Asterias*, *Cribrella* and *Solaster* there is but one. In *Luidia* the members of each pair of these bodies are wider apart than in *Astropecten*.

Luidia savignii, Audouin (sp.).

Asterias savignii, Audouin; Savigny, "Histoire de l'Egypte," p. iii. (1809); description (1828), vol. xxiii., p. 9.

Luidia fragilissima, Forbes, "Brit. Starfishes," p. 135. 1841.

Luidia savignii, Müller and Troschel, "Syst. der Asteriden," p. 77. 1842.

Specimens of this fine Asterid were dredged from a depth of twenty fathoms between the Calf of Man and Port Erin Bay, on 20th May, 1888. The species had not previously been obtained by the committee.

The pedicellariæ of this species are well described by Rev. Canon A. M. Norman,* as "short, broad, and tumid—in fact, in the form of a nearly equilateral and equiangular triangle." Some few examples, however, nearly approach in form the same organs in *Luidia sarsii*, in which they are "much more elongated, narrow, and not tumid, and have the outline of a somewhat produced isosceles triangle." The pedicellariæ of *Luidia* differ from those of other Asterids in being composed of three valves or blades.

ECHINOIDEA.

The recent additions to our list of Echinoderms do not include any Echinoidea. Of the species recorded in Prof. Herdman's Report of 1886, I have twice taken *Echinus*

* "On the Genera and Species of British Echinodermata," *Ann. and Mag. Nat. Hist.*, 3rd series, vol. xv. 1865.

esculentus on the shore, within two hundred yards of Beaumaris pier, at times when the tide has been exceptionally low; and from the deeper parts of Beaumaris Bay I have frequently dredged specimens of *Echinus miliaris* of much larger size than those recorded by Prof. Herdman. A number of very fine specimens of *Spatangus purpureus*, some of them measuring 11 cm. across their longer diameter, were dredged from a depth of 25 fathoms, twenty miles S.E. of the Isle of Man, during the cruise of the "Weathercock," in the summer of 1886, while others were obtained off Red Wharf Bay, during the "Hyæna" expedition of the same year.

HOLOTHUROIDEA.

The Holothurians submitted to me are referable to three species. Of these *Thyonidium drummondii* and *Cucumaria hyndmanni* were recorded in Prof. Herdman's first Report, and are represented in the present collection, the former by one specimen from the neighbourhood of Puffin Island, and one from the "Hyæna" expedition of 1886; the latter by three specimens taken from a depth of 20 fathoms about twenty miles S.E. of the Isle of Man, during the cruise of the "Weathercock," in the summer of 1886.

The third species is well represented, and has, the Rev. Canon A. M. Norman informs me, been mistaken by several British authors, and was mistaken by myself, for *Cucumaria pentactes*, a form which it very closely resembles. Dr. Norman, however, identifies it as the *Cucumaria planci* of Marenzeller.* It is now, I believe, recorded for the first time under its correct name as a British species.† It occurs in considerable numbers in the deep waters surrounding Puffin Island to the north-east.

* *Abh. zool-bot. Ges. Wien*, xxiv. (1874), p. 300.

† Prof. Jeffrey Bell writes to Prof. Herdman that he has seen specimens from the south coast of England and the west of Scotland.

THIRD REPORT on the COPEPODA of LIVERPOOL BAY (the L.M.B.C. DISTRICT).

By Isaac C. Thompson, F.L.S., F.R.M.S.

With Plate VIII.

[Read 8th March, 1889.]

In the two previous Reports* on the marine Copepoda of the district *fifty* species were recorded. The second of these reports was drawn up at the close of 1887, and it is now most satisfactory to be able to record *thirty-three* additions since that time, of which five are new to British seas. As before, the majority have been taken by tow-net in the open sea, or by hand-net from the rocky shore pools seldom touched by ordinary tides.

A considerable number of the additional species we have lately obtained from sand and mud brought up by the dredge, and taken at low water in tidal pools, &c. Want of success in this direction has probably arisen previously from washing the material in sieves which allowed many of the very minute forms to escape with the water. The method latterly adopted has been to place the solid material direct into a very fine muslin bag, or into the finest meshed tow-net itself. Tied at the top, the bag is placed in a running stream of water, by which means all the soluble portion and the very finely suspended mud particles constituting the bulk of the mass are washed out. On examining the residue in a saucer of water, numbers of Copepoda are found floating upon the surface, which washed in the ordinary way would have been lost, and

* See "Fauna of Liverpool Bay," &c., vol. i., p. 201, 1886; and "Proc. L'pool Biol. Soc.," vol. ii., p. 63, 1888.

numbers of other species are found amongst the sand and debris, being easily picked out under the microscope.

Professor Herdman has again also added to the record several species taken from the branchial sacs of Ascidians, and it is probable that still further additions to the list of parasitic species will be made from the same source, this branch of the subject not having been specially dealt with hitherto.

The five species new to Britain are as follows:—

Pontella kröyeri, Brady.
Giardella callianassæ, Canu.
Lichomolgus albens, Thorell.
Cymbasoma rigidum, Thompson.
Lernæa branchialis, Linn.

Two night tow-nettings from Puffin Island contained single specimens of *Caligus rapax*, a parasitic species recorded by Dr. Byerley as occurring upon the Sapphirine Gurnard, but not since taken. Like the *Trebius caudatus*, alluded to in the last report, it seems probable that this species is a free swimmer at night only.

Mr. Rutherford, the curator of the Puffin Island Biological Station, has continued to send tow-nettings taken at various localities near the island whenever weather permitted, and the majority of the newly recorded species have been obtained from this source; this being one of the many ways in which the station has proved to be of the greatest benefit in the investigation of our marine fauna and flora.

Some of the species described for the first time in the last report have again been found. *Cyclops (Hersiliodes) puffini*, has occurred sparingly, and Professor Herdman has found *Lichomolgus sabellæ* again, attached to its host, the *Sabella*, this time in the sand near the landing place at Puffin Island.

By means of a continued series of observations throughout the seasons of the year, such as a biological station affords, we are enabled to study the distribution not only of the various groups but also of the different species. In the case of the Copepoda, the facts as regards the species are striking though difficult of explanation. A particular species may be comparatively abundant at one time and then appear to become extinct in the same locality. Instances of this occur in the case of *Pontella wollastoni* and of *Euterpe gracilis*, two rare forms alluded to in the last report as having been found off Puffin Island, and for a time both frequently met with. For many months past, however, neither species has occurred in the gatherings, though carefully looked for in the same localities as heretofore.

A very striking example of the seeming propensity of these minute Crustaceans to congregate in shoals was noticed during the "Hyæna" expedition of May, 1888. During the whole of the second day, whilst cruising near the east and south coasts of the Isle of Man, viz. from Douglas to Port Erin, the surface of the water literally swarmed with the large and beautiful Copepod, *Anomalocera patersonii*. Each cast of the tow-net brought up thousands of them; they were so numerous as to be distinctly visible to the eye on the smooth edge of the waves, and had the appearance of fine dust as seen from the side of the vessel. They were equally abundant during the day and after sundown, but, strange to say, none were to be found next morning, although we were traversing the same route as that on which they were in such profusion the previous day. Nor have we taken a single specimen of *Anomalocera* since that date, nor for three years previous to it, when a single pair was taken in the open sea, near the North-west Lightship.

It was natural to suppose that the animals might be found at a greater depth, after having left the surface, but such was apparently not the case, for while my tow-net swept the surface, Mr. McMillan used a deep sea tow-net of his own devising, allowing it to be drawn along while at the bottom, and occasionally to pass up through the intermediate depths. It is evident that we have yet much to learn as to the habits and distribution of these minute Crustaceans.

In this connexion it may be important to notice the extreme abundance of *Sagitta* in the tow-nets throughout the year.

Family. Calanidæ.

Pontella kröyeri, Brady.

One specimen, a fine male of this striking species, was taken off Puffin Island in August, 1888. With the exception of a few specimens which I found in the tow-nettings sent from Malta by Dr. Bruce (Proc. Biol. Soc., L'pool, vol. ii., p. 143), this species has been hitherto recorded only from Australasia and the Philippine Islands (Brady's "Challenger" Report on the Copepoda, p. 94).

Family. Hersiliidæ.

Giardella callianassæ, Canu.

This new species is fully described by M. E. Canu in "Bulletin Scientifique," series iii., September, 1888, p. 410. The only specimen I have of it was taken by tow-net in Liverpool Bay, during the "Despatch" expedition, 1886, and finding it to be something new, I waited for further specimens, in order to describe it fully. M. Canu has formed the new family *Hersiliidæ*, including therein three genera: *Hersilia*, Phillipi, *Giardella*, Canu, and *Hersiliodes*, Canu. The genus *Giardella* comprises our

present species only; the genus *Hersiliodes* includes two species, *Hersiliodes thompsonii* and *H. puffini*. The former species he most courteously connects with my name, the latter being the species hitherto known as *Cyclops puffini*, which he considers to be more correctly included in *Hersiliodes* than in the genus *Cyclops*. He thinks it possible that my specimens of *Hersiliodes puffini* are not fully developed forms, the adult being yet unknown. M. Canu figures three stages of *Giardella callianassæ;* the specimen found in our district corresponds with the second the "Cyclops" or less developed stage.

Family. NOTODELPHYIDÆ.

Notodelphys allmani, Thorell.

Notodelphys ascidicola, Allman, "Ann. and Mag. Nat. Hist.," vol. xx., pl. i., figs. 1—13 (1847).

Notodelphys ascidicola, Baird, "Brit. Entom.," p. 238, pl. xxx., figs. 7 and 8 (1850).

Notodelphys allmani, Thorell, "Bidrag till Kännedomen om Krustaceer som lefva i arter af Slägtet Ascidia," p. 31, tab. i. and ii., fig. 1 (1859).

A few specimens, male and female, were found by Prof. Herdman in the branchial sacs of the Ascidian, *Ciona intestinalis*, dredged in the "Weathercock" expedition of 1886, and off the south end of the Isle of Man in the "Hyæna" cruise of 1888.

Doropygus pulex, Thorell.

Found by Prof. Herdman in company with the preceding species, and also in the branchial sac of *Ascidiella scabra*, dredged in Groudle Bay, Isle of Man; also in the branchial sac of *Ascidia plebeia*, dredged from the "Hyæna," off the Calf of Man, May, 1888, in twenty fathoms.

Doropygus poricauda, Brady.

One specimen of this species was amongst several of the

last preceding taken from the branchial sac of *Ascidia plebeia*.

Botachus cylindratus, Thorell.

Found by Professor Herdman in the branchial sacs of *Ascidia mentula* and *Ascidia plebeia*, from the Isle of Man. About a dozen females were found, but only one male.

Family. HARPACTICIDÆ.

Ectinosoma spinipes, Brady.

Ectinosoma melaniceps, Brady and Robertson, "Ann. and Mag. Nat. Hist.," p. 130 (1873).

Taken by tow-net, between Liverpool and Isle of Man, from "Weathercock," August, 1886. Found in considerable numbers in mud dredged from Soderick Bay, Isle of Man, 1887; also from mud gathered at low water at Llanfairfechan, on the Welsh coast opposite Puffin Island.

Ectinosoma erythrops, Brady.

A single specimen of this species was taken by tow-net off Puffin Island, January, 1888.

Brady typica, Boeck.

Found by Mr. W. S. McMillan, F.L.S., in quantities in mud from the shore at Penmon Point, Anglesey; also in mud from Llanfairfechan shore. In material dredged at Port Soderick, Isle of Man.

Tachidius brevicornis, Müller.

In brackish water at the mouth of the Alt, near Formby, May, 1888; also in mud taken from the shore at Penmon Point.

Tachidius littoralis, Poppe.

Common in mud from Penmon Point, Anglesey, and from Llanfairfechan shore.

Stenhelia hispida, Brady.

Found sparingly in mud from Llanfairfechan shore, February, 1889; also in rock pools at Hilbre Island, March, 1889.

Stenhelia ima, Brady.

Canthocamptus rostratus, Claus, "Die frei-lebenden Copepoden," p. 122, t. xiii., figs. 5—8 (1863).

A single specimen was found in mud dredged by Mr. Clubb, in Soderick Bay, Isle of Man, 1887.

Mesochra lilljeborgii, Boeck.

Taken by tow-net off Puffin Island, June, 1886.

Laophonte thoracica, Boeck.

Taken sparingly by tow-net near Puffin Island lately.

Laophonte lamellifera, Claus.

Cleta lamellifera, Claus, "Die frei-lebenden Copepoden," p. 123, t. xv., figs. 21—25 (1863).

Like the last species this has been recently taken very sparingly by tow-net about Puffin Island.

Laophonte curticauda, Boeck.

I found one specimen of this species in a tidal pool at Hilbre, March, 1889.

Cletodes limicola, Brady.

Cletodes pectinata, Brady and Robertson, "Brit. Assoc. Report," p. 196 (1875).

Common in mud from shore at Penmon Point.

Cletodes longicaudata, Brady and Robertson.

? *Cletodes laticauda*, Boeck, "Nye Slægter og Arter af Saltvands-Copepoder," p. 20 (1872).

Occurs sparingly in mud taken from Llanfairfechan shore.

Cletodes propinqua, Brady and Robertson.

Occurs very sparingly with the last species in mud taken from Llanfairfechan shore.

Enhydrosoma curvatum, Brady and Robertson.

Rhyzothrix curvata, Brady and Robertson, "Brit. Assoc. Report, p. 19 (1875).

A number of this species were also found in mud from Llanfairfechan shore.

Nannopus palustris, Brady.

Another mud-frequenting species, although the first specimen taken was by surface tow-net near Puffin Island, in December, 1888. We have since found it sparingly in mud from Llanfairfechan shore, and also in mud dredged at Port Soderick, Isle of Man.

Platychelipus littoralis, Brady.

Numbers of this species, both sexes, were found by Mr. W. S. McMillan, in mud taken from Penmon Point.

Thalestris harpactoides, Claus.

A few specimens were taken by tow-net from "Hyæna," in May, 1888, both at Douglas Bay, Isle of Man, and at Port Erin. We have since found it off Puffin Island, and in tidal rock pools at Hilbre Island; also in mud taken from the shore at Penmon Point.

Thalestris serrulata, Brady.

One specimen only, a female, of this extremely rare species, I found in a tow-net gathering from Puffin Island, in January, 1889.

Scutellidium tisboides, Claus.

One specimen only of this rare species was dredged in Port Soderick, Isle of Man.

Scutellidium fasciatum, Boeck.

Porcellidium fasciatum, Boeck, "Oversigt Norges Copepoder," p. 56 (1864).
Aspidius fasciatus, Norman, "Brit. Assoc. Report," p. 298 (1868).

One specimen, found in a tidal pool at Hilbre Island, March, 1889, appears unmistakably to belong to this

species. It has, however, minute nodules in the middle of many of the setæ of the swimming feet.

Family. Sapphirinidæ.

Lichomolgus fucicolus, Brady.

Frequent amongst algæ on rocks around Puffin Island, and occasionally taken there in surface tow-net.

Lichomolgus albens, Thorell.

A few specimens of this species, new to Great Britain, have been taken by tow-net off Puffin Island.

Family. Artotrogidæ.

Cyclopicera lata, Brady.

One specimen was dredged at Port Soderick, Isle of Man, 1887.

Cyclopicera gracilicaudata, Brady.

One specimen was taken by tow-net at Puffin Island, April, 1888.

Dyspontius striatus, Thorell.

Mr. W. S. McMillan found one specimen in a tow-net gathering from Puffin Island, May, 1888.

Family. Cymbasomatidæ.

Cymbasoma rigidum, Thompson.

It is interesting to be able to record amongst those new to Britain the capture of a single specimen of *Cymbasoma rigidum*, the original species for which the family Cymbasomatidæ was first established, having been taken by myself at the Canary Islands, in 1887. It occurred later very sparingly in the material sent by Dr. Bruce from Malta. Then a second species of the same genus, *Cymbasoma herdmani*, was found near Puffin Island, and it has also been found by Mr. W. S. McMillan at Torbay, and in

large numbers by Mr. Sinel at Jersey. Still later, isolated specimens of *C. herdmani* and *C. rigidum* have been found in tow-nettings taken both in the Firth of Clyde and the Firth of Forth. Both species appear to be widely distributed, but rarely plentiful.

Family. Lernæidæ.

Lernæa branchialis, Linn. (Pl. VIII., figs. 1—6).

About a year ago two very minute Crustacea (fig. 1) were taken in the tow-net off Puffin Island, which appeared to be larval forms of a *Lernæa*. Since then two adult specimens (one from the same locality) have been found, apparently belonging to the same species as the larval specimens. They agree in the main with *Lernæa branchialis*, Linn., described and figured by Claus in his "Beobachtungen ueber Lernæocera, Peniculus und Lernæa, 1868." The adult forms correspond in most particulars with the male and female described by Claus, and I have provisionally included them under this species. Our specimens differ from those figured by Claus chiefly in the form of the prehensile posterior antennæ and in the segmentation of the abdomen; but as will be seen (Pl. VIII., figs. 1, 5 and 6), this animal appears to vary much in these very particulars according to age and sex, and it is therefore quite likely that Claus's specimens may represent slightly other stages of development. The group is extremely interesting, as exhibiting progressive and retrogressive development, and deserves more attention than it appears to have hitherto received. The female (fig. 6) is about 1-18th inch in length, the male rather smaller, and the larval form (fig. 1) about half the size of the female. I am indebted to our colleague Mr. Helenus Robertson for kindly producing enlarged micro-photographs of this

and other species from my mounted specimens, thus greatly facilitating the task of subsequently drawing them. Fig. 6 is taken from Mr. Robertson's photograph.

Description of Plate VIII.

Fig. 1. *Lernæa branchialis*, Linn., larval stage. × 250
Fig. 2. Anterior antenna of the same 400
Fig. 3. Larval stage, swimming feet..... 400
Fig. 4. Do. footjaw 400
Fig. 5. Adult male 250
Fig. 6. Adult female 250

APPENDIX to THIRD REPORT on the COPEPODA of LIVERPOOL BAY (the L.M.B.C. DISTRICT).

By Isaac C. Thompson, F.L.S., F R.M S.

With Plate IX.

[Read 10th May, 1889.]

Since the Third Report on the Copepoda of Liverpool Bay was published, a new and interesting species of Copepod was taken by the dredge in Port Erin Bay, Isle of Man, during the fifth cruise of the "Hyæna," in April, 1889. Several specimens, all females, some having ovisacs, were found by both Mr. W. S. McMillan and myself in washings of muddy sand dredged from five fathoms. Besides a large number of Amphipoda, a few other species of Copepoda were found, amongst which were a number of specimens of *Ectinosoma spinipes*, Brady, which in general appearance the new species much resembles. It differs, however, from the characters of the genus *Ectinosoma* in several important particulars, especially in the anterior and posterior antennæ and in the form of the fifth foot. In these and other particulars it so nearly agrees with the general form and generic characters of *Jonesiella*, Brady, that I have placed it in this genus. After careful dissection, however, I am unable to make out any jointing whatever in the anterior antennæ, except one joint near the apex, and the animal is too minute and fragile to allow of the use of potash or any other clarifying medium which might disclose further structure. Another point of difference is in the inner branch of the first pair of swimming feet, which in *Jonesiella* has only two joints, while all the specimens of this species we have dissected have three joints. But I

think that these points should constitute specific rather than generic differences when the other more important characters agree, and I therefore prefer to slightly modify an existing genus rather than make a new one.

I have named this species after the steamer "Hyæna," belonging to the Liverpool Salvage Association, who have on many occasions most courteously placed that vessel at the disposal of Professor Herdman for the work of the L.M.B.C.

Family. Harpacticidæ.

Jonesiella hyænæ, n. sp. (Pl. IX., figs. 1 to 10).

Length 1-30th inch. Body ovate, of nearly equal thickness throughout; head and first thoracic segment coalescent. Rostrum (fig. 4) long and spatula like; rounded anteriorly. Anterior antennæ (fig. 2) broad at base with cleft on each side near the base, then widening and surmounted by a tree-like crown, having a second segment at apex and several spinose and plumose setæ. Posterior antennæ (fig. 3) two branched, the outer branch being two jointed. The lower joint has two short plumose spines; the apical joint is edged on cuter side with short spines, and has several long spinose setæ at the apex. The inner branch is short (joints not made out), and is terminated by two long plumose setæ. Mandibles (fig. 5) broad and strongly toothed; palp of one short stout joint and bearing several long and short spines. First footjaw (fig. 6) much resembles that of *Jonesiella fusiformis*, Brady and Robertson. Second footjaw (fig. 7) two jointed, bearing a finely curved narrow clawed hand, the latter being jointed near the centre. The first joint has two or three short plumed spines at the apex; the second joint is finely ciliated on its inner margin. First pair of swimming feet (fig. 8) have three joints to each branch, the inner branch being rather

longer than the outer; outer margins of all the joints fringed with spines, the lateral and terminal spines being plumose. The inner side of the base of each of the first pair bears a short stout spine curved at the end. The second, third and fourth swimming feet (fig. 9) have both branches three jointed and are spinose like the first. The fifth pair of swimming feet (fig. 10) have two large rounded foliacious joints and a smaller one at outer side, each edged all round with fine cilia, the large joints bearing several long and short spear shaped spines, plumose near the apex. Caudal segments very short and broad and appear like a divided abdominal segment terminated on each side by two spear shaped spinose setæ, plumose near the apex, the inner ones considerably longer than the outer, and narrowed at the base.

Explanation of Plate IX.

Jonesiella hyænæ, n. sp.

Fig. 1.	Adult female	× 250 diams.
Fig. 2.	Anterior antenna	500 ,,
Fig. 3.	Posterior antenna	500 ,,
Fig. 4.	Rostrum	500 ,,
Fig. 5.	Mandible and palp.....	500 ,,
Fig. 6.	First footjaw	500 ,,
Fig. 7.	Second footjaw	500 ,,
Fig. 8.	First swimming foot.....	500 ,,
Fig. 9.	Third swimming foot	500 ,,
Fig. 10.	Fifth swimming foot.....	500 ,,

THIRD REPORT* on the HIGHER CRUSTACEA of the L.M.B.C. DISTRICT.

By Alfred O. Walker, F.L.S.

With Plates X. and XI.

[Read 8th March, 1889.]

The collections made this year (1888) of the Podophthalmata, Cumacea, Isopoda, and Amphipoda, are undoubtedly the most interesting since the foundation of the Liverpool Marine Biology Committee. Five species of the first, three of the second, four of the third, and fifteen of the fourth of these orders are new to our fauna, while probably one Isopod and four Amphipoda are new to the British lists, two of these latter being new to science. The collections that have been examined were:—

I. From Puffin Island, collected at the following dates.

a. March 24th, by Prof. Herdman and three others, chiefly by dredging and with the weighted tow-net, in the Turbot Hole.

b. July 24th, by Prof. Herdman, Mr. Hurst, and Mr. Dutton of Chester.

c. August 15th, by Mr. Hurst and Mr. Clubb, off the N.E. end of the island.

d. September 8th and 9th, by Professor Herdman, Mr. Hurst, and the Reporter, at extreme low water, chiefly on the Spit at the south end of the island.

II. May 19th to 21st, in the "Hyæna," during a trip to the Isle of Man, when the electric light (E.L.) was

* For First Report, see "Fauna of Liverpool Bay," vol. i., pp. 212—226, 1886; for the Second Report, see "Proc. Biol. Soc., L'pool," vol. ii., pp. 171—181, 1888.

used, as mentioned in Professor Herdman's Report for 1888 on the Puffin Island Biological Station, with excellent results.

III. April to July, at Colwyn Bay, shore-hunting, dredging, &c. by the Reporter.

IV. September 20th, at Bull Bay, Anglesey, by Mr. R. Newstead, Curator of the Grosvenor Museum, Chester.

The following species are either recorded for the first time in the fauna or in the locality indicated, or are mentioned on account of some point of interest in connexion with them.

BRACHYURA.

Xantho rivulosa, Risso.

X. tuberculata, Couch.

II. Three specimens, dredged between Calf of Man and Port Erin. They belonged to the *tuberculata* form, which was considered by Couch to be distinct, and is described and figured as such in Bell's "British Stalk-eyed Crustacea." It has since been shown to be a mere variety.

Portunus puber, Linn.

Bull Bay (IV.), in the lobster-pots, where it is said to be common. The specimens were of large size.

ANOMURA.

**Eupagurus pubescens*, Kröyer.

II. This was taken abundantly in the dredge west of the Calf of Man, but all young specimens.

**Anapagurus hyndmanni*, Thompson.

II. Scarce.

**Galathea dispersa*, Sp. Bate.

II. Thanks to the admirable monograph of the Galatheidæ by M. Jules Bonnier ("Bull. Scient. de la France

* Indicates a species not previously recorded in "Fauna of Liverpool Bay."

et de la Belgique," 1888), which the author has been kind enough to send me, I was able to identify all the specimens dredged off the Isle of Man as belonging to this species. It is best distinguished by the strong tooth on the inner side of the merus joint of the third maxillipedes being connected with the distal extremity of the joint by a ridge on which are two to four smaller teeth.

**Munida bamffia*, Pennant.

II. One specimen. Notwithstanding the high authority of Mr. G. O. Sars, who considers *M. rugosa*, Fabr., as distinct from *M. rondeletii*, Bell,† I agree with M. Bonnier and others in holding them to be the same, and therefore referable to the older name of Pennant. Mr. R. Pocock, of the British Museum, and I examined a large number of individuals at that institution, and found them to vary so much in the characters relied on by Sars that it was impossible to separate the two forms.

Macrura.

**Caridion gordoni*, Sp. Bate.

II. One female, with ova, between Calf of Man and Port Erin.

Pandalus brevirostris, Rathke.

II. Several between Calf of Man and Port Erin.

Cumacea.

**Cuma scorpioides*, Montagu.

II., E.L. Two young males. Taken by electric light (E.L.) at Ramsey. Recognizable by the lateral carina extending longitudinally from the rostrum across the carapace and free thoracic segments (see Norman, "Brit. Assoc. Report," 1868, p. 273).

† "Oversigt af Norges Crust.," p. 6, pl. i., fig. 5.

**Iphinoe trispinosa*, Goodsir.

II., E.L. Three males. Port Erin. These were the variety without the serrated dorsal crest.

**Pseudocuma cercaria*, Van Beneden.

II., E.L. A very large number, all males, at Port Erin. This is certainly the species described under the above name by G. O. Sars,† but it is difficult to believe that Van Beneden's‡ figures and description (which Sars remarks are "faulty in the extreme") can refer to the same. Our experience in the "Hyæna" confirms Norman's statement, that this is "the most numerically abundant species of Cumacean in the British seas."§

Isopoda.

**Anceus maxillaris*, Mont.

III. A specimen of the Praniza form of this (?) species, taken in a rock pool at Penmaenrhos, attached to a young *Cottus* behind the second dorsal fin. Colour, brilliant blue-green.

Janira maculosa, Mont.

II. A number of specimens on a mass of *Alcyonium digitatum*, dredged between the N.W. Lightship and Isle of Man, on the outward trip of the "Hyæna," 19th May, 1888.

**Munna fabricii*, Kröyer (Pl. XI., figs. 16 to 18).

I. A single specimen, without the long ambulatory legs and long outer antennæ. The telson agrees with Kröyer's

† Middelhavet's Cumaceer, Arch. fur Math. og Naturvidenskab, 1878, p. 114, pls. 40—42.

‡ "Recherches sur la Faune litorale de la Belgique." Crust., p. 85, pl. xiv. *Leucon cercaria*.

§ "Ann. and Mag. Nat. Hist." 5th series, vol. xix., p. 102.

figure in general form, but wants the teeth at the edge both near the proximal and distal extremity (see G. O. Sars, "Oversigt af Norges Crust.," p. 65). The first pair of feet also agree with Kröyer's figure.

**Dynamene rubra*, Mont. (Female.)

D. viridis, Leach. (Female.)

Næsa bidentata, Leach. (Male.)

D. varians, Stebbing.

I. and IV. On Algæ. Stebbing† and Hesse‡ have pointed out that the above are all one species. The colour appears to depend upon that of the weed on which they feed. The specimens from Bull Bay were green when taken, but turned red in spirit.

**Dynamene montagui*, Leach.

IV. With the last species, of which it may possibly be the adult female.

Ligia oceanica, Linn.

I. A specimen was found by Dr. Herdman in a rock pool on the N.E. end of Puffin Island, on 14th February, 1889. As this species is not usually found in the water (its habits being much the same as those of the strictly terrestrial Oniscidæ, except that it lives near the sea), it is probable that the specimen in question was a female that had gone into the sea to deposit its ova, as appears to be the case with the otherwise practically terrestrial Amphipod *Orchestia gammarellus*. The space under the thoracic segments was quite empty, as if it had recently been filled with ova. It is an interesting fact as bearing upon the phylogeny of the terrestrial Isopoda, that the common *Porcellis scaber* if it falls into water sinks at once to the bottom, where it will crawl and live for a considerable

† "Proc. Linn. Soc.," vol. xii., 1876. Zool., p. 146, pl. vii.

‡ "Ann. des Sciences Nat." 5th series, vol. xvii., p. 1.

time. This, coupled with the amphibious habits of *Ligia*, seems to point to an aquatic origin.

Amphipoda.

Hyperia medusarum, Müller.

Two large females with ova from lobster-pots. IV. Mr. Newstead says the eyes were brilliantly luminous.

Hyale nilsonii, Rathke.

A single female. I.*a*.

Orchestia gammarellus, Pallas.

A male under a stone on grass close under Burton Rock, on the Dee, on 7th February. Another near Port Erin, "fully 500 yards from the shore" (T. L. Denson in lit.).

**Lysianax ceratinus*,† n. sp. (Pl. X., figs. 1 to 8).

Lateral lobes of the head prominent, subangular. First four epimera deeper than the corresponding dorsal segments, the first equal in width at the widest part to the two next together. *Third pleon segment having the hinder angle rounded, but approaching to subangular.*

Eyes large, oval, dark, occupying the greater part of the head.

Upper Antennæ: First joint as long as the lateral lobe of head, upper and lower margins produced to a point, the lower rather the longer; second joint rather more than half as long as the first; third joint about half as long as the second. Flagellum eight-jointed, the last joint minute. Accessory appendage four-jointed, the first

* It is possible that this may be the female of *L. longicornis*, Lucas, though it differs from the male of this species as described and figured by this author in not having the telson terminated by a rounded point, in the form and armature of the last uropods, and in the shape of the lateral cephalic lobe. From the same (?) species as figured by Bate and Westwood it differs in having no spines on the telson and no hairs on the last uropods.

† κεράτινος, horny.

reaching to the middle of the second joint of the flagellum, the last joint minute.

Lower Antennæ: First joint shorter and thicker than the second, which is equal to the third. Flagellum ten to eleven-jointed, the first joint nearly equal to the three succeeding united.

First Gnathopods: First joint as long as the three following, the second and third being very short, wrist and hand about equal. First joint with a few hairs on the front margin, the second densely hairy on the hind margin, the third with short fur on the hind margin and long hairs at the distal end. The hand tapers and forms with the immoveable finger an elongated cone, furnished on the hinder (i.e. lower) margin *with a row of five or six short spines* and a few setæ. On account of the roundness of this joint the spines cannot always be seen. The finger has a hinged spine articulated to the upper side near the point beyond which it extends, giving it the appearance of being split.

Second Gnathopod: First joint the longest, second equal to the fourth (wrist), which is longer and deeper than the hand. This limb is of a type common in this family, and is well represented by that of *Orchomene serratus*, in Boeck's "Amphipoda," pl. v., fig. 2.*k*.

First Peræopods: Hinder margins of third and fourth joints equal, and furnished with long hairs. Front margin of third produced to one-third of the length of the fourth. Fifth joint half as long again as the fourth, with nine or ten strong spines on the hinder margin and three more slender on the front.

Last Peræopods: First joint dilated; a row of twelve or thirteen spines on the anterior margin gradually increasing in size downwards and terminating at the apex, which is produced downwards, in a group of one large and

two smaller spines. Second joint short and terminated anteriorly by a similar group of spines. Third joint produced downward for about one-third the length of the fourth, the lobe thus formed being crowned with a double spine and the hind margin having three strong spines. The remaining joints are somewhat variable in length and armature in different specimens.

All the peræopods have the third joint produced.

Uropods: First pair projecting beyond the others; peduncle longer than rami, both spinous. Second pair projecting as far as the third, spinous as the first. Third pair with the peduncle longer than the rami, widening suddenly at the proximal and tapering slightly towards the distal end; it has three small spines on the upper margin. The rami are round, the outer slightly the longer, the inner with two minute spines. There are no hairs (setæ) of any kind on the uropods.

Telson concave, entire, quadrate, with the side curved; hinder margin straight.

Length 10 mm.

The integument is hard, and horny both in colour and texture—hence the specific name, from κεράτϊνος, horny.

I. *b*. A single female specimen of the same species as those recorded in Report I. as *L. costæ*, and corrected in Report II. to *L. longicornis*, Lucas. Neither of these appears to be correct, as far as it is possible to judge from females only, no male having yet been taken in our district. Stebbing ("Challenger" Report) shows that *Lysianassa* was already preoccupied in the Mollusca and substitutes *Lysianax*. I include the present species in the genus in spite of the uropoda not being ciliated, which I submit is scarcely a fit generic character. The squamiform entire telson, and the conical propodos of the first gnathopod with apparently immoveable dactylos, are such marked

characteristics as to be sufficient reason for referring it to *Lysianax*.

**Lysianax audouinianus*, Sp. Bate (Pl. X., figs. 9 and 10).

II. Two young specimens on *Halichondria*, dredged in thirty fathoms, twenty-two miles S.E. of Isle of Man. Length 3 mm. Heller† has described a form which he calls *Aristias tumidus*, (jun.), Kröyer, but which he says differs in some of the mouth organs from the adult. It also differs in having an entire telson. But Hansen‡ says that *A. tumidus* of all authors except Kröyer is not the same species as the latter's, and proposes the name of *A. neglectus* for *A. tumidus*, Auct. Boeck includes with this *Lysianassa audouiniana*, Bate, but, as Hansen points out, this species has an entire telson, while in the genus *Aristias*, Boeck, it is cleft to the base. I therefore refer both my specimens and those of Heller to *L. audouiniana*, although they should properly be placed in a new genus, as the strongly subchelate character of the first gnathopod does not agree with Boeck's definition of *Lysianassa*. In my specimens the inner rami of all the uropods are minutely toothed on *both* edges, as are also the outer rami on the inner edge. As however it requires a high power ($\frac{1}{4}$-inch objective) to see this denticulation, it may have escaped observation.

**Hippomedon denticulatus*, Bate and Westwood.

One young specimen, Port Erin, five fathoms. II., E.L. Hansen§ points out differences between this species and *H. holbolli*, Kr., with which Boeck unites it. In the former the integument is smooth, while in the latter it is reticulate and granulate. The hinder angle of the third pleon

† "Crust. &c., Oster. Ungar. Nordpol. Expn.," p. 6, pl. iv., figs. 1—8.

‡ "Videnskabliger Meddelelser Nat. Forening i Kjobenhavn," 1887.

§ "Vidensk. Med. Nat. Forening i Kjob.," 1887, p. 63.

segment in the former is much more produced and curved than in the latter. Bate and Westwood's figure differs from both as figured by Hansen in the shape of the telson; also in the second uropods, which they figure as spinous, but describe as "simple." In my young specimen these have a single spine about one-third of the length of the ramus from the peduncle, and a similar spine on the inner (?) ramus of the third uropods about the middle.

**Orchomene goësii*, Boeck.

I. *d.* A single specimen. New to the British lists. Distinguishable by the short and wide hand and wrist of the first gnathopod, and by the very broad peduncle and short rami of the third uropods.

**Tryphosa höringii*, Boeck.

I. *a.* Three specimens. New to British lists.

Tryphosa ciliata, Sars.

I. *a.* One specimen. I question whether this is distinct from *T. nana*, Kr.

**Euonyx chelatus*, Norman.

Euonyx chelatus, Norman, "Brit. Assoc. Rep.," 1866.

Opis leptochela, Bate and Westwood, "Brit. Sess. Crust.," vol. ii., p. 501.

One specimen off the Lighthouse. I. Norman, in his report on the Shetland dredging, *l.c.*, describes this species. As the first gnathopods have the hand long and slender instead of very large, according to the character of *Opis*, as defined by Kröyer, it should not in any case have been referred to that genus. Norman says it is parasitic on *Echinus esculentus*. In my specimen the second gnathopod is not so hairy as shown in Bate and Westwood's figure, and the tooth or hump on the dorsal surface of the fourth pleon segment is much more marked.

Bathyporeia pilosa, Lindström.

II., E.L. In immense numbers, of both sexes.

Urothoe marinus, Bate.

U. elegans, Bate.

One specimen. Male. I.

**Amphilochus manudens*, Bate.

One specimen. I. *a*.

Metopa alderi, Bate.

Several specimens, all very small. I. and II.

Iphimedia obesa, Rathke.

One specimen. Length 4 mm. I. *a*. This specimen was nearer *I. eblana*, Bate, which however Stebbing considers is only a (? young) form of *I. obesa*.†

**Monoculodes longimanus*, Bate and Westwood.

M. longimanus, Bate and Westwood.

M. grubei, Boeck, "Brit. Sess. Crust.," vol. ii, p. 507.

Several specimens. II., E.L.

**Megaluropus agilis*, Norman.

A few specimens. II., E.L. An undescribed species, having some remarkable characters, notably the very broad third uropods, and the position of the eye in the front portion of the lateral cephalic lobe. It has long been in the rich collection of Norman, who is about to publish a description in the "Ann. and Mag. Nat. Hist."‡ He informs me that he has specimens from the east, west, and south coasts of Great Britain. The third uropods are very fragile and often missing in dead specimens.

Dexamine spinosa, Mont.

Not common on Puffin Island. I. *d*.

**Atylus vedlomensis*, Bate and Westwood.

Dexamine vedlomensis, Bate and Westwood.

Not common. I. *d*. II., E.L.

† "Challenger" Report, p. 295.

‡ "Ann. and Mag. Nat. Hist.," 6th series, vol. iii., p. 445, pl. xviii., figs. 1 to 10.

**Tritæta gibbosa*, Bate.

Atylus gibbosus, Bate and Westwood.

Not uncommon on Sponges, Ascidians, &c. I., II., III. Most easily obtained by placing freshly gathered pieces of *Halichondria panicea* in sea water, when it emerges from them.

Halirages bispinosus, Bate.

I. *d.*, IV.

Calliopius leviusculus, Sp. Bate.

Very abundant. I. *d.* All the specimens taken were freckled with red. This species varies in colour remarkably in different localities. At Colwyn Bay it is generally greenish white, while those I have seen from Penmaenmawr were olive coloured.

**Calliopius norvegicus*, Rathke (?).

Llandudno. I. *b.*, III., IV. It is remarkable that this species, which has not been previously recorded as British, should this year have been taken at all the above localities, at Bull Bay (IV.) abundantly. Mr. Stebbing informs me, however, that it is not uncommon at Ilfracombe. Meinert† and Zaddach‡ do not consider it distinct from the preceding. I am surprised at this statement, for the longer and more slender antennæ, the teeth on the under side of the last joints of the peduncle of the upper antennæ in the male (in place of the strong tooth at the distal extremity of the last joint in *C. leviusculus*), the smaller and weaker gnathopods with the wrist not produced into a spur, and lastly the angulated hind margin of the third pleon segment above the lower angle, make the distinction unmistakeable. At the same time, I doubt whether *C. norvegicus* of Boeck (which is certainly our species)

† "Crust. Isop. Amphip. und Decap. Daniæ." Natur. Tidsk. 1877-8.

‡ "Die Meeres-Fauna an die Preuss. Küste."

be identical with *Amphithoe norvegicus* of Rathke. The latter has the upper antennæ only half as long as the lower, whereas I have never seen a specimen in which they were not almost exactly equal as shown by Boeck. Rathke's other characters also are scarcely sufficient to connect them.

Gammarus marinus, Leach.

I. *a*.

Melita obtusata, Mont.

I. *a*., II. A number on *Asterias rubens*, dredged between the N.W. Lightship and the Isle of Man on the outward voyage of the "Hyæna," May 19th, 1888.

Amathilla sabini, Leach.

I. *a*.

**Ampelisca tenuicornis*, Lilljeborg.

A. typica, Boeck, non Bate.

(?) *A. carinatus*, Bruzelius.

I. *a*. II., E.L., and dredged. The confusion as regards the above species is great (see Stebbing, "Challenger" Report, p. 542). As this author remarks,† his *A. zamboangæ* from the Philippine Islands approaches closely to *A. carinatus*, Bruz. Two of the specimens from Port Erin agree so closely with the admirable drawings of *A. zamboangæ* that the two forms can hardly be regarded as other than local varieties.

Ampelisca lævigata, Lillj.

II., E.L. Many specimens, both at Ramsey and Port Erin. This appears to be the commonest species of the genus in Liverpool Bay.

Photis reinhardi, Kr.

One female, with ova. II., E.L.

† "Challenger" Report, p. 1687, note.

Nœnia rimapalma, Bate.

I. *a*.

Amphithoe podoceroides, Rathke.

I. *a*. Stebbing† considers this to be the same as *A. rubricata*, Mont., though the former is green and the latter red. Here again, as in *Dynamene rubra*, Mont., and *D. viridis*, Leach, the colouring probably depends on that of the weed in which the animals are found. Montagu's name being the older should have the precedence, as Stebbing points out.

**Podocerus capillatus*, Rathke (Pl. XI., figs. 14 and 15).

Janassa variegata, Boeck.

I. *c*. One small specimen, 2 mm. long, taken in the tow-net by Mr. I. C. Thompson. There is much confusion about this species, which appears to me to have arisen chiefly from the figure in Bate and Westwood,‡ and from their statement that it is possibly only a variety of *P. variegatus*, Leach. The figure of the entire animal as shown by these authors may or may not be the last named species, but the separate drawings of the lower antennæ and second gnathopod unquestionably indicate *P. capillatus* of Rathke. Leach's characters are so unsatisfactory that it seems hopeless to determine whether his *P. variegatus*, *Jassa pulchella*, and *J. pelagica*, are one and the same species (*P. falcatus*, Mont.) or not. But the upper antennæ without a secondary appendage, the thickness and dense hairiness of the lower antennæ, with the flagellum consisting of one long and two minute joints unprovided with the hooks which occur in the same member in *P. falcatus* (and *P. variegatus*, as figured by Bate and Westwood), together with the form of the second gnathopod, all mark *P. capillatus* as very distinct from

† "Challenger" Report, pp. 204 and 594.

‡ Brit. Sess. Crust., p. 442.

P. falcatus at any age. Indeed the absence of a secondary appendage would seem to justify Bruzelius in placing it in a separate genus, *Jassa* of Leach, though it is not easy from Leach's description (in the Trans. Linn. Soc., vol. xi., p. 361) to see in what material point this genus differs from his *Podocerus*.

**Podocerus isopus*, n. sp. (Pl. XI., figs. 11 to 13).

Lateral lobe of the head a sharp right angle. Eyes round, centre dark, surrounded by a ring of clear facets.

Antennæ subequal, the upper rather the longer, sparsely hairy; the peduncle of the lower and the flagellum of the upper being the longer. The *upper antennæ* have the second and third joints equal, about five tufts of two hairs on the under side of each. The secondary appendage, which consists of one long and one minute joint terminated by setæ, is rather more than half as long as the first joint of the flagellum. This has five joints, the second and last being the shortest; the last is also much thinner than the penultimate. The *lower antennæ* have the second joint of the peduncle about three-fourths the length of the third; the flagellum is five-jointed, the first joint nearly as long as the second and third together; the fourth joint is terminated by two, and the fifth (which is small) by one curved spine.

First Gnathopods: Wrist shorter than the hand, rounded posteriorly. Hand ovate, palm undefined, with many hairs, two strong spines in the middle and one nearer the wrist. Finger long, reaching the lower spine, and serrated on its distal half, but not as far as the point.

Second Gnathopods: Like the first gnathopods, except that the margin of the palm in the distal half is somewhat sinuate. In the male (?) the hand is about one-third larger than in the first pair; in the female the two limbs differ but little in size.

Uropods: The three pair extend about equally backwards; in the first the peduncle is slightly longer, in the second shorter, and in the third much longer than the rami. The peduncle of the third has three short spines on its upper margin, and five or six at the distal end. The outer ramus is longer than the inner, straight, smooth and tapering, terminated by a minute nail; the inner is curved, minutely denticulate on the concave side, with a comb-like process of five or six somewhat larger teeth overlapping the nail.

Telson convex, triangular, with curved sides and rounded apex; a pair of upright spines on each side of a median line, somewhat nearer the apex than the base.

The specific name is derived from ἴσος equal, πούς foot, referring to the equality between the first and second gnathopods, which is unusual in the genus *Podocerus*. The animal is variable in colour and prettily mottled.

I. *a.*, III. It is with great hesitation that I describe as new a small species taken as above. One at least of the specimens was a female, with ova, which agrees with Boeck's description of the female of *P. anguipes*, Kr., except in size—Boeck giving 10 mm. as the length, while this specimen was not more than 3 mm. If I am right in believing some of my specimens to be males, then it is certainly not *P. anguipes*, for the second gnathopod (which is almost the same shape as, and but little larger than the first) in these differs from that in the female only in being slightly larger. It is possible that Boeck has been mistaken in referring the small males he mentions as resembling the females to *P. anguipes*. If this be so, the present species may be considered as new to science, and I propose to name it provisionally *Podocerus isopus*. Mr. Stebbing informs me he has received similar forms from Mr. D. Robertson, taken in the Clyde district, and con-

sidered them to be females of *P. anguipes*, Kr., in spite of their small size. No male of this species, which has a very characteristic second gnathopod, is known to have been taken on the British coasts, which furnishes another reason for believing our species to be distinct.

**Corophium crassicorne*, Bruzelius.

I. *d.* Two or three specimens of what I take to be the young form of the above. The upper antennæ have three spines on the first joint; the lower have one double spine on the first joint, two double and one single on the second, and one single on the third joint of the peduncle. Hoek,† who describes and figures this form, also considers it probably the young of the above species, though some females had eggs. In other respects my specimens agree closely with Hoek's figures of the adult *C. crassicorne*. Norman has taken this form at Roundstone, in Ireland.

Caprellidæ.

Proto ventricosa, Müller.

P. pedata, Mont.

P. goodsiri, Bate. (Old male.)

Three or four specimens. I. *d.* Stebbing‡ holds that *P. goodsiri* is merely a form of *P. ventricosa*, in which he has been confirmed by Mayer.§

Ægina phasma, Mont.

Protella phasma, Bate and Westwood.

Several fully developed specimens. I. *d.*

**Caprella acanthifera*, Leach.

Three or four specimens. I. *d.*, IV. None of the specimens had fully developed tubercles or spines, and they

† "Tijdschrift Nederland. Dierkund. Vereen.," Deel. iv., p. 118, pl. viii., figs. 9 and 10.

‡ "Ann. and Mag. Nat. Hist." Series 4, vol. xvii., p. 78.

§ "Fauna, &c. des Golfes v. Neapel.," part vi., 1882. Caprelliden.

were only recognizable by the peculiar skull-shaped head and the sparse hairiness of the lower antennæ. A female, with eggs, from Bull Bay, had a large tubercle on the first segment. Mayer (*l.c.*) shows that perfectly smooth forms are not uncommon, but that it is on this segment that a spine or tubercle is most often developed.

In conclusion, I have to tender my hearty thanks to the Rev. T. R. R. Stebbing and the Rev. Canon Norman, for their kind assistance, and especially to the former, for the gift of his magnificent work on the "Challenger" Amphipoda. The bibliography alone of this work is a perfect monument of patient work, and, consisting as it does of a resumé of all that has been written on the entire subject, accompanied by the author's comments, is a complete library in itself. It is no exaggeration to say that it will be indispensable to every student of the Amphipoda.

Description of Plates.

Plate X.

Figs. 1 to 8, *Lysianax ceratinus*, n. sp.
- Fig. 1. Antennæ.
- Fig. 2. Mandible and palp.
- Fig. 3. Maxillipede.
- Fig. 4. First gnathopod.
- Fig. 5. Third segment of pleon.
- Fig. 6. First and second joints of last peræopod; 6*a*, spines on the same.
- Fig. 7. Telson.
- Fig. 8. Third uropod.

Figs. 9 and 10. *Lysianax* (?) *audouinianus*, Sp. Bate.
- Fig. 9. First gnathopod.
- Fig. 10. Second gnathopod.

Plate XI.

Figs. 11 to 13, *Podocerus isopus*, n. sp.
- Fig. 11. Head and antennæ.
- Fig. 12. First (*a*) and second (*b*) gnathopods of female.
- Fig. 13. Third uropod.

Figs. 14 and 15, *Podocerus capillatus*, Rathke.
- Fig. 14. Antennæ.
- Fig. 15. Second gnathopod.

Figs. 16 to 18, *Munna fabricii*, Kröyer.
- Fig. 16. First foot.
- Fig. 17. Second foot.
- Fig. 18. Telson.

SECOND REPORT on the POLYZOA of the L.M.B.C. DISTRICT.

By Joseph Lomas, Assoc. N.S.S.,
special lecturer on geology in university college, liverpool.

[Read 12th April, 1889.]

In the last report ninety-eight species of Polyzoa were recorded as occurring in the L.M.B.C. district. Since that time numerous dredging and shore expeditions have taken place, resulting in the addition of ten species new to the locality. These, along with a new species, described in the previous report as a new variety of *Pedicellina gracilis*, bring the total number up to 109.

Membranipora flemingii, Busk, mentioned in the first report without any definite localities, has been met with off Anglesey, Calf of Man, &c.

The "Weathercock" expedition of August, 1886, is notable among those held since the former report for the abundance of Celleporas brought up. *Cellepora pumicosa*, *C. costazii*, *C. armata*, *C. avicularia*, and *C. dichotoma* were dredged in a deep hole (thirty-five fathoms), about ten miles from the Isle of Man, the three last being new to the district. *Mucronella peachii*, *Scrupocellaria scruposa*, *Crisia cornuta*, *C. eburnea*, *Cellaria fistulosa*, and *Diastopora patina* also appeared in this prolific region.

The "Hyæna" expeditions of 1886, 1887 and 1888, and Easter, 1889, have also resulted in important additions to our fauna. While dredging near the Calf of Man, in May, 1888, a bank of dead shells, chiefly Pectunculi, was touched. The valves were thickly encrusted with Polyzoa, and twenty-three species were obtained, four of them

being new to the district. On a single Pecten valve thirteen species existed, among them being *Hippothoa distans*, *Stomatopora incrassata*, *Membranipora dumerilii*, *M. craticula*, and *Schizoporella unicornis*. A Buccinum shell also was found encrusted with ten species.

The Biological Station at Puffin Island has afforded a large amount of good material, and the results obtained after examining the same are embodied in a "Report on the Polyzoa of Puffin Island,"* read before the Biological Society in November, 1887. Altogether fifty-one species are recorded from the island, and five species and three varieties are given which have not been found in any other part of the L.M.B.C. district.

In addition to the above localities, shore collecting in all parts has been conducted, but little has resulted from this source. This leads one to the conclusion that future successes are to be looked for when examining the deeper parts of the area during our dredging expeditions.

Species New to the Locality.

Cellaria sinuosa, Hassall.

Farcinia sinuosa, Hassall.
Salicornaria sinuosa, Johnst., Busk, &c.

Fine specimens were dredged at a depth of twenty-seven fathoms, near Port Erin, in the "Hyæna" expedition of Easter, 1889.

Schizoporella unicornis, Johnston.

Lepralia unicornis, Johnst., Busk, Alder, Hincks.
Lepralia cusata, Johnst., Busk, Hincks, Reuss, &c.

Dredged in the "Hyæna" expedition of 1888, near the Calf of Man, from a depth of twenty fathoms.

* Proc. L'pool Biol. Soc., vol. ii., p. 74.

Mastigophora hyndmanni, Johnston.

Lepralia hyndmanni, Johnst., Busk.

This species is given on the authority of Mr. R. Kirkpatrick, of the British Museum, who found it among specimens collected by Mr. J. Gregory, F.G.S., at Puffin Island, in August, 1887. It has not since been met with.

Mucronella ventricosa, Hassall.

Lepralia ventricosa, Hass., Johnst., Busk, &c.

Puffin Island.

Cellepora armata, Hincks.

This rare species, which has only been found in a few localities, was dredged in the "Weathercock" expedition of 1886, between Liverpool and the Isle of Man, from a depth of twenty-five fathoms.

Cellepora avicularis, Hincks.

"Weathercock" expedition of 1886, from twenty-five fathoms.

Cellepora dichotoma, Hincks.

Cellepora avicularis, Smitt.

"Weathercock" expedition of 1886, from twenty-five fathoms. "Hyæna" expedition (Easter, 1889), south of Port Erin, from twenty-seven fathoms.

Stomatopora incrassata, Smitt.

Alecto retiformis, Hincks.

On Pecten shell, "Hyæna" expedition of 1888, near the Calf of Man, depth twenty fathoms.

Stomatopora granulata, M-Edwards.

Alecto granulata, M-Edwards, Johnst., Busk.

Dredged near Puffin Island.

Stomatopora johnstoni, Heller.

Alecto granulata, Johnst.

Dredged near the Calf of Man, during the "Hyæna" expeditions of 1888 and of Easter, 1889.

Ascopodaria nodosa, Lomas.

Pedicellina gracilis, var. *nodosa*, "Fauna of Liverpool Bay," vol. i.
Ascopodaria nodosa, Lomas, "Proc. L'pool Lit. and Phil. Soc.," 1886, vol. xli., p. xlvi.

Zoarium consists of a slender chitinous stolon, from which branches, bearing polypides, are given off at intervals.

Peduncle chitinous, hollow, expanding below into a muscular swelling. A second muscular swelling is found in the middle, and a third at the top, just under the head.

This form was described in the "First Report upon the Fauna of Liverpool Bay" (p. 190, pl. iii., fig. 2), under the name of *Pedicellina gracilis*, var. *nodosa*. Further research, however, led me to believe that it should be placed in the new genus lately founded by Busk, *Ascopodaria* ("Challenger" Report, vol. xvii.); so in 1886 I described it as *Ascopodaria nodosa*, in a paper read before the Literary and Philosophical Society of Liverpool.

The characteristic features of the new genus mostly reside in the stem, which is chitinous, tubular, and rigid, and joins the stolon by a broad barrel-shaped dilatation. In *A. nodosa*, the "basal cylinder" is broad below, and tapers suddenly near the top, becoming continuous with the stem. It is not annulated like *A. discreta*.

Separating the basal cylinder from the stem is a septum, which stretches nearly across, leaving a perforation in the middle. The whole swelling is filled with muscular tissue, which is prolonged for a short distance on each side into the stolon; and a septum, similar to the one in the stem, separates the muscular portion from the tubular stolon on each side. The septum may serve to give attachment to the muscles which have to do with the movement of the peduncle.

The most striking feature, however, is the presence of a second swelling in the middle of the stem, muscular in

its nature; and there is a third and smaller one under the head.

The portion between the basal cylinder and the medial swelling is about the same length in all the specimens I have examined, but the part between the medial swelling and the head varies very greatly. In one colony there was, along with the ordinary type, a form without a medial swelling, but the length of the stem was equal to the first joint in the others. This may be an imperfectly developed specimen, and it would seem to indicate that, as the individual grows, the head swelling becomes the medial one by an elongation of the upper joint. The differences in length of the upper joint also favour this view.

The stem may be described as a rigid chitinous tube. Now chitin, being merely a product of the ectodermal cells, cannot be regarded as supplying any living connexion between the different parts of the zoarium. But under a high power a very delicate tissue of elongated nucleated cells is seen, inside the chitinous covering, connecting the different muscular parts in the stem and stolon.*

The specimens were collected by Professor Herdman, off Port Erin, in the summer of 1885, and were adherent to seaweeds (*Ptilota*, &c.). It has not since been observed in the L.M.B.C. district.

Besides the above additions to our fauna, the following observations have been made on species previously recorded.

Alcyonidium gelatinosum, Linn.

Some points in the anatomy† of this species have been worked out; and it has been found to contain certain

* Busk has observed the same "parenchymatous tissue" in other species of *Ascopodaria*.

† Lomas, "Proc. L'pool Biol. Soc.," vol. i., p. 29.

calcareous spicules* in the peripheral parts of the gelatinous ectocyst. Professor Herdman has described† some specimens obtained from the west coast of Scotland, and recently also from Puffin Island,‡ in which the colony was conspicuously spotted. These whitey spots were found on sectionizing to be very much enlarged "cells," containing polypides, and greatly distended with mature spermatozoa. These colonies were virtually males, as none of the polypides were found to contain mature ova. A spotted colony collected lately at Puffin Island was found, however, to contain large numbers of ripe ova and embryos, but no spermatozoa. Professor Herdman has suggested that this unisexual condition may be the result of proterandry—the male reproductive organs being developed first, and the female later on, but he leaves it an open question whether the individual polypides are proterandrous hermaphrodites, or whether the polypides are unisexual and the proterandry refers only to the colony as a whole.

Cellaria fistulosa, Linn.

Some of the specimens of this species have afforded me material for investigating the mode of branching.§ The stems are dichotomously branched, but in some cases a lateral branch may originate in the middle of an internode (see fig. 1). When the branches are young they are rigidly connected by elongated cells, which have mouth opening and avicularia like those of ordinary cells (see fig. 2). As the branch elongates these cells break and display horny

* Lomas, "Proc. L'pool Geol. Soc.," vol. v., p. 241. Mr. Waters quite independently discovered these spicules, and communicated a paper on the subject to the Manchester Lit. and Phil. Soc.

† See "Nature," for Dec. 29th, 1887, p. 213.

‡ And I have seen at the British Museum a similar specimen, brought by Mr. Ridley from the Isle of Thanet.

§ See Lomas, "Research," for August, 1888, p. 22.

tubes beneath, connecting the cells of the branch with those of the parent stem (see fig. 3).

Fig. 1.
Cellaria fistulosa, natural size, showing the mode of branching.

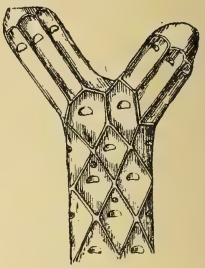


Fig. 2.
Cellaria fistulosa, magnified, showing the arrangement of the cells and the formation of lateral branches.

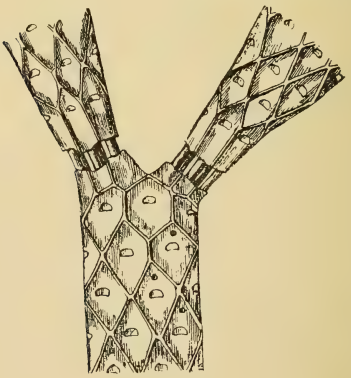


Fig. 3.*
Cellaria fistulosa, magnified, showing lateral branches further developed and separated from the stem by flexible joints.

* I am indebted to Mr. A. N. Tate, F.I.C., &c., editor of "Research," for permission to use these wood-cuts.

TABLE SHOWING DISTRIBUTION OF THE SPECIES OF POLYZOA IN THE DISTRICT.

SPECIES.	Cheshire Coast and Hilbre Island.	Welsh Coast, Rhyl to Penmaenmawr.	Menai Straits, Puffin Island and Anglesey.	Lancashire Coast, Liverpool to Fleetwood.	Isle of Man.
Sub-Order I. **CHEILOSTOMATA.**					
Aetea anguina, Linn..	×	×	×	...	×
A. recta, Hincks	...	...	...	...	×
A. truncata, Landsb.	...	...	...	...	×
Eucratea chelata, Linn	...	×	×	...	×
α repens	...	...	...	...	×
β gracilis	...	...	...	...	×
γ elongata	...	...	...	...	×
Gemellaria loricata, Linn.	×	×	×	×	...
Cellularia peachii, Busk	×	...	...	...	...
Scrupocellaria scruposa, Linn.	×	×	×	×	×
S. scrupea, Busk	×	×	...	...	×
S. reptans, Linn	×	×	×	×	×
Bicellaria ciliata, Linn	×	×	×	×	...
Bugula turbinata, Alder	×	×	×	...	×
B. flabellata, J. V. Thomp.	×	×	×	×	×
B. avicularia, Linn.	...	×	×	×	×
B. plumosa, Pallas	×	×	×	×	×
B. purpurotincta, Norman	...	...	×	...	...
Beania mirabilis, Johnst	...	...	...	...	×
Cellaria fistulosa, Linn	...	×	×	...	×
C. sinuosa, Hassall	...	...	...	...	×
Flustra foliacea, Linn.	×	×	×	×	×
F. carbasea, Ellis and Sol.	...	...	...	×	...
F. securifrons, Pall.	...	×	...	...	...
F. papyracea, Ellis and Sol.	×	...	×	...	...
Membranipora lacroixii, Aud.	×	×	×	×	×
M. monostachys, Busk.	×	...	×	...	...
M. catenularia, Jameson	...	...	...	...	×
M. pilosa, Linn.	×	×	×	×	×
M. flemingii, Busk	...	...	×	...	×
M. hexagona, Busk	...	...	×	...	×

Species.	Cheshire Coast and Hilbre Island.	Welsh Coast, Rhyl to Penmaenmawr.	Menai Straits, Puffin Island and Anglesey.	Lancashire Coast, Liverpool to Fleetwood.	Isle of Man.
M. lineata, Linn.	...	...	×	...	×
M. craticula, Alder	...	..	...	...	×
M. spinifera, Johnst.	...	...	...	...	×
M. dumerilii, Aud.	...	...	...	...	×
M. rosselii, Aud.	...	...	...	...	×
M. aurita, Hincks.	...	...	...	...	×
M. membranacea, Linn.	×	×	×	...	×
Micropora coriacea, Esper	...	...	...	...	×
Cribrilina radiata, Moll.	...	...	...	...	×
C. punctata, Hass.	...	...	...	...	×
C. annulata, Fabr.	...	...	...	...	×
Membraniporella nitida, Johnst.	...	...	...	...	×
Microporella ciliata, Pallas	...	...	...	...	×
M. malusii, Aud.	...	...	...	...	×
M. impressa, Aud.	...	...	...	...	×
M. violacea, Johnst.	...	...	...	...	×
Chorizopora brongniartii, Aud.	...	...	...	...	×
Schizoporella linearis, Hass.	...	×	...	...	...
S. spinifera, Johnst.	...	×	...	...	×
S. auriculata, Hassall	...	...	×	...	×
S. hyalina, Linn.	...	...	×	...	×
S. unicornis, Johnst.	...	...	...	...	×
Mastigophora hyndmanni, Johnst.	...	...	×	...	...
Hippothoa distans, McGill	...	...	×	...	×
H. divaricata, Lamx.	...	...	×	...	...
Lepralia pallasiana, Moll.	...	×	...	...	×
L. foliacea, Ellis and Sol.	...	...	×	...	×
L. pertusa, Esper.	...	...	...	...	×
Umbonula verrucosa, Esper	...	...	...	...	×
Porella concinna, Busk	...	...	...	...	×
P. compressa, Sow.	...	...	...	...	×
Smittia landsborovii, Johnst.	...	×	...	...	×
S. reticulata, McGill	...	...	...	...	×
S. trispinosa, Johnst.	...	...	...	...	×
Phylactella collaris, Norman	...	...	...	...	×
Mucronella peachii, Johnst.	...	...	...	...	×
M. variolosa, Johnst.	...	...	×	...	×

Species	Cheshire Coast and Hilbre Island.	Welsh Coast, Rhyl to Penmaenmawr.	Menai Straits, Puffin Island and Anglesey.	Lancashire Coast, Liverpool to Fleetwood.	Isle of Man.
M. coccinea, Abild.	...	...	×	...	×
M. ventricosa. Hassall	...	...	×	...	...
Cellepora pumicosa, Linn.	×	×	×	×	×
C. costazii, Aud.	...	×	×	×	×
C. armata, Hincks	...	...	...	...	×
C. avicularis, Hincks	...	...	...	...	×
C. dichotoma, Hincks	...	...	...	...	×
Sub-Order II. **CYCLOSTOMATA.**					
Crisia cornuta, Linn.	×	×	×	×	×
var. *geniculata*	...	×	...	...	×
C. eburnea, Linn.	×	×	×	×	×
C. denticulata, Lamk.	×	...	×	...	×
Stomatopora expansa, Hincks	...	...	...	...	×
S. major, Johnst.	...	...	...	...	×
S. incrassata, Smith	...	...	...	...	×
S. johnstoni, Heller	...	...	...	...	×
S. granulata, M-Edwards	...	...	×	...	...
Tubulipora lobulata, Hass.	...	...	...	...	×
T. flabellaris, Fabr.	..	×	...	...	...
Idmonea serpens, Linn.	×	×	×	×	×
Diastopora patina, Lamk.	...	×	×	...	×
D. suborbicularis, Hincks	...	...	...	...	×
D. obelia, Johnst.	...	×	×	...	...
Lichenopora hispida, Flem.	×	...	...	...	×
L. verrucaria, Fabr.	...	×	...	...	...
Sub-Order III. **CTENOSTOMATA.**					
Alcyonidium gelatinosum, Linn.	×	×	×	...	×
A. hirsutum, Flem.	×	×	×	...	×
A. mytili, Dal.	...	×	×	...	×
A. parasiticum, Flem.	×	×	×	...	...
Flustrella hispida, Fabr.	×	×	×	...	×
Arachnidium hippothooides, Hincks	...	...	...	...	×
Vesicularia spinosa, Linn.	×	×	×	×	×
Amathia lendigera, Linn.	×	×	×	×	×

Species.	Cheshire Coast and Hilbre Island.	Welsh Coast, Rhyl to Penmaenmawr.	Menai Straits, Puffin Island and Anglesey.	Lancashire Coast Liverpool to Fleetwood.	Isle of Man.
Bowerbankia imbricata, Adams ...	×	×	×	...	×
B. pustulosa, Ellis and Sol.	...	×	×	...	×
Farella repens, Farre.....	...	...	...	...	...
var. *elongata*.....	...	...	...	×	...
Buskia nitens, Alder	...	×	...	...	...
Cylindrœcium dilatatum, Hincks...	...	×	...	...	×
Anguinella palmata, Van Ben.....	×	...	...	...	...
Valkeria uva, Linn.	...	...	...	...	...
form *uva*	...	...	×	...	...
form *cuscata*.....	...	×	×	...	×
V. tremula, Hincks.....	...	...	...	...	×
Mimosella gracilis, Hincks	...	...	...	...	×
Sub-Class ENTOPROCTA.					
Pedicellina cernua, Pall.....	...	...	...	...	×
P. gracilis, Sars.....	...	×	...	×	×
Ascopodaria nodosa, Lomas	...	...	...	...	×

SECOND REPORT on the NUDIBRANCHIATA of the L.M.B.C. DISTRICT.

By W. A. Herdman, D.Sc., F.L.S., F.R.S.E,
PROFESSOR OF NATURAL HISTORY; AND
J. A. Clubb,
ASSISTANT IN THE NATURAL HISTORY DEPARTMENT, UNIVERSITY COLLEGE, LIVERPOOL.

With Plate XII.

[Read 10th May, 1889.]

In Professor Herdman's Report upon the Nudibranchiata, in the first volume of the "Fauna," published in 1886, forty-two species were referred to as having been found in this district. We have now, as the result of the last three years' exploration of the neighbourhood, and especially as a consequence of the establishment of the Biological Station on Puffin Island, to place on record some additional localities for many of these species, including some of the rarer ones, some information in regard to their relative abundance and times of spawning, and we have to add to the list *Fiona marina*, a rare species new to the district.

We also include in this report some anatomical and histological observations upon a few of the species of the neighbourhood, especially upon the hepatic cæca of *Dendronotus* and the apertures in the cerata of *Eolis;* and we append a short note upon some British specimens of *Hero formosa*, Lovén, a Scandinavian Nudibranch.

The greater part of the practical work for this report has been carried out by Mr. Clubb, in the zoological laboratory of University College; while Prof. Herdman has suggested the lines of investigation, has examined all the specimens and sections, and has discussed the results.

NUDIBRANCHIATA.

Sub-Order. ACANTHOBRANCHIATA.

Family. DORIDIDÆ.

Archidoris tuberculata, Cuv.

This species is not uncommon on the shore at Puffin Island. It is very variable in the colouring.

Lamellidoris bilamellata, Linn.

In abundance at Hilbre Island on the 2nd March, 1889, when it was spawning; a month later very few specimens were found.

L. proxima, Ald. and Hanc.

Several specimens of this local species were found at Puffin Island in March, 1888, and on 18th February, 1889.

The radula of this species is as described and figured by Alder and Hancock, except that the large lateral spines in our specimens have their points directed forwards and lying parallel to one another, in place of pointing outwards laterally as is shown in Alder and Hancock's figure.* The exact shape of these large spines differs considerably in different parts of the series.

Acanthodoris pilosa, Müller.

Specimens were found on the shore at Puffin Island on 11th June, 1887, in March, 1888, and on 18th February, 1889, and at Hilbre Island on 2nd March, 1889. Among the latter were some dark coloured and speckled specimens approaching the black form previously recorded. Those found at Puffin Island include white, grey and nearly black forms.

* Ray Society, "British Nudibranchiata." Part vii., pl. xlvi., fig. 8.

Family. Polyceridæ.

Goniodoris nodosa, Montagu.

In April, 1888, Dr. Hanitsch collected half-a-dozen specimens on the South Spit, at Puffin Island.

We find that there may be a second smaller denticulated ridge on the large lateral spines of the radula in this species.

Polycera ocellata, Ald. and Hanc.

We have found this species on both the North and South Spits, at Puffin Island, near low water mark, on 11th June, 1887, on 24th March, 1888, and on 25th May, 1889. Some of the specimens closely approach *Polycera lessoni* in their characters.

Ancula cristata, Alder.

A specimen of this species was found at Hilbre Island, on 2nd March, 1889, which was entirely of a hyaline transparent white colour, without any yellow markings on the dorsal papillæ, and with no opaque white pigment on any part of the body. On the 16th May, 1889, this species was very abundant at Hilbre Island, and was spawning. Thirty specimens were collected, and about twenty-five specimens were counted on an area of rock about one foot square.

Sub-Order. POLYBRANCHIATA.

Family. Tritoniidæ.

Tritonia plebeia, Johnst.

Two specimens found at Hilbre Island, on 2nd April, 1889, differed considerably in their colouring, the one being yellowish brown, as figured by Alder and Hancock, while the other was marked with blues and greys.

We have found this species on the Beacon rocks, Puffin

Island, on 26th June, 1887, and on both the North and South Spits in May, 1889.

Dendronotus arborescens, Müller.

The variations in the abundance of this species at Hilbre Island were commented upon in the last report. In September, 1888, it was so abundant that forty to fifty specimens were collected in about fifteen minutes, while at the next visit to Hilbre, in the beginning of March, 1889, only a few specimens were seen, and in April none were found.

As Professor Herdman has recorded in the "Second Annual Report upon the Puffin Island Biological Station,"* a number of specimens collected at Hilbre Island were carefully taken to Puffin Island, last September, and placed in suitable spots on the South Spit. They disappeared and have not since been seen, but would hardly be expected to appear again on the shore till later in the summer.

As this species is of large size, and is relatively abundant in this neighbourhood, we have made use of it for anatomical purposes, and shall now place on record some observations we have made as the result of our sections and dissections of a considerable number of specimens.

Alder and Hancock, in their Ray Society Monograph,† gave a general account of the anatomy of *Dendronotus*, illustrated by drawings of dissections of various parts. Recently Dr. Rudolph Bergh, in his Report upon the Nudibranchiata collected during the "Willem Barents" expedition,‡ gave some further details in regard to the

* Proc. Biol. Soc., L'pool, vol. iii., p. 29.

† *Loc. cit.* Part ii., fam. 3, pl. ii.

‡ "Bijdragen tot de Dierkunde." Natura artis magistra, Afl. xiii., viii. p. 25, Amsterdam, 1886.

anatomy of *Dendronotus*, which in some respects supplement and correct the older account.

Both Alder and Hancock and Bergh describe and figure the liver of *Dendronotus* as giving off branched prolongations, which run upwards into the rhinophores (the dorsal tentacles) and other dorsal processes. Alder and Hancock show them as conspicuous prolongations from each side of the liver, while Bergh represents these hepatic cæca as being of large size in the terminal twigs of the cerata or dorsal papillæ, occupying more than half the diameter of the stem and branches. He does not figure their basal parts.

In our specimens from Hilbre Island, however, we do not find, either in dissections or in thin transverse and longitudinal sections, any trace of prolongations from the liver extending actually into the rhinophores and the dorsal papillæ.

Alder and Hancock's description and figures of the anatomy of the liver are not quite correct. They speak of its central trunk lying "above the ovarium, and not below it as in *Eolis*." This is not the case. In *Dendronotus*, just as in some species of *Eolis*, the liver lies *below*, or ventrally to, the ovo-testis, as we show in our transverse section (Pl. XII., fig. 2, *o.t.* and *l.*). Then in their figure 2 (*loc. cit.* fam. 3, pl. 2), they do not represent correctly the three regions since described very fully and accurately by Bergh as the right and left anterior and the posterior lobes.

Bergh, while giving a correct account of the liver itself, has described in addition a system of prolongations into the dorsal papillæ which we are convinced from our sections has no existence. Dissections alone are misleading in this matter, and if the distinguished zoologists whose results we venture to controvert have worked

entirely without the aid of thin serial sections, then it is not surprising that they have been led into error.

Our figure 1 on Plate XII. shows a dissection of *Dendronotus* from the left side, exhibiting distinct prolongations from the liver extending upwards towards the base of the rhinophore and the two succeeding dorsal processes; and as further dissections show distinct cavities branching through these processes, it is not unnatural to suppose that such cavities are the continuations of the hepatic cæca. This, however, is not the case. In our serial sections we can trace the hepatic prolongation towards the rhinophore forwards through sixty-six sections, gradually narrowing until it ends blindly, the last section passing through its anterior wall. At this point it has not nearly reached the base of the rhinophore. Similarly we can trace backwards the next hepatic prolongation in the sections till we reach its blind extremity, which is in the body wall vertically below the first dorsal papilla.

On the right side of the body we can also trace the hepatic cæca going some way towards the rhinophore and the two succeeding cerata, but not entering any of these processes.

In the sections of the cerata themselves we find:—

(1) Large spaces in the mesoderm, containing blood corpuscles (Pl. XII., figs. 2 and 3, *c.s.*). These run, in the main, longitudinally. They occasionally branch, and they open into innumerable minute lacunæ in the mesodermal tissues, all of which here and there contain blood corpuscles.

(2) A good deal of pigmented connective tissue forming branched masses and ramifying threads of a brownish colour. These frequently, in a surface view of the terminal branches of the cerata under a low power, give rise to the appearance of a dark coloured granular central cæcum

such as that figured by Bergh (*loc. cit.* pl. ii., fig. 22). Sections, however, show the true nature of this pigmented tract.

(3) Masses of large distinctly nucleated cells lying in meshes of fibrous connective tissue. These are possibly mucus-secreting glands. They occur chiefly in the smaller branches of the cerata.

We figure (Pl. XII., fig. 4) a transverse section through one of the cerata of an *Eolis*, with the contained hepatic cæcum, to compare with that of *Dendronotus* (Pl. XII., fig. 3).

At the bases of the dorsal processes in *Dendronotus* the blood spaces, which may be called the ceratal sinuses, communicate with the large anterior and posterior dorso-lateral veins (Pl. XII., fig. 2, *d.l.v.*) which open directly into the auricle. At the point of junction of a ceratal sinus with the dorso-lateral vein, a lateral sinus is found running ventrally through the mesoderm of the body wall, outside the liver. The diagrammatic figure (Pl. XII., fig. 7), constructed from several sections, shows how the hepatic cæcum comes into close proximity with these blood sinuses, and so may have given rise, in dissections, to the appearance of a direct continuity between the liver and the spaces in the dorsal papillæ, a continuity which our sections show does not exist.

Family. Melibidæ.

Doto coronata, Gmelin.

Taken off the north coast of Anglesey, in the "Hyæna" expedition of 1886. This species was present in great numbers on 2nd April and on 16th May, 1889, at Hilbre Island, while none had been seen a month before on the same ground; thirty-four specimens were collected, all from the under surfaces of stones covered with large colonies of the Hydroid *Clava multicornis*.

This species is very variable both in colour and in form in this district. In some of these specimens* the dorsal papillæ have not the usual tuberculated appearance, but are merely irregularly rounded or slightly lobed. One specimen had the third papilla of the left side distinctly bifurcated, the central vessel giving off a branch into each of the forks. In some cases a few of the dorsal papillæ, besides the terminal pair, are of very small size.

A specimen of *Doto coronata*, found on a Compound Ascidian from the shore at Puffin Island, has the tubercles of the dorsal papillæ slender and tipped with black spots so as to approach the character of *Doto pinnatifida*.

Alder and Hancock figure the radula of *Doto fragilis* (pl. xlvii., supplementary) alone, and state that that of *D. coronata* is "like *D. fragilis*, but rather more distinctly denticulated at the sides" (*loc. cit.*). We find, however, in our specimens of *D. coronata* that the plates of the radula are *not* denticulated at the sides.

Doto fragilis, Forbes.

We dredged this species on 24th March, 1888, in the Turbot Hole, off the N.E. end of Puffin Island, and also brought up a specimen on a long line set for fish off the rocks immediately below the Biological Station.

Family. Eolidiдæ.

Eolis papillosa, Linn.

This species has been taken in January, March and April, on the South Spit at Puffin Island. We have also found a very light coloured variety in shore pools at Fleshwick Bay, Isle of Man.

* These notes, as to colour and form in the various species, were all made from the living animals.

Facelina coronata, Forbes.

Taken at Puffin Island on the shore in January, March and May, and dredged from the Turbot Hole in March, 1888.

We have found this species at Hilbre Island since the last report on 6th September, 1888, and on 2nd April and 16th May, 1889. Two of the specimens found on the last occasion were of the paler coloured form mentioned by Alder and Hancock.

In his article "Mollusca,"* Professor Ray Lankester states that the supposed communication of the hepatic cæca in the dorsal papillæ, of some of the Ceratonota, with the exterior by means of apertures in the apices of the papillæ requires confirmation. Bergh has recently figured a continuous tubular passage in the case of *Chlamylla borealis* and *Gonieolis typica*, and we now give figures of sections (Pl. XII., figs. 4 to 6) showing the exact manner in which the communication takes place in specimens of *Eolis* from Puffin Island.

The upper end of each dorsal papilla is occupied by a sac containing a large number of cnida or thread cells (Pl. XII., fig. 5, *t.*). This cnidophorous sac is evidently an invagination of the ectoderm, and it communicates with the exterior by a small but perfectly distinct and clearly bounded aperture at its apex, through which the thread cells are sometimes found protruding (see Pl. XII., fig. 5, *ap.*).

The hepatic cæcum (Pl. XII., figs. 4, 5, 6, *h.c.*) occupying the greater part of the dorsal papilla reaches nearly to the lower end of the sac containing the thread cells, and we find in several of our serial sections (Pl. XII., fig. 6, *p.*) a tube with muscular walls leading from the base of the cnidophorous sac, and opening into the apex of the

* "Ency. Brit." 9th edition, vol. xvi., p. 659.

hepatic cæcum by a small terminal aperture, surrounded by a distinct sphincter muscle, so as to allow the lumen of the hepatic cæcum to communicate with the cavity in which the thread cells lie, and therefore with the exterior when the sphincter is relaxed.

Flabellina drummondi, Thomp.

Taken at Hilbre Island on 6th September, 1888, and on 16th May, 1889. In the cerata of this species we find the cnidophorous sac elongated, overlapping the upper end of the hepatic cæcum and joined to it by a long slender recurved tube.

Coryphella rufibranchialis, Johnst.

We have taken this species at Hilbre Island on the 6th September, 1888, and on 2nd March and 16th May, 1889 (large specimens).

Cavolina viridis, Forbes.

We found a specimen of this rare species on the North Spit, Puffin Island, near low water mark, on the 18th February, 1889. It was 7 mm. in length, and had the dorsal process nearest to the middle line in the seventh row on the right side distinctly bifurcated at the tip.

Cuthona nana, Ald. and Hanc.

We have found this species again at Hilbre Island, on 2nd March, on 2nd April, and on 16th May, 1889; and also at Puffin Island in April, 1888.

In this species, as in *Galvina picta*, the auditory sac contains a single large spherical otolith.

The two specimens found at Hilbre in March resemble *Eolis pustulata*, Ald. and Hanc., in one or two points. The one specimen has the rose-red colouring of *C. nana*, but shows the pustulate condition of the white granules characteristic of *E. pustulata;* while the second specimen

presents the more tawny yellow colouring of *E. pustulata*, along with the dark granules found in *C. nana*. Both individuals have the foremost row of dorsal processes in front of the dorsal tentacles, and in both the radula is identical with that of *C. nana*, as figured by Alder and Hancock. These two forms are evidently very closely allied, if indeed they can be considered as distinct species.

Galvina picta, Ald. and Hanc.

We found this species at Hilbre Island, on 2nd March, 1889.

Fiona marina, Forskahl.

Fiona nobilis, Ald. and Hanc.

Three specimens of this species, which is an addition to our fauna, have been found in the district since the last report. Mr. Thompson collected two specimens at Penmaenmawr, in July, 1886; and Mr. Vicars found the third near the end of the Southport pier at low tide in 1887.

We add a table showing the distribution of the species of Nudibranchiata in the four parts of the L. M. B. C. district in which they have been most carefully collected and recorded. The first column includes Hilbre Island, while the third takes in the entrance to the Menai Straits and Bangor: we separate Puffin Island from the preceding region, merely because it may be convenient for those working at the Biological Station to know what species may be found on their shore. Fourteen species have now been found on Puffin Island and the immediate neighbourhood.

NUDIBRANCHIATA.	Estuary of the Mersey.	Isle of Man.	North Wales.	Puffin Island.
Archidoris tuberculata	×	×	×	×
A. johnstoni	×	...	...	...
A. flammea	...	×	...	...
Lamellidoris bilamellata	×	...	...	...
L. depressa	×	...	...	...
L. proxima	×	...	...	×
Acanthodoris pilosa	×	...	...	×
A. quadrangulata	×	...	...	...
Goniodoris nodosa	...	×	×	×
G. castanea	...	×	...	...
Triopa claviger	...	×	...	...
Polycera lessoni	×	...	...	...
P. ocellata	×	...	...	×
P. quadrilineata	...	×	...	...
Ancula cristata	×	...	...	...
Tritonia hombergi	×	×	...	...
T. plebeia	×	...	...	×
Dendronotus arborescens	×	×	×	...
Doto coronata	×	×	...	×
D. fragilis	...	×	...	×
Antiopa cristata	×	...	×	...
A. hyalina	×	...	...	...
Eolis papillosa	×	×	×	×
E. glauca	...	...	×	...
Facelina coronata	×	...	...	×
Flabellina drummondi	×	...	×	...
Coryphella lineata	...	×	...	...
C. gracilis	...	...	×	×
C. landsburgi	×	...	...	...
C. rufibranchialis	×	...	...	...
Cavolina concinna	×	...	...	...
C. olivacea	×	...	...	...
C. amœna	...	×	...	...
C. aurantiaca	×	...	...	...
C. arenicola	...	...	×	...
C. viridis	...	×	...	×
Cuthona nana	×	...	...	×
Galvina picta	×	×	×	×
G. tricolor	...	×	×	...
Tergipes despecta	×	...	×	...
T. exigua	×	...	×	...
Embletonia pallida	×	...	...	...
Fiona marina	×	...	×	...

Note on some British Specimens of *Hero formosa*, Lovén, by Professor W. A. Herdman.

Hero is a Scandinavian Nudibranch, which was first made known by Lovén* in 1839, and has been more fully described by G. O. Sars† and by Bergh.‡ At the time of publication of Alder and Hancock's monograph, *Hero formosa* had not been found in British Seas, but Gwyn Jeffreys records§ in 1869, that it had then been dredged off the Northumberland coast by G. S. Brady, in the Clyde district by Robertson, and in the Minch, from a depth of sixty fathoms, by himself.

In 1880, I dredged two specimens of this beautiful animal in Lamlash Bay, Arran,‖ and since then I have dredged a third specimen off Salen in the Sound of Mull from a depth of twenty fathoms. So that altogether I have collected three specimens on the west coast of Scotland. Of these, I have one in the Zoological Museum of University College, Liverpool, the second was given to Dr. A. M. Norman, and the third was sent to Dr. R. Bergh, who has made most excellent use of it in his recently published account¶ of the anatomy of the species.

The remarkable dorsal papillæ of this species have been figured by several of the above mentioned investigators, and their branched condition has been recognised by all. Lately, however, M. A. Vayssière has published a note on

* "Vetensk. Akad. Handl.," 1839, p. 234.

† "Mollusca Regionis Arcticæ Norvegiæ," 1878, p. 316.

‡ "Malacol. Untersuch." Ht. vii., p. 309, 1874.

§ "British Conchology," vol. v.

‖ "Additional Notes on the Invertebrate Fauna of Lamlash Bay." Proc. Roy. Phys. Soc., Edin. vol. vi., p. 15, pl. i, figs. 4 to 6, 1881.

¶ Beitr. z. kenntn. d. Æolid., Verh. d. k. k. zool.-bot. Gesellsch. i. Wien, 1888, p. 699.

the systematic position of the genus *Hero*,* in which he states that the dendritic appearance of the dorsal papillæ is due to preservation in alcohol, and that these processes are really fusiform dorsal cirri, like those of *Eolis*, arranged in pedunculated groups.

On reading this paper I re-examined my specimen, which is well preserved, and also my drawings made from the living animal at Lamlash, and I can only say that my published figures (Proc. Roy. Phys. Soc., Edin., vol. vi., pl. i., figs. 4, 5) represent the branched cerata correctly. Possibly M. Vayssière's specimens may belong to another species; if not, I am at a loss to conceive how he can regard the dorsal papillæ as being pedunculated groups of fusiform processes. The branches do *not* all arise together at the top of a peduncle; but the main stem divides, and then the branches sub-divide some three or four or five times in the various papillæ in my specimen,† so that the structure produced is a distinctly dendritic one; and, moreover, this condition is not the effect of contraction, but is as distinct or even more distinct in the living animal than in preserved specimens.

* Comptes rendus, cvii., p. 136, July 9, 1888.

† See also Bergh's figures (*loc. cit.* pl. xix., figs. 9 and 10).

Explanation of Plate XII.

a.	Artery.	*mes.*	Mesodermal tissue.
ap.	Aperture on apex of papilla.	*n.*	Nerve in cerata.
b.c.	Blood corpuscles.	*o.t.*	Ovo-testis.
c.s.	Ceratal blood sinus.	*p.*	Passage from hepatic cæcum to cnidophorous sac.
d.l.v.	Dorso-lateral vein.		
f.	Foot.	*r.c.*	Renal chamber.
f.g.	Foot glands.	*rh.*	Rhinophore.
h.c.	Hepatic cæcum.	*s.*	Cnidophorous sac.
l.	Liver.	*t.*	Thread cells (cnida).
m.	Muscle bands.	1, 2, 3.	Cerata or dorsal papillæ.

Fig. 1. Dissection of *Dendronotus arborescens*, from the left side × $1\frac{1}{2}$, showing the cæcal processes of the liver running towards the cerata.

Fig. 2. Transverse section of the body of *Dendronotus* in the region of the second pair of cerata: that on the right side is cut longitudinally. Drawn from Swift's 1 in. obj.

Fig. 3. Transverse section of one of the third dorsal cerata of *Dendronotus*. Swift, $\frac{1}{4}$ in.

Fig. 4. Transverse section of one of the dorsal cerata of *Eolis*. Swift, $\frac{1}{4}$ in.

Fig. 5. Longitudinal section of the extremity of one of the dorsal cerata of *Eolis*, showing the opening of the cnidophorous sac to the exterior. Swift, $\frac{1}{4}$ in.

Fig. 6. A neighbouring section to the preceding one, showing the communication between the cnidophorous sac and the hepatic cæcum. Swift, $\frac{1}{4}$ in.

Fig. 7. Diagrammatic transverse section of *Dendronotus*, showing the relations of the short hepatic cæca to the ceratal and lateral blood sinuses.

SECOND REPORT upon the TUNICATA of the L.M.B.C. DISTRICT.

By W. A. Herdman, D.Sc., F.L.S., F.R.S.E.,
PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, LIVERPOOL.

With Plate XIII.

[Read 10th May, 1889.]

In the previous report* I recorded forty-seven species, seven of which were new to British seas and two new to science; and this long list appears to have nearly exhausted the Tunicate fauna of the district, since, although a large number of specimens have been collected during the last three years, I am only able now to add four species to the record. Of these, however, two are of great interest:—the one is a *Molgula* new to science, obtained during the "Weathercock" expedition of 1886; while the second, *Molgula citrina*, is a species which was described in 1848 by Alder and Hancock, and has not since been heard of. I have found it on the shore at Puffin Island, and at two or three other localities.

The successive cruises of the "Hyæna" in Liverpool Bay have yielded a good deal of the material from which the following notes were drawn up, and the shores of Puffin Island have proved to be very rich in Compound Ascidians, upon some of which I have commenced investigations which will form the subject matter of a future report.

The following twenty species of Ascidians have been

* See "Fauna of Liverpool Bay," vol. i., 1886, p. 281; and also "Notes on Variation in the Tunicata," *tom. cit.*, p. 354.

found round the shores of Puffin Island since the opening of the Biological Station in May, 1887 :—

Ascidiæ Simplices.	Ascidiæ Compositæ.
Clavelina lepadiformis.	*Polycyclus savignyi.*
do., var. *rissoana.*	*Botryllus smaragdus.*
Ascidiella virginea.	*B. schlosseri.*
A. scabra.	*Botrylloides rubrum.*
Styela grossularia.	*B. leachii.*
Polycarpa rustica.	*B. albicans* (?).
Molgula citrina.	*Sarcobotrylloides* sp. (?).
	Distoma rubrum.
Larvacea.	*Morchellium argus.*
Oikopleura flabellum.	*Leptoclinum maculosum.*
	L. durum.
	Diplosoma gelatinosum.

I shall adhere to the same classification as that employed in the previous report.

LARVACEA.

Family. Appendiculariidæ.

Oikopleura flabellum, J. Müll.

This species has now been taken with the tow-net in all parts of our district, but it is the only Appendicularian which has been noticed.

ASCIDIACEA.

ASCIDIÆ COMPOSITÆ.

Family. Botryllidæ.

Polycyclus savignyi, Herdman.

Dredged off the north coast of Anglesey, in the "Hyæna" cruise of 1886. A large colony growing over *Hydrallmania* was found on the Beacon Rocks at Puffin Island.

Botryllus schlosseri, Pallas.

On September 8th, 1888, I found on the South Spit at Puffin Island several very large colonies of this species, one measuring 12 cm. by 8 cm., and nearly covered with small colonies of Polyzoa, both encrusting and branched, and of Hydroids, and with many Amphipoda (*Tritæta gibbosa*) and Læmodipoda adhering. It has also been found at Puffin Island in February, 1888, and at Black Point, Anglesey, in October, 1887.

There are various specimens of *Botryllus* from:—Douglas Bay, dredged, August, 1886; Puffin Island, shore, June 26th, 1887; and off Port Erin, "Hyæna" expedition, 1888; which were not sufficiently examined when alive, and cannot now be identified with certainty.

Botryllus smaragdus, Milne-Edwards.

Found on the Beacon Rocks, Puffin Island, on June 26th, 1887, and July 24th, 1888. These colonies are very fine, and vary a good deal in their colouring. The pigmented corpuscles in the blood are of various tints of green, blue, yellow, red, and opaque white. The larger lateral tentacles of the ascidiozooids (described and figured in the last report) are occasionally found to be branched at their tips. In several cases I have found an *Acineta* adhering to the tentacles at the base of the branchial siphon; and a small Hydrachnid, coloured dark blue and green like the colony, is found running over the surface.

Botrylloides rubrum, Milne-Edwards.

This species is not uncommon at low tide on the shore at Puffin Island. It is also found, I believe, on the shore at Llandudno. We have brought it up on a long fishing line set off the rocks below the Biological Station.

Botrylloides leachii, Savigny.

A large colony was collected on the South Spit, Puffin

Island, at low tide, on September 8th, 1888. The species was found in October, 1887, at Black Point, Anglesey, opposite Puffin Island; also at Puffin Island in January, 1888, and on February 17th, 1889.

Botrylloides albicans (?), Milne-Edwards.

Some colonies collected on the South Spit, Puffin Island, in January and July, 1888, and on September 8th, 1888, probably belong to this species, but some of them are of a yellower tint than is usual. We find two forms, the one of an amber tint and the other more of a chrome yellow. They may be distinct species, or possibly only local varieties. In the first mentioned the ascidiozooids and the marginal bodies are of an amber colour, the common cloacal apertures are four-lobed and are bordered with lemon yellow, and the ascidiozooids have sixteen tentacles of four sizes.

Sarcobotrylloides sp. (?).

A colony found on the South Spit, Puffin Island, in March, 1888, seems to belong to this genus, separated in 1883 by von Drasche from *Botrylloides*. The specimen was not sufficiently examined when alive to warrant its description here as a new species. Only two species of the genus are at present known, *S. superbum*, von Drasche, from the Adriatic, and *S. wyvillii*, Herdman, from the Färoe Channel.

Family. Distomidæ.

Distoma rubrum, Savigny.

This beautiful species is common under stones at low water mark and below it on the South Spit, Puffin Island. On September 8th, 1888, I collected colonies up to 5 cm. in diameter containing ova, embryos and large tailed larvæ.

Some of the large colonies are only slightly attached by

the middle of the lower surface, the edges being free all round. The specimens vary considerably in their colour and in the size and arrangement of the ascidiozooids.

This species is also common at the south end of the Isle of Man.

Family. Polyclinidæ.

Morchellium argus, Milne-Edwards.

Not uncommon under stones on the South Spit, Puffin Island, about low water mark. The peduncles of most of the colonies are quite sandy on the surface, and sections show that there are sand grains in the interior also, so that the test is beginning to assume an appearance like that characteristic of the genus *Psammaplidium*.*

This species was also found, in October, 1887, at Black Point, Anglesey, opposite Puffin Island, and was dredged off the Anglesey coast in the "Hyæna" expedition of 1886.

Amaroucium proliferum, Milne-Edwards.

Collected at Douglas in August, 1886. Some specimens were also dredged off the north coast of Anglesey during the "Hyæna" expedition of 1886.

Family. Didemnidæ.

Leptoclinum candidum (?), Savigny.

Some very fine specimens were dredged from the "Hyæna" on May 20th, 1888, between the Calf of Man and Port Erin from a depth of twenty fathoms. They are attached to a worm tube and to a specimen of *Hyas araneus*.

Leptoclinum maculosum, Milne-Edwards.

A large specimen was obtained on the South Spit, Puffin Island, on September 8th, 1888, at low water mark, and another in July, 1888.

* Zool. Chall. exped., Report upon the Tunicata, part ii. p. 237.

Leptoclinum durum, Milne-Edwards.

A small colony of a pale brown colour, probably belonging to this species, was collected on the shore at Puffin Island, on September 10th, 1888.

Family. Diplosomidæ.

Diplosoma gelatinosum, Milne-Edwards.

Some colonies were obtained at Douglas in 1886, and also on the shore at Puffin Island on July 3rd, 1887. They contain stellate calcareous spicules scattered through the test.

ASCIDIÆ SIMPLICES.

Family. Clavelinidæ.

My original contention that this group, the "Social Ascidians," ought to be considered as a family of the Simple Ascidians, *Clavelina* being united to *Ciona* by such intermediate forms as *Ecteinascidia* and *Rhopalona*, has received powerful support lately from the investigations of Sluiter into the species of *Ecteinascidia*, and of Roule upon *Rhopalona neapolitana*. Roule has discovered that *Rhopalona* is in every respect similar to *Ecteinascidia*, except that it does not produce buds.

Clavelina lepadiformis, O. F. Müller.

This species was formerly recorded from Hilbre Island and the Isle of Man. I can now add the following localities at which it has been taken:—Off Colwyn Bay, on July 9th and September 7th, 1887, dredged by Mr. A. O. Walker, in two fathoms; off Groudle Bay, north of Douglas, Isle of Man, dredged by Mr. J. Clubb in August, 1886; under stones on the South Spit, Puffin Island, collected on July 3rd, 1887, and September 8th and 9th, 1888.

The variety *rissoana* (sometimes considered as a distinct species, *Clavelina rissoana*, M.-Edw.), which differs from the ordinary form in having the pigmented lines on the thorax of a pure white colour in place of being some shade of yellow, was found on the South Spit, Puffin Island, in January, 1888.

Perophora listeri, Wiegmann.

We had previously obtained this species only from the Isle of Man. Shortly after the publication of the First Report, however, we dredged some colonies during the cruise of the "Hyæna," along the north coast of Anglesey (the locality in which it was found by Edward Forbes and McAndrew in 1843), in May, 1886; and we also dredged some fine colonies, attached to *Hydrallmania falcata*, on the "Weathercock" expedition of September, 1886, about twenty miles S.E. of the Isle of Man, from a depth of twenty-five fathoms.

Family. Ascidiidæ.

In 1882, in the "Challenger" Report, I divided this family into three sub-families:—the Hypobythinæ, the Corellinæ and the Ascidinæ. Roule subsequently formed two sections, the Cionæ and the Phallusiæ in the last sub-family. The Cionæ includes the genera *Ciona* and *Rhopalona*, and the Phallusiæ the genera *Ascidiella*, *Ascidia* and *Phallusia*.

Ascidinæ.

Ciona intestinalis, Linn.

This species was recorded in our former report from Hilbre Island and the Isle of Man. It has since been found as follows:—

During the "Weathercock" expedition of 1886, about a

dozen large specimens were dredged from twenty fathoms, about twenty miles S.E. of the Isle of Man. In January, 1888, a specimen was collected on the shore at Puffin Island. In the dredgings made from the "Hyæna," on May 20th, 1888, between the Calf and Port Erin, several specimens were obtained from a depth of twenty fathoms. Some of these were very transparent.

A number of very large specimens were dredged in November, 1888, from a trawler, at about twenty miles north of Puffin Island, depth twenty fathoms. These last, and also the "Weathercock" specimens obtained from the centre of the Irish Sea, are very fine, some of them extending to 8 cm. in length, and have a very powerful muscular system. The longitudinal muscle bands of the mantle are especially large, and the anterior ends of the specimens are more completely retracted than I have ever seen before, being invaginated to such an extent that a deep pit is formed, at the bottom of which are found two small pits formed by the branchial and atrial siphons having been turned completely outside in (see Pl. XIII., fig. 13).

In some of the specimens the colour of the pigment has not been changed by the alcohol, and the ocelli are still bright red. One has a specimen of *Saxicava rugosa* partly imbedded in the test; the Mollusc usually found in Ascidians is *Modiolaria marmorata*.

Many of these specimens might be referred to Roule's sub-genus *Pleurociona*,* as they lie flat and are attached to large shells or other objects along the greater part of the

* Roule, "Revision des espèces de Phallusiadées des Cotes de Provence," Recueil Zoologique Suisse, t. iii., no. 2, p. 239, 1886. Roule describes a new species, *Pleurociona edwardsi*, which appears to differ little if at all from *Ciona intestinalis*. Besides the condition of attachment of the body, the membrane which separates the viscera from the peribranchial cavity is said in *Pleurociona* to be oblique in place of perpendicular to the longitudinal axis of the body.

left side of the body. In some cases the test is prolonged, especially at the posterior end, to form extensive expansions, and stolon-like processes.

Most of these specimens of *Ciona intestinalis* have their branchial sacs infested with the parasitic Copepoda *Notodelphys allmani* and *Doropygus pulex*.

Mr. Henry Thomas of Llandudno has kindly sent me a number of specimens of this species which he found growing on the sides of the plunge bath in the Llandudno Hydropathic. Some of these specimens were of very large size, one of the largest observed by Mr. Thomas measuring over four inches in length. Specimens of over two inches long have grown on the sides within a month from the emptying and scrubbing of the bath. This gives some idea of the rate of growth of this species.

Ascidia mentula, O. F. Müller.

In the former report this species was only recorded from the Isle of Man on the authority of Forbes. The L.M.B.C. dredged it from a depth of twenty fathoms off Port Erin, on May 20th, 1888, during the cruise of the "Hyæna." The test is irregular in form and encloses several large specimens of *Modiolaria marmorata*. The tentacles are rather abnormal, being very short and stout, but tapering rapidly. A large Amphipod was found in the branchial sac, and a number of specimens of the parasitic Copepod *Botachus cylindratus* were obtained in the peribranchial cavity.

Ascidia plebeia, Alder.

This species had been found by the L.M.B.C. in 1885 off the south end of the Isle of Man, and it has since been dredged again in the same locality, off the Calf, twenty fathoms, during the cruise of the "Hyæna," on May 20th, 1888, and also off the north coast of Anglesey, where

several specimens were obtained during the "Hyæna" expedition of 1886.

One of the specimens dredged off the Calf of Man resembles *Ascidia depressa* in external form, being flattened and elongated and attached by the whole length to a shell. Some of these specimens are of a rich brown colour, not only on the outside, but also in the mantle, branchial sac and viscera.

The nerve ganglion in this species is placed far behind the dorsal tubercle, consequently this species may be referred to the genus *Ascidia* in the limited sense employed by Roule, and which will be referred to below. The tentacles are in nearly all specimens placed distinctly in two rows, the smaller ones being inserted on a line anterior to the rest. There are seventy-two tentacles in all, eighteen large, eighteen medium sized, and thirty-six small.

In one of the specimens from the Isle of Man there is no dorsal tubercle in the large triangular peritubercular area, but there are a number of small rounded secondary apertures of the duct from the subneural gland into the peribranchial cavity.

The specimens from near the Calf of Man contained in their branchial sacs some Copepoda which Mr. Isaac C. Thompson has identified as *Doropygus poricauda*, *D. pulex*, and *Botachus cylindratus*. The latter was present in large numbers both in the branchial sac and in the peribranchial cavity, and adhered firmly to the walls by its hooked appendages.

Ascidiella venosa, O. F. Müller.

This species, the *Ascidia venosa*, or *Phallusia venosa* of most authors, is an addition to our fauna. Two large specimens and a small one were dredged from the "Hyæna"

between Port Erin and the Calf, depth twenty fathoms, on May 20th, 1888. Each specimen had a large Amphipod (*Leucothoe spinicarpa*, Abildg.) in the branchial sac.

Roule* in 1884 proposed that the large and well-known genus *Ascidia* (= *Phallusia*, Savigny) should be broken up into three smaller genera which he named *Ascidiella*, *Ascidia* and *Phallusia*. He took as the type of the last Cuvier's *Ascidia mamillata*, characterized by having the branchial sac reduplicated at its posterior end; while he separated the two former groups by two chief features, viz: (1) the anterior position of the nerve ganglion close to the dorsal tubercle in *Ascidiella*, and (2) the absence of a dorsal lamina posterior to the œsophageal aperture in the same genus.

I believe that these are to a certain extent natural groups, and I have decided to adopt them here; but I must point out that while *Phallusia* is quite distinct, *Ascidia* and *Ascidiella* are not so easily distinguished as Roule supposes, and his definitions will have to be slightly altered if they are to have a more extended application than to the Ascidians of the coast of Provence. For example the present species, which I now place as an *Ascidiella*, while it has the ganglion placed close to the dorsal tubercle, possesses at the same time a well developed prolongation of the dorsal lamina behind the œsophageal aperture, and would consequently not find a place in any one of the three genera as defined by Roule.† I propose, then, to modify Roule's generic characters by leaving the condition of the dorsal lamina out of consideration, and to be guided in arranging the species by the position of the nerve ganglion alone.

* "Recherches sur les Ascidies simples des cotes de Provence," Ann. du Musée de Marseille, Zoologie, t. ii., mem. i.

† *Loc. cit.*, and Recueil Zoologique Suisse, t. iii., no. 2, p. 214, 1886.

Ascidiella virginea, O. F. Müller.

This is probably the commonest species of Ascidian in this neighbourhood. It has been found since the former report as follows:—

Several specimens adhering to *Hydrallmania falcata* were dredged off the north coast of Anglesey, in the "Hyæna" expedition of 1886. Half-a-dozen were dredged from the centre of the Irish Sea, in the "Weathercock" expedition of 1886. One specimen attached along its left side to Zoophytes was collected, about half-tide, at the N.E. end of Puffin Island, on December 3rd, 1887. Specimens, some of them attached to *Hydrallmania falcata* by a very small area, were dredged off the N.W. side of Puffin Island in February, 1888. It was also found at the N.E. end of Puffin Island, at extreme low water, in February, 1888. It is found under stones on the South Spit, Puffin Island, at spring tides. Several specimens were dredged off Port Erin in the "Hyæna" cruise of May, 1888; and finally one was obtained under a stone at low tide, at Hilbre Island, on March 2nd, 1889.

Many of these specimens, especially those from between tide marks, are flat, and attached by the left side, have the apertures close together, and bear a strong resemblance to *Ascidiella scabra*, a species which I am inclined to regard as the shore variety of *A. virginea*. Roule has pointed out that at Marseilles *A. scabra* is variable, and passes into the varieties of *A. aspersa*. There is no doubt that several of these smaller species of *Ascidiella* are very closely related forms, and are very variable.

Many of the specimens of *A. virginea* collected in this neighbourhood are very much infested with *Modiolaria marmorata*, as many as six large specimens being sometimes found in one test. I find, however, very few parasitic Copepoda in the branchial sac, possibly on account of the

numerous closely-placed tentacles. In *Ciona intestinalis*, the next commonest species, Copepoda are abundant in the branchial sac. There is a great deal of opaque white pigmentation in the mantle and branchial sacs of many of the specimens from round Puffin Island, and most of them have the stomach and intestine distended with fine mud, while the tentacles and vessels of the branchial sac are coated with the same, showing the muddy condition of the water in which the animals live.

The dorsal tubercle is very variable in this species; one specimen from Puffin Island has it of elliptical form, the horns having united anteriorly.

Ascidiella scabra, O. F. Müller.

This is a species which I regard with a certain amount of doubt. Some specimens found on the shore at Puffin Island may either belong here or to the last species.

Two small specimens of *Ascidiella* obtained at Groudle Bay, Isle of Man, by Mr. Clubb, most probably belong here. Their dorsal tubercles are very like those of *Ascidia plebeia*, but there are no papillæ in the branchial sacs, and their nerve ganglions are placed far forward, close to the dorsal tubercle. The branchial sac contained a parasitic Copepod, *Doropygus pulex*.

A specimen found by Mr. Henry Thomas in the plunge bath at Llandudno Hydropathic, along with a number of specimens of *Ciona intestinalis*, appears to be referable to the present species. It is an abnormal specimen, as it has two atrial apertures placed side by side on distinct atrial siphons. They are almost of the same size, and are each six-lobed. This is an interesting case of the persistence of an early post-larval character.

Ascidiella aspersa, O. F. Müller.

A few specimens of this species were dredged off the

south end of the Isle of Man during the "Hyæna" expedition of 1888.

Corellinæ.

Corella parallelogramma, O. F. Müller.

A number of specimens of this form, our only representative of the sub-family Corellinæ, were dredged from the "Hyæna" on May 20th, 1888, between the Calf and Port Erin, from a depth of twenty fathoms. Some of them were adhering to the tests of *Ascidiella virginea*.

Family. Cynthiidæ.

In the "Challenger" Report I divided this family into the three sub-families Bolteninæ, Styelinæ and Cynthinæ. We have no British representative of the Bolteninæ.

Styelinæ.

Styela grossularia, van Beneden.

In the former report this species was recorded from the Menai Straits and the Isle of Man. It has since been found as follows:—In various dredgings along the north coast of Anglesey during the cruise of the "Hyæna" in 1886; in the "Weathercock" expedition, September, 1886 (on *Pecten opercularis*); under stones on the North Spit, Puffin Island, June 11th, 1887, and July 24th, 1888; off the south end of the Isle of Man, between the Calf and Port Erin, in several hauls of the dredge from the "Hyæna," May 20th, 1888, depth twenty fathoms.

These last specimens were of the small, flat, blister-like form, but many of those obtained off Anglesey from the "Hyæna," in 1886, were elongated antero-posteriorly, and were closely crowded together on aggregated masses of sand grains and shell fragments, while others obtained at

the same time, attached to *Mytilus edulis* and *M. modiolus* and to the test of *Polycarpa pomaria*, were of the depressed form.

Polycarpa pomaria, Savigny.

Only a single specimen of this species had been recorded before from the district. It has since been taken on three occasions. One large specimen was dredged off the north coast of Anglesey in the "Hyæna" cruise of 1886: a small specimen was collected at Hilbre Island on June 4th, 1887; and half a dozen large specimens and some small ones were obtained in the dredgings from the "Hyæna" between the Calf and Port Erin in May, 1888, depth twenty fathoms.

These last are very much mis-shapen from containing large specimens of *Modiolaria marmorata*, but had no parasitic Amphipoda or Copepoda in their branchial sacs, with the exception of one specimen of probably a new species of *Doropygus*, a specimen of which was also obtained along with a *Doropygus normani* in the branchial sac of a *Styela rustica* dredged off Skate Island in Loch Fyne.

Polycarpa rustica, Linn.

A specimen of this species was collected at Puffin Island on July 24th, 1888.

Cynthinæ.

Cynthia echinata, Linn.

A single small specimen of this beautiful species was dredged from the "Hyæna," on May 20th, 1888, between the Calf and Port Erin, from a depth of twenty fathoms. It is new to the fauna, not having been taken in the L.M.B.C. district before, and it is our only representative of the sub-family Cynthinæ.

Family. Molgulidæ.

Eugyra glutinans, Möller.

Several specimens were dredged in Port Soderick Bay, Isle of Man, by Mr. Clubb, in August, 1886.

A curious abnormality was noticed in the branchial sac of one individual, the spirally coiled stigmata being interrupted down one of the angles in the case of several meshes. One of these is figured on Plate XIII. (fig. 14).

Molgula occulta, Kupffer.

A dozen specimens, large and small, were dredged by Mr. Clubb, in Port Soderick Bay, Isle of Man, in August, 1886.

Molgula citrina, Alder and Hancock (Pl. XIII., figs. 7 to 12).

This species was named and briefly described, as to its external appearance, by Alder,* in 1848. So far as I am aware, it has not been recorded or referred to for over forty years. The mode of attachment by the posterior end and part of the left side, the smooth test free from sand, the prominent apertures, the translucent amber colour, and the orange mark caused by the viscera showing through, are all characteristic features by which the species can be recognised.

Alder and Hancock's specimens were obtained "on the under side of stones between tide-marks, Cullercoats and Whitley, not common." I have found it during the last few years on the Wardie shore, near Granton, Firth of Forth; at Loch Ranza, Arran; on the south-west coast of Bute; and, in the L.M.B.C. district, at Puffin Island, on the Beacon Rocks, on June 26th and July 3rd, 1887, on June 17th and 18th, 1888, and May 26th, 1889;

* Cat. of the Moll. of Northumberland and Durham, Trans. Tyneside Nats. Field Club, vol. i., p. 104.

and on the North Spit, on July 24th, 1888. Alder gives the size as three-eighths of an inch. Most of the specimens at Puffin Island are rather smaller, about quarter of an inch to five-sixteenths in length, but I have one which measures even in the contracted state, fully half an inch (13 mm.) in its dorso-ventral extent.

The obliquity of the plane of attachment (Pl. XIII., fig. 8, *ad.*) is a constant character, the flattened area being not only more on the left side than on the right, but also more dorsally than ventrally so that the branchial aperture projects more freely than the atrial does. This appears to be solely a littoral species, as I have never taken it except between tide marks. It is found generally under large stones close to low water mark. In its external appearance from the absence of any coating of sand or shell fragments it is very unlike a *Molgula*, and has probably been often mistaken for the young of an *Ascidia*, such as *A. scabra*. An examination of the apertures, however, shows at once that it belongs to the family Molgulidæ (Pl. XIII., figs. 7 and 8).

As in the original account of this species only the external appearance is referred to, I shall add here the characters of the internal organs so as to complete the necessary description of the species:—

The *Test* is thin, but cartilaginous like that of an *Ascidia*. It is semi-transparent, and has no encrusting sand.

The *Mantle* is fairly muscular, but has none of the peculiar short fusiform muscle bundles usually found in the Molgulidæ, except to a slight extent at the sides of the endostyle. The branchial and atrial sphincters are very strong.

The *Branchial Sac* has seven folds on each side. These are all much of the same size, and have three to five internal longitudinal bars each (Pl. XIII., fig. 9, *br.f.*). The

vessels are relatively large. The stigmata are few, and are arranged so as to form well developed spirals. There are a large number of very delicate membranous connections between the vessels. Some of these are very wide and break up the stigmata considerably (Pl. XIII., fig 9).

The *Endostyle* is large and conspicuous.

The *Dorsal Lamina* is a narrow plain membrane.

The *Tentacles* are very large. There are about sixteen altogether: they are of two sizes placed larger and smaller alternately. The smaller ones are about one-third of the size of the larger (Pl. XIII., fig. 10). The latter are very much branched, and the numerous minute twigs are all slightly knobbed at their ends.

The *Dorsal Tubercle* has a simple horse-shoe shape with the opening turned to the side. It lies in a deep peritubercular area (Pl. XIII., fig. 11).

The specimens from Puffin Island contain embryos and tailed larvæ in their peribranchial cavities. The larvæ have a well developed tail, and a single pigmented sense-organ (Pl. XIII., fig. 12).

Molgula hancocki, n. sp. (Pl. XIII., figs. 1 to 6).

External Appearance: Shape ovate, elongated antero-posteriorly, scarcely compressed; posterior end tapering into a mass of matted hair-like filaments. Apertures at the anterior end, near one another, slightly prominent. Slightly covered with sand anteriorly, more closely encrusted in its posterior half (Pl. XIII., fig. 1). Colour lightish yellow. Length 1·5 cm. Breadth 1 cm. Thickness 8 mm.

The *Test* is fairly thick in its posterior part, thinner anteriorly; it is smooth and glistening on its inner surface. The prolongations of the test to which sand grains are attached are long and closely placed at the posterior end,

but short, unbranched and scattered over the rest of the surface (Pl. XIII., fig. 4). There are a few small sparingly branched vessels with elongated slightly dilated ends (Pl. XIII., fig. 3, *v.*). The test in thin sections shows a clear slightly fibrillated matrix in which a few test cells are scattered.

The *Mantle* is not adherent to the test except at the apertures. It is moderately thick. The interlacing muscle bands are slender, but numerous. On the left side of the body, over the viscera, they are very delicate. The siphons are rather large and muscular.

The *Branchial Sac* has five folds on each side. They are all of the same size, and bear each three or four internal longitudinal bars on the surface. The stigmata are not very much curved, and in some places are quite straight (Pl. XIII., fig. 5, *sg.*).

The *Dorsal Lamina* is a plain, short, wide membrane with an irregular free edge.

The *Tentacles* are eight large and eight smaller alternating, and a few very small ones placed irregularly.

The *Dorsal Tubercle* has a simple circular or quadrangular opening (Pl. XIII., fig. 6, *d. t.*).

A single specimen of this new species, which I name in honour of Albany Hancock, who was a distinguished investigator of the British Tunicata, was dredged from a depth of twenty fathoms, at about twenty miles S.E. of the Isle of Man, in the "Weathercock" expedition of September, 1886. It may have been attached by the matted fibres at the posterior end of the test. Most of the adhering sand grains are behind the middle of the body. At first sight it seems as if there were no hair-like processes, and that the sand was attached directly to the test, but on scraping away some of the encrusting grains it is seen (see Pl. XIII., fig. 4) that a comparatively small

number of short unbranched filaments are present. The branchial and atrial apertures are slight prominences.

In external appearance (Pl. XIII., fig. 1) this species is not unlike *Polycarpa comata*, with which it has, however, no close relationship. The body when removed from the test is of rounded outline. The left reproductive mass, nearly enclosed in the very long curved intestine, is seen on the left side (Pl. XIII., fig. 2, *g.*); while the other reproductive mass, the renal organ and the heart, lie upon the right side of the body.

In possessing only five folds on each side of the branchial sac, this species differs from most members of the genus *Molgula* and agrees with *Molgula (Pera) chrystallina*,* Möller, from which species, however, it differs totally in external appearance and in the condition of the test.

The dorsal tubercle (Pl. XIII., fig. 6) is in that interesting, simple condition which I first described† in the cases of *Molgula pyriformis* and *Eugyra kerguelenensis*, and which has since been found in the case of several other species.

The alimentary canal is very long, and is closely folded upon itself throughout the whole length (Pl. XIII., fig. 2, *i.*). The stomach is very far forward, and the double intestinal loop is bent ventrally anteriorly and then dorsally.

* For a description of this species see Traustedt, Vid. Medd. Nat. For. Kopenhagen, 1879–80, p. 27 ; and for a figure see Verrill, Amer. Jour. Sc. and Arts, 1872, pl. viii., fig. 9.

† Zool. Chall. Exped., Report on Tunicata, part i., pp. 79 and 81, pl. vi., figs. 3 and 9.

Explanation of Plate XIII.

Figs. 1 to 6, *Molgula hancocki*, n. sp.
Figs. 7 to 12, *Molgula citrina*, Ald. and Hanc.
Fig. 13, *Ciona intestinalis*, Linn.
Fig. 14, *Eugyra glutinans*, Möller.

ad.	Adhering area.	*i.*	Intestine.
at.	Atrial aperture.	*i.l.*	Internal longitudinal bar.
br.f.	Fold of branchial sac.	*p.p.*	Peripharyngeal band.
d.l.	Dorsal lamina.	*sg.*	Stigmata.
d.t.	Dorsal tubercle.	*st.*	Stomach.
g.	Reproductive gland.	*v.*	Vessel of test.

Fig. 1. *Molgula hancocki*, n. sp., natural size, from the right side.
Fig. 2. Part of left side of same, with test removed to show the viscera, slightly enlarged.
Fig. 3. Section of test of same, highly magnified, S. $\frac{1}{4}$ in.
Fig. 4. Part of outside of test, showing the short processes and sand grains, magnified, S. 1 in.
Fig. 5. Part of branchial sac from the inside, magnified, Swift's 1 inch objective.
Fig. 6. Dorsal tubercle and neigbouring parts, magnified, S. 1 in.
Fig. 7. *Molgula citrina*, Alder and Hancock, natural size, from the right side.
Fig. 8. The same from the anterior end, showing the area of attachment (*ad.*).
Fig. 9. Part of the branchial sac from the inside, magnified, S. 1 in.
Fig. 10. A large and a small tentacle, magnified, S. 1 in.
Fig. 11. The dorsal tubercle and neighbouring parts, magnified, S. 1 in.
Fig. 12. The tailed larva of *Molgula citrina*, magnified, S. 1.
Fig. 13. Diagram showing the inversion of the anterior end of *Ciona*, natural size.
Fig. 14. Part of an abnormal mesh of the branchial sac of *Eugyra glutinans*.

REPORT on the SEALS and WHALES (Pinnipedia and Cetacea) of the L.M.B.C. DISTRICT.

By Thomas J. Moore, Corr. Memb. Zool. Soc. Lond.,
curator of the free public museum, liverpool.

[Read 10th May, 1889.]

Part I. Seals :—

In the second edition of Bell's "British Quadrupeds" (Van Voorst, 1874), six species of Seals, including the Walrus, are enumerated as having occurred on the coasts of Great Britain and Ireland. Two of these, the Hooded Seal and the Grey Seal, have occurred in the Mersey, are preserved in the Liverpool Museum, and came under my own personal observation as recorded below. Other notices of Seals in our district are few, vague and unsatisfactory. Byerley, in his "Fauna of Liverpool," 1854, p. 7, mentions only one, *Phoca vitulina*, the Common Seal or Sea-Calf, as having occurred occasionally in the Dee and Mersey, and neighbouring parts of the coast. Dr. Cuthbert Collingwood, in his carefully compiled paper on "The Historical Fauna of Lancashire and Cheshire," says :* "Seals have occasionally come up our rivers. Dr. Leigh mentions a Sea-Calf Seal as taken in the Ribble ; and Pennant (Zool., vol. i., p. 177) describes a Pied Seal (*Phoca bicolor*), of which he says, 'this I saw at Chester ; it was taken near that city in May, 1766.'" To this Collingwood adds, "This appears to have been an individual of the species *Monachus albiventer* (Gray, Mus. Catal.), a rare Mediterranean species, of which this is the only specimen recorded as captured upon British

* Proc. Lit. and Phil. Soc. L'pool, 1864.

coasts." Much stress, however, must not be laid on these conclusions.

For the correct determination of Seals, examination and comparison of their skulls are absolutely necessary. The colour of the fur varies much in individuals, and in the Harp Seal more than in any others. In this species the adult male has a black face and a black harp-like figure on its back, whence its name. In the female this is with the face brown and less well defined; immature specimens are mottled with greyish black spots, and the young cubs are creamy white. These differences are well displayed in the Museum series of specimens from Newfoundland, presented by Messrs. Bowring, and arranged in a characteristic group. An examination of the skulls from these individuals at once shows their identity. This difficulty in determination applies with much force to attempts to make out the species described or even figured by the older authors, and was much felt by the late Dr. J. E. Gray, in cataloguing the rich collections of the British Museum under his care. He set to work with characteristic energy to work out both the skins and skulls, giving a great impetus both to collectors and describers, and inaugurating a new era. Previously confusion was inevitable, for those whose knowledge was based on personal observation of the creatures in life, however wide and accurate, being cut off from access to the observations recorded in books were at great disadvantage in making their observations accurately known, while those with the fullest command of book knowledge had but scant opportunities of studying from living creatures in their natural state. These remarks apply with even greater force to the study of the Cetacea with respect to which Dr. Gray also applied himself with similar zeal, though not always with equal success.

To return to the Seals: in the absence of published

notes on their occurrence, I applied to Mr. Alfred O. Walker, late of Chester, who has long taken a keen interest in the marine zoology of the district, and he writes me, May 7th, 1889, "I have occasionally heard of Seals being taken in the Dee and Mersey, but have never seen them, and can give you no information as to species." I cannot find a record of the Common Seal, *Phoca vitulina*, even as a visitor, though many particulars are noted of it visiting the Scotch and Irish coasts. Its extreme shyness, and the vast increase in shipping are, doubtless, the causes of its absence here.

PINNIPEDIA.

Family. Phocidæ.

Phoca grœnlandica, Fabr.

A specimen identified as the Harp Seal by Sir William Turner and Mr. T. Gough, was captured on the coast of Lancashire, in 1874.*

Halichœrus grypus, Fabr.

In 1861 I noted and exhibited a fine recently stuffed specimen of a Seal, caught in the Canada Dock, and presented to the Museum by Mr. George Hulse, turtle merchant, of Liverpool. Owing to the difficulties of determination, alluded to above, I then supposed this to be the Common Seal (*Phoca vitulina*), and it was not till I was able to compare in the British Museum the skull from the stuffed specimen that I found it to be an example of the Grey Seal† (*Halichœrus grypus*).

* Journ. Anat. and Physiol., vol. ix., p. 163.

† Bell's "British Quadrupeds," ed. 2, p. 262; Gray's "Museum Catalogue," ed. 2, p. 34.

Cystophora cristata, Erxleben.

On February 24th, 1873, I announced* the capture of a Seal, which was found alive on the Mersey shore at Frodsham Marsh, on the 3rd of February, and was exhibited at Widnes, near Warrington, where I saw it alive and made sketches from it. It was large and powerful, being about six feet in length and in very fine condition, though it had taken very little food. The face, breast and fore flippers were of a blackish colour, the body paler, with a few dark blotches; but the colours were not very noticeable while the creature was wet. From the dilatation of the nostrils, shown under the slightest provocation, I was inclined to consider it to be a Hooded Seal,† but considering the extremely rare occurrence of that species on the British coast, I refrained from speaking positively, and waited in hopes of securing the specimen after death for the museum, in which I ultimately succeeded, and a comparison of the skull at the British Museum confirmed my original supposition. The second edition of Bell's "British Quadrupeds" was then in the press, and I wrote to Mr. Edward R. Alston, who was engaged thereon, informing him of the above occurrence, but the notice was too late for reference therein. Two other specimens of the Hooded Seal are certainly known to have been killed in Britain:—one in the Orwell in 1847,‡ and the other at St. Andrews in 1872.§

The following notes on the Hooded Seal were taken at Widnes, soon after the death of the creature:—General colour brownish; front streak from eyes, front of fore and hind legs, black; belly and throat whitish. Tail and hind

* Proc. Lit. Phil. Soc. Liverpool, vol. xxvii., p. lxxiii.

† Bell's "Brit. Quad.," ed. 2, p. 257; Gray's "Mus. Catal.," ed. 2, p. 41.

‡ "Brit. Quad.," ed. 2, p. 258.

§ "Scottish Naturalist," vol. ii., p. 1.

flippers worn on the upper surface and wherever the surface could rub. Webs of hind feet extended twelve inches when fully stretched, of fore feet seven inches, brownish and hairy beneath. The hair of arm pits and underside of fore flipper longer and thicker than elsewhere. A bare space indicating the navel measured three inches wide and two-and-a-half long. Two inches behind this a pair of orifices, admitting pencil points, indicated nipples. The sexual orifice hidden with long hair. The outer and lower rows of bristles in the moustache longest, increasing in length gradually to the outermost; the extreme one of the lowest row but one being the longest, and measuring five and three-quarters inches. A solitary hair on each cheek between nostril and eye; and four or five slender hairs grouped an inch behind each eye. The hairs, on skinning the creature, were found to have long roots projecting beyond the inner surface of the skin, and were deeply imbedded in the muscle. The moustaches consisted of six rows of bristles, consisting of five hairs in the lowest, seven in the next, eight, seven, six and three in the others. The cheeks and chin, shoulders and loins were white, slightly mottled. The shoulders, paws and belly whitish, the rest of the creature being bare and everywhere black or darkly coloured. Scarcely any indication of the cavity of the hood was noticeable on skinning the head. The total length was five feet three inches.

PART II. WHALES:—

CETACEA.

Sub-Order I. MYSTACOCETI.

Family 1. BALÆNIDÆ.

Megaptera longimana, Rudolphi.

On July 17th, 1863, a large specimen of a whale was observed by some fishermen stranded on a sand-bank at Speke. Its struggles were so evident that no boatmen durst venture near it: all they could do for a length of time was to keep an eye on it. When dead it was secured with ropes and towed to the shore. I visited it on the 22nd, made an external examination, and took correct measurements, as under. It was lying on its back, a position very favorable for examination of the under surface, but hiding all view of the blowers. I believed it to be a specimen of "Johnston's Hump-backed Whale, *Megaptera longimana*," of Dr. Gray's "Catalogue," 1850, p. 26, and it would appear to have been up to that date only once before observed on the British coast, namely, at Newcastle, by Dr. Johnston, and it is remarkable that both specimens were females.

The dimensions are:—	Ft.	In.
Total length in a straight line, from snout to cleft of tail	31	4
Length of gape, about	8	0
From snout to the eye	8	0
Length of the eye	0	3
From snout to commencement of pectoral fin	11	0
Length of pectoral fin	10	0
Extreme width of tail at the tip	11	0

From snout to commencement of dorsal fin, or rather hump	18	0
Length of hump	3	3
From snout to cloaca	21	0

I had no opportunity of examining the viscera, but learned from the butchers that a quantity of shrimps were found in the stomach.

The genus *Megaptera* is distinguished from the genus *Balæna*, or whalebone whales, by the presence of a dorsal fin or hump; by the belly being plaited or deeply grooved, and the plates of baleen being broad and short: which characters agree with this specimen. The longest plate of baleen measures about two feet long by five and a half inches at base, and the plates were so close together that I counted thirty-eight in the length of a foot. The creature was quite black, except the belly, which was mottled and streaked with white, and the pectoral fins were milk-white except a black blotch here and there.

The carcase was purchased by Mr. Brock, of Clement Street, Vauxhall Road, who most liberally presented the skeleton to the Museum, where it was carefully mounted by Mr. Henry Reynolds, the Museum Taxidermist.

Sub-Order II. ODONTOCETI.

Family 2. Ziphiidæ.

Hyperoodon rostratus, Chemn.

Gray (Cat. 1874, p, 331) says, "This is one of the most generally caught whales on our coast." Byerley notes four examples of the common Beaked or Bottle-nosed Whale* which have occurred in our district, to which I have to add a fifth. Byerley's notes are as follows:—

* Bell's "Brit. Quad." ed. 2, p. 421; Gray's "Catal." p. 330; Flower's "List of Cetacea," 1885, p. 9.

"One stranded upon East Hoyle Bank, 1858, and exhibited at Tranmere Slip, after which it was cut up at Hoylake, and 140 gallons of oil obtained from its blubber. The stomach contained great numbers of the horny beaks of some species of cuttle. Although these have been found frequently in the stomachs of whales, in this instance the mode of their arrangement was remarkable, as the beaks were inserted one within another, so as to ride, regularly imbricated, in rows of ten, fifteen, or twenty together. I have pulled as many as seven asunder, and the person who took them from the stomach informed me that they formed rows, in some instances, of an inch and a half. Many were so firmly impacted that they required strong traction to separate them, and sometimes they would break rather than come asunder. This curious arrangement must have been brought about by the peristaltic movements of the stomach. Another specimen was captured at the Little Meols two years ago."

"August 25th, 1853, a male of this species was stranded upon the East Hoyle Bank; its length was twenty-one feet; from the angle of the mouth to the tip of the snout, twenty inches; from tip of snout to eye, three feet six inches; eye to spiracle, two feet three inches. The pectoral fins were one foot nine inches long and nine inches broad; tail fin or propeller, five feet six inches broad and two feet long; the dorsal fin about ten or eleven feet from the tail; from the vent to the tail, seven feet six inches; orifice of urethra to anal opening, one foot ten inches; the length of the snout was one foot three inches. I had an opportunity of seeing the stomach opened, and observed great numbers, certainly many hundreds, of the cuttle beaks; many were unattached, but others were placed one within another, as in the foregoing instance. Another of the same species, probably his female mate, was seen swimming about the

same locality for three weeks after his capture, and was driven by three fishing boats upon the same bank, which, however, was covered with sufficient water to enable him to flounder off."

On the first of September, 1881, two fishermen named William Dunbobin and Adam Ireland, while fishing in the Lancashire side of the Mersey, near Speke, observed something unusual lying on the beach. On getting to the place they found that a whale had been left by the receding tide. They at once set about capturing the beast, which they succeeded in doing after a smart struggle. I visited it as soon as possible afterwards and found it to be a fine specimen of the Beaked Whale, *Hyperoodon rostratus*, measuring twenty-three feet in length and twelve feet in greatest girth. The skeleton was obtained for the Museum, but owing to unavoidable difficulties was not succesfully macerated.

It is somewhat singular that this specimen was captured near the spot where the Whale, said to have been twenty-four feet long, was caught (in October, 1856), whose skeleton was mounted for the Museum of the Liverpool Royal Institution. That skeleton was sold with the rest of the Mammalia collection, and other objects, to the authorities of the Nottingham Museum, to which they were removed a few years since. Fortunately before the removal I was favoured by the Committee of the Institution with the loan of the skull, from which a large series of well executed pencil drawings was made by Mr. John Chard, Museum Draughtsman, under my personal supervision.

Family 3. Delphinidæ.

Phocæna communis, F. Cuvier.

The Common Porpoise is frequent in shoals during stormy and changeable weather. A very young Porpoise,

eighteen inches in length, was brought to me at the Museum, on the 22nd March, 1888. It was the usual black colour on the tail, fins and upper parts, but a rosy pink on the sides and lower parts, especially on the abdomen. It was brought up in a shrimp-net after being down two hours, but lived only about ten minutes after. The same shrimper, John Hanmer, reported to me on the 20th of May, 1889, that when at the North-west Lightship, about an hour after daylight, he observed within ten yards of his boat a shoal of porpoises which he estimated to extend fully three miles.

Dr. Gray pointed out in 1865 (P. Z. S.) a series of short spiny processes on the front edge of the dorsal fin, and named a specimen living in the Zoological Society's Garden, and after death removed to the British Museum, *Phocæna tuberculifera*. It was subsequently found that this peculiarity was known to the ancients and also to Camper. Examples would appear to be not uncommon, for two at least have come under my observation in our own district, namely, one speared a quarter of a mile off the Rock Lighthouse, February 7th, 1867, measuring four feet eight and three-quarter inches in length; and another, four feet four inches in length, taken near the Herculaneum Dock, October 12th, 1881.

Orca gladiator, Lacépède.

At the end of March, 1876, a Cetacean, reported to have been twenty-five feet in length, was captured near West Kirby, at the mouth of the Dee, by a couple of Parkgate fishermen who were out in a small boat. It had evidently come in too far in pursuit of food, and the receding tide effectually prevented its return into deep water. The fishermen secured it by a hook and line, and were soon surrounded by a number of people, the place where it lay

being about half a mile from the village. Though out of water, it still retained some strength, lashing its tail in an alarming manner, and with sufficient violence to break in pieces the iron anchor belonging to the boat. This was, however, of short duration, for a gash in its side with a knife put an end to its struggles. It was soon after cut up and carted away by a person in the neighbourhood, who had bought it for boiling and extracting the oil. This process was so far advanced when I was able to visit the place that I was only able to procure a flipper for the Museum, and to recognise this as belonging to an *Orca** (the Killer or Grampus). Unfortunately the bones of this member were lost in the long process of maceration.

Lagenorhynchus albirostris, Gray.

On the 29th December, 1862, at daybreak, a fresh wind blowing from W.S.W., and the tide being about quarter-ebb, a Cetacean was discovered stranded at Little Hilbre, one of two closely contiguous islands at the mouth of the Dee. It was observed by Mr. Barnett, Inspector of Buoys, who resided on the larger island, and who had noticed others off the shore a few days previously. I had urged Mr. Barnett, on the occurrence of such creatures, to endeavour to secure examples for the Liverpool Museum; and he was, in consequence, kind enough immediately to proceed to the mainland for a suitable conveyance, into which it was carefully removed and brought to Birkenhead Ferry, and thence across the Mersey to the Museum.

The creature was still living, spasmodically breathing at irregular intervals; the body was warm to the hand, and tear-like moisture oozed from its eyes as it lay quiescent in the cart. I was desirous of giving it a fresh chance of

* Bell's "Brit. Quad." ed. 2, p. 445; Gray's Catal., p. 279; Flower's "List of Cetacea," p. 18.

life, and my first anxiety was to obtain a vessel large enough to form a bath for it. This I succeeded, after some delay, in securing in a turtle tank belonging to Mr. Hulse, at the back of the present Sessions' House; but, to my great mortification, the creature gave up the ghost (with considerable violence, too) at the very moment when we were prepared to remove him into the tank. It was then getting dark, and the poor animal had thus lived about eight hours out of water. It was a male; and upon endeavouring to make out the species, I was agreeably surprised to find it approximate most nearly to the description of the White-beaked Bottle-nose (*Lagenorhynchus albirostris*),* as given in Dr. Gray's "Catalogue of Cetacea in the British Museum," p. 99, and in the "Zoology of the Voyage of the *Erebus* and *Terror*," p. 35, the skull agreeing well with the figures in the latter work, pl. 11. I subsequently sent the skull to Dr. Gray for comparison; and he confirmed my supposition of its being an individual of the species above named, namely, *L. albirostris*, which was founded upon a specimen taken at Great Yarmouth in October, 1845, and recorded by Mr. Brightwell in the "Annals for 1846" (vol. xvii., p. 21, pl. 2) under the name of *Delphinus tursio*. This addition to our local fauna was a matter of considerable interest, as its place of capture comes within the range taken by Byerley in his "Fauna of Liverpool," 1854, and in which only two Cetaceans are recorded, namely, *Phocæna communis* and *Hyperoodon rostratus*.

The general colour was a rich black. A long and narrow greyish streak extended on either side diagonally across the ribs; and a similar greyish hue occurred on each side of the dorsal ridge, extending nearly from the fluke to the tail. The beak white, irregularly blotched with blackish,

* *Delphinus albirostris*, Gray, Bell's "Brit. Quad.," ed. 2, p. 472; *L. albirostris*, Gray's "Catal.," p. 272; Flower's "List of Cetacea," p. 22.

the white extending slightly above the constriction of the beak. The under jaw and throat milk-white, which colour extended along the belly, but became less clear as it approached the vent. Its dimensions were as follows:—

	Feet.	Inches.
Total length from snout to cleft of tail...	9	0
Length of gape	0	$10\frac{1}{2}$
Length of beak.....	0	$2\frac{1}{4}$
Length of under jaw beyond the upper..	0	$0\frac{1}{2}$
Length from snout to eye	1	$1\frac{1}{2}$
Length from snout to blow-hole	1	3
To commencement of dorsal fluke	3	11
To end of dorsal fluke.....	5	6
To pectoral fin	1	9
Breadth of tail.....	2	5
Deflection of cleft of tail from a line drawn between its tips	0	$6\frac{1}{2}$
Girth in front of pectoral fin.....	3	11
Girth in front of dorsal fluke.....	5	0
Girth behind dorsal fluke	4	3

The body became much attenuated towards the tail. Immediately in front of the dorsal fluke, the vertical and transverse diameters were nearly the same, the former being thirty-one and a half inches, and the latter thirty and a half inches. Half way between the end of the fluke and the commencement of the tail the vertical diameter is thirteen inches, and the transverse six and three-quarters; and immediately before the commencement of it, the vertical diameter was four and a half inches, and the transverse two and a quarter, or exactly one half. The dorsal fluke measured twenty-four inches along its convexity, and was eleven inches high. The pectoral fin at its junction with the trunk was seven inches across, and its greatest length (diagonal) nineteen inches; measured

round the curve it was twenty-one inches. The eye was seven-eighths of an inch long by half an inch. The orifice of the ear was two and a half inches behind the eye in a slightly diagonal direction, and was less in diameter than a puncture by an ordinary pin. The transverse diameter of the blow-hole was one and three-quarters inches, and the longitudinal one inch, the points being directed *forwards*.

The skin was stuffed, though with much difficulty, owing to its want of tenacity; and the contrast of colour became almost imperceptible. The skeleton was mounted in due course, and continues to be exhibited alongside the stuffed skin, a combination rarely possible, but repeated in the case of a Pilot Whale, *Globicephalus svineval*, from the Humber, June 9th, 1862, the skin and skeleton of which are also exhibited close by.

The dimensions of the skull are as follows:—

	Inches.
Total length	19½
Length of nose	9
Width at orbit	10
Width at notches	5¾
Width middle of nose	4½
Length of lower jaw	15½
Width of condyles	9

Teeth $\frac{25}{23}$, $\frac{24}{23}$, curved, and acute where not slightly worn.

Delphinus delphis, Linn.

A specimen of this Dolphin* was found on the Cheshire shore, at New Brighton, February 13th, 1879, minus its tail, evidently cut off by collision with the fan of a screw steamship. Two accurate coloured drawings,† showing

* Bell's "Brit. Quad.," ed. 2, p. 462; Gray's "Catal.," p. 242; Flower's "List of Cetacea," p. 24.

† These drawings agree very closely with the coloured plate given in the Transactions of the Zoological Society of London for 1879, vol. xi., pl. 1, in

under and side views of the creature, were made while it was quite fresh by Mr. J. Chard, which are of considerable interest. As the finder would not part with the skin, it was only possible to secure the skeleton, which has been carefully mounted for the Museum.

Mr. Alfred O. Walker, of Colwyn Bay, writes, "Some years ago a school of Dolphins passed through Colwyn Bay. I did not see them, but my wife and others did, and described them as Porpoises, but said they spouted and sometimes threw themselves clean out of the water. The station master here saw them, and I remember, told me that he could see the herrings flying up out of the water in front of 'their noses.' This was, no doubt, the spouting. The above facts, according to Bell, are quite characteristic of the species, and as the observers, who informed me of them, did not know there was anything remarkable in 'porpoises spouting,' I think you may fairly book the Dolphin."

Tursiops tursio, Fabr.

Into the northernmost of the two bays formed by the railway embankment connecting Holyhead with Anglesey, a small shoal of Cetaceans found their way on April 14th, 1866, and proceeded so far that they got stranded near Valley, on the Anglesey shore. The workmen at the Valley foundry waded into the water and succeeded in killing and capturing fifteen or sixteen of the animals. I arrived on the spot, with Mr. F. Archer, ten days after, just in time to make a few notes before the remains were

illustration of Prof. Flower's paper "On the External Characters of Two Species of British Dolphins" (*Delphinus delphis*, Linn., and *Delphinus tursio*, Fabr.), no really adequate figure having been previously given in any Zoological publication. This specimen was caught in mackerel nets about twenty miles south of the Deadman Headland, Cornwall, March 13th, 1879, just a month after the stranding of our New Brighton specimen.

all dispersed. All the heads and most of the bodies had already been purchased for the Cambridge and London museums, but I managed to secure for the Liverpool museum one of the decapitated bodies and the head to match. I took the dimensions, &c., of several of the skulls and skeletons, also of a skin which was being prepared for stuffing by two of the foundry men, and these notes I give below. So far as I could determine on the spot, with Dr. Gray's British Museum Catalogue of Seals and Whales, the specimens seemed to belong to the species given above, the Bottle-nosed Dolphin,* which is also the opinion arrived at by Mr. J. W. Clark, of Trinity College, Cambridge, from an examination of the specimens which were conveyed there, and by Mr. E. Gerrard, on examining those which went to London.

Dimensions :—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Length of body.	9 2	8 7	8 0	9 0	9 3	...
Length of head.	1 10	1 10	1 10	1 10	1 8	1 10
Total length.	11 0	10 5	9 10	10 10	10 11	...
Teeth	$\frac{21}{21}$ $\frac{21}{21}$	$\frac{21}{20}$ $\frac{20}{20}$	$\frac{22}{22}$ $\frac{23}{}$	$\frac{21}{21}$ $\frac{21}{20}$	$\frac{3}{5}$ $\frac{14}{2}$	$\frac{21}{19}$ $\frac{21}{15}$
	All much worn.		First from the snout very small and nearly embedded in the gum.		Very old and many lost, but the first and last of each series remaining.	and several gone.

Two of the largest carcases lay beheaded on the shore. Putting these and their heads together the total length of the one was eleven feet six inches, and of the other eleven feet eight inches, the tail of the latter being two feet six inches across from tip to tip. All the above were males;

* *Delphinus tursio*, Bell's "Brit. Quad.," ed. 2, p. 467; *Tursio truncatus*, Gray's "Catal.," p. 358; *Tursiops tursio*, Flower's "List," p. 26.

the teeth of all interlocked; many were much worn, and the under jaw was in every instance somewhat longer than the upper, and of a white colour. The ribs were thirteen pairs, the last pair hanging free. The stomachs were examined, and their principal contents were remains of fish of various kinds, and in various stages of digestion. There were several large skulls of Conger-eels, and a few of the vertebræ of the Garfish (*Belone*), which are of a pale green colour. There were also a few ear bones of the Codfish tribe, a few Crabs, one small Cuttlefish beak, and the opercula of several Whelks, but *no shells of this Mollusc*, showing plainly that these Cetaceans have the power of crushing and rejecting the shells and swallowing the soft parts.

The following dimensions were taken, as accurately as circumstances would permit, from the skin, which was flattened out for the purpose, and the measurements taken in a straight line representing the vertebræ.

	Feet.	In.
From the snout to the rise of the forehead (external "beak")	0	4
From the snout to the end of the gape	1	0
Do. do. eye	1	2
Do. do. blow-hole	1	2½
Do. do. anterior insertion of pectoral flippers	1	10
From the snout to the posterior insertion of pectoral flippers	2	4
From the snout to the commencement of dorsal fluke	4	0
From the snout to the apex of dorsal fluke	5	4½
Do. do. external orifice	6	6
Do. do. vent	7	1
Do. do. origin of tail	9	1

From the snout to the cleft of tail	9	11
Do. do. tips of tail.....	10	2
Height of the dorsal fluke	0	10

The body as it approached the tail was compressed into a sharp ridge above and below. The pectoral flipper measured in its greatest length (from its tip to its anterior insertion) one foot seven inches, the eye was one and one-eighth inches long; the ear-hole, owing to the condition of the skin, could not be distinguished; the horns of the blower were pointed forward. The whole skin was smooth, and was entirely black, except on the underside, which was white from the chin to beyond the vent. In a younger and smaller specimen, retaining a portion of the skin, and which without the head measured six feet in length, there was much more white, which extended to and over part of the tail. The abortive hinder limbs in this example consisted of a right and a left bone lying in the long axis of the body near the vent, and about twenty-seven inches from the cleft of the tail. They were about two inches and three-eighths long, and a quarter of an inch broad, somewhat curved upwards, flattened forwards, and rounded and thickened behind, where they nearly met.

LAWS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

I.—The name of the Society shall be the "Liverpool Biological Society," and its object the advancement of Biological Science.

II.—The Ordinary Meetings of the Society shall be held at University College, at Seven o'clock, during the six Winter months, on the second Friday evening in every month, or at such other place or time as the Council may appoint.

III.—The business of the Society shall be conducted by a President, two Vice-Presidents, a Treasurer, a Secretary, a Librarian, and twelve other Members, who shall form a Council; four to constitute a quorum.

IV.—The President, Vice-Presidents, Treasurer, Secretary, Librarian, and Council shall be elected annually, by ballot, in the manner hereinafter mentioned.

V.—The President shall be elected by the Council (subject to the approval of the Society) at the last Meeting of the Session, and take office at the ensuing Annual Meeting.

VI.—The mode of election of the Vice-Presidents, Treasurer, Secretary, Librarian, and Council shall be in the form and manner following:—It shall be the duty of the retiring Council at their

final meeting to suggest the names of Members to fill the offices of Vice-Presidents, Treasurer, Secretary, Librarian, and of four Members who were not on the last Council to be on the Council for the ensuing session, and formally to submit to the Society, for election at the Annual Meeting, the names so suggested. The Secretary shall make out and send to each Member of the Society, with the circular convening the Annual Meeting, a printed list of the retiring Council, stating the date of the election of each Member, and the number of his attendances at the Council Meetings during the past session; and another containing the names of the Members suggested for election, by which lists, and no others, the votes shall be taken. It shall, however, be open to any Member to substitute any other names in place of those upon the lists, sufficient space being left for that purpose. Should any list when delivered to the President contain other than the proper number of names, that list and the votes thereby given shall be absolutely void. Every list must be handed in personally by the Member at the time of voting. Vacancies occurring otherwise than by regular annual retirement shall be filled by the Council.

VII.—Every Candidate for Membership shall be proposed by three or more Members, one of the proposers from personal knowledge. The nomination shall be read from the Chair at any Ordinary Meeting, and the Candidate therein recommended shall be balloted for at the succeeding Ordinary Meeting. Ten black balls shall exclude.

VIII.—When a person has been elected a Member, the Secretary shall inform him thereof, by letter, and shall at the same time forward him a copy of the Laws of the Society.

IX.—Every person so elected shall within one calendar month after the date of such election pay an Entrance Fee of Half a Guinea and an Annual Subscription of One Guinea (except in the case of Student Members); but the Council shall have the power in exceptional cases, of extending the period for

such payment. No Entrance Fee shall be paid on re-election by any Member who has once paid such fee.

X.—The Subscription (except in the case of Student Members) shall be One Guinea per annum, payable in advance, on the day of the Annual Meeting in October.

XI.—Members may compound for their Annual Subscriptions by a single payment of Ten Guineas.

XII.—There shall also be a class of Student Members, paying an Entrance Fee of Two Shillings and Sixpence, and a Subscription of Five Shillings per annum.

XIII.—Resignation of Membership shall be signified *in writing* to the Secretary, but the Member so resigning shall be liable for the payment of his Annual Subscription, and all arrears up to the date of his resignation.

XIV.—The Annual Meeting shall be held on the second Friday in October, or such other convenient day in the month as the Council may appoint, when a Report of the Council on the affairs of the Society, and a Balance Sheet, duly signed by Auditors previously appointed by the Council, shall be read.

XV.—Any person (not resident within ten miles of Liverpool) eminent in Biological Science, or who may have rendered valuable services to the Society, shall be eligible as an Honorary Member; but the number of such Members shall not exceed fifteen at any one time.

XVI.—Captains of vessels and others contributing objects of interest shall be admissible as Associates for a period of three years, subject to re-election at the end of that time.

XVII.—Such Honorary Members and Associates shall be nominated by the Council, elected by a majority at an Ordinary Meeting, and have the privilege of attending and taking part in the Meetings of the Society, but not of voting.

XVIII.—Should there appear cause in the opinion of the Council for the expulsion from the Society of any Member, a Special General Meeting of the Society shall be called by the Council for that purpose; and if two-thirds of those voting agree that such Member be expelled, the Chairman shall declare this decision, and the name of such Member shall be erased from the books.

XIX.—Every Member shall have the privilege of introducing one visitor at each Ordinary Meeting. The same person shall not be admissible more than twice during the same session.

XX.—Notices of all Ordinary or Special Meetings shall be issued to each Member by the Secretary, at least three days before such Meeting.

XXI.—The President, Council, or any ten Members can convene a Special General Meeting, to be called within fourteen days, by giving notice in writing to the Secretary, and stating the object of the desired Meeting. The Circular convening the Meeting must state the purpose thereof.

XXII.—Votes in all elections shall be taken by ballot, and in other cases by show of hands, unless a ballot be first demanded.

XXIII.—No alteration shall be made in these Laws, except at an Annual Meeting, or a Special Meeting called for that purpose; and notice in writing of any proposed alteration shall be given to the Council, and read at the Ordinary Meeting, at least a month previous to the meeting at which such alteration is to be considered, and the proposed alteration shall also be printed in the Circular convening such meeting; but the Council shall have the power of enacting such Bye-laws as may be deemed necessary, which Bye-laws shall have the full power of Laws until the ensuing Annual Meeting, or a Special Meeting convened for their consideration.

BYE-LAW.

All nominations of Student Members shall be passed by the Council previous to nomination at an Ordinary Meeting. When elected, Student Members shall be entitled to all the privileges of Ordinary Members, except that they shall not receive the publications of the Society, nor vote at the Meetings, nor serve on the Council.

LIST OF MEMBERS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

SESSION 1888-9.

A. Ordinary Members.

(Life Members are marked with an asterisk.)

ELECTED.

1888 Atkin, Hope T., Egerton House, Egerton Park, Rock Ferry.
1886 Banks, Prof. W. Mitchell, M D., F.R.C.S., 28, Rodney-street.
1886 Bark, John, M.R.C.S., 42, Balliol-road, Bootle.
1886 Barron, Prof Alexander, M.B., M.R.C.S., 31, Rodney-street.
1888 Beasley, Henry C., Prince Alfred-road, Wavertree.
1889 Brown, Prof. J. Campbell, University College.
1889 Buchanan, J. R. M., M.B., University College.
1887 Caine, Nathaniel, 10, Orange-court, Castle-street.
1886 Capon, Robert M., L.D.S., Rodney-street.
1886 Caton, Prof. R., M.D., F.R.C.P., Lea Hall, Gateacre.
1886 Chisholm, J. M., M D., White House, Woolton.
1886 Dillcock, T., 8, Church-street, Egremont.
1886 Drysdale, John, M.D., Vice-President, 36A, Rodney-street.
1886 Edmonds, William, 69, Albany, Oldhall-street.
1886 Ellis, J. W., M.B. Vic., F.E.S, Ryde, Isle of Wight.
1887 Gasking, Rev. S., B.A, F.G.S., 8, Hawthorne-terrace, Townfield-lane, Liscard.
1886 Glynn, Prof., M.D., F.R.C P., 62, Rodney-street.
1886 Gibson, R. J. Harvey, M.A., F.R.S.E., Botanical Laboratory, University College.
1886 Gatehouse, C., Westwood, Noctorum, Birkenhead.
1888 Gutridge, Henry, 102, Hartington-road.

ELECTED.

1886 Halhed, W. B., Sunnyside, Prince's Park.
1886 Halls, W. J., 35, Lord-street.
1887 Hanitsch, R., Ph.D., Zoological Laboratory, University College
1887 Healey, George F., Oakfield, Gateacre.
1886 Herdman, Prof. W. A., D.Sc., F.L.S., F.R.S.E., PRESIDENT, University College.
1887 Hewitt, W., B.Sc , 16, Clarence-road, Birkenhead.
1887 Higgin, T., F.L.S , Ethersall, Roby.
1887 Hill, G. J., 17, Worthing-street, Blundellsands.
1888 Hurst, C. H , Owens College, Manchester.
1886 Jones, Charles W., Field House, Prince Alfred-road, Wavertree.
1886 Larkin, F. C., M.R.C.S., SECRETARY, 29, Bedford-street North, or Physiological Laboratory, University College.
1886 Leicester, Alfred, 24, Aughton-road, Birkdale.
1886 Lomas, J., Assoc.N.S.S., 23, Avondale-street, Smithdown-road.
1889 Macalister, E. L., Alexandra-terrace, Prince's-road.
1888 Melly, W. R., 90, Chatham-street.
1886 McMillan, William S., F.L.S., Brook-road, Maghull.
1886 McClelland, Joseph, M.D., 7, Sefton-drive, Sefton Park.
1886 Moore, Thomas J., C.M.Z.S., VICE-PRESIDENT, Free Museum.
1886 Moore, G. F., 15, Kremlin-drive, Tuebrook.
1886 Morton, G. H., F.G.S., 209, Edge-lane, E.
1887 Narramore, W., F.L.S., 5, Geneva-road, Elm Park.
1888 Newton, John, M.R.C.S., Rodney-street.
1889 Ogle, John J., Museum, Bootle.
1888 Phillips, Reg. W., B.A., University College, Bangor.
1886 *Poole, Sir James, J.P., Abercromby-square.
1886 Rathbone, Theodore, F.L.S., Backwood, Neston.
1886 Read, William H., 6, Dingle-lane.
1886 Roberts, I., F.G.S., Kennessee, Maghull.
1887 Robertson, Helenus R., Glendaragh, Livingstone-drive.
1887 Rowlands, W. Ellison, 28, Green-lane, Stoneycroft.
1887 Ryley, Thomas C., 31, Alexandra-drive.
1886 Smith, Andrew T., Jun., 13, Bentley-road, Prince's Park.
1889 Stewart, W. J., B.A., 25, Lord-street.
1886 Tate, A. Norman, F.I.C., 9, Hackins-hey.

ELECTED.

1886 Thompson, Isaac C., F.L.S., F.R.M.S., TREASURER, Woodstock, Waverley-road.

1889 Thurston, Edgar, Gov. Central Museum, Egmont, Madras, India.

1888 Toll, J. M., 340, Walton Breck-road.

1886 Vicars. John, 8, St. Albans-square, Bootle.

1886 Walker, Alfred O., J.P., F.L.S., Colwyn Bay.

1886 Walker, George, F.R.C.S., 43, Rodney-street.

1889 Warriner, J. B., Central Buildings, North John-street.

1889 Williams, Miss Leonora, 55, Rocky-lane.

B. STUDENT MEMBERS.

Armstrong, Miss A., 26, Trinity-road, Bootle.

Baylis, W. J , 56, Vine-street.

Bell, R. G., 8, George's-hill.

Brown, W. M., 14, Great George-street.

Browne, H. J. M., 39, Rodney-street.

Buckley, Miss L., Mildmay House, Blackburne-place, Hope-street.

Clapham, G. P. P., 13, Ducie-street.

Clubb, J. A., Zoological Laboratory, University College.

Coventry, P. H., 15, Albert-road, Birkdale.

Earnshaw, W. H., Leavy Greave, Rudgrave-place, Egremont.

Edgecombe, W , Uplands, Blundellsands.

Evans, John, 7, Elm Bank, Walton Breck-road, Anfield.

Fowler, Miss C., High School, Belvidere-road.

Gould, Joseph, Littledale-road, Egremont.

Hannah, J. H. W., 4, Adderley-street, Edge-lane.

Harding, Miss M., Kremlin-drive, West Derby.

Hayward, W. D., 117, Grove-street.

Hornell, James, 105A, Grove-street.

House, S. H., 44, Edge-lane.

Hughes, W. Rathbone, 3, Prince's-gate, Prince's Park.

Jones, C. R., St. John's Vicarage, Waterloo.

Lomas, Mrs. J., 23, Avondale-street, Smithdown-road.

McMillan, R., 20, Aubrey-street.

Morris, Thomas, 22, Newstead-road.
Nixon, H. T., 40, Spellow-lane, Kirkdale.
Nixon, J. P., 40, Spellow-lane, Kirkdale.
Noble, Miss Jessie, 6, Prince's-avenue.
Nowell, S. J., 2, St. Alban's-square, Bootle.
O'Brien, Miss Mary, 47, Kingsley-road.
Palethorpe, Miss F., 85, Gladstone-road, Edgehill.
Partridge, A. J., 25, Seacombe Villas, Seacombe.
Robinson, H. A., 68, Promenade, Southport.
Schröder, Miss K., High School, Belvidere-road.
Stahlknecht, B., 37, Prince's-avenue.
Tarbet, W. E., 8, Gambier-terrace.
Tarleton, Thomas, 1, Hyde-road, Waterloo.
Thompson, D. W. M., 19, St. Domingo-vale.
Veale, F. J. de C., 20, Parkfield-road.
Warham, Miss, 89, Grove-street.
Williams, Henry, Jun., 57, Balliol-road, Bootle.
Woodhouse, J. P., 35, Scarisbrick New-road, Southport.

C. Honorary Members.

Claus, Prof. Carl, University, Vienna.
Fritsch, Prof. Anton, Prague, Bohemia.
Giard, Prof. Alfred, Sorbonne, Paris.
H.M. King Kalakao, the Palace, Honolulu, Sandwich Islands.
Marshall, Prof. A. Milnes, D.Sc., M.D., F.R.S., Owens College, Manchester.

REPORT of the LIBRARIAN.

Our Society has arranged an exchange of publications with thirty-eight societies, of which thirty-four have already sent us their Proceedings for the past or former years. The following list gives the titles of the exchanges received, and includes also four works which have been presented to the library by some of our members :—

1. Annales du Musée d'Histoire naturelle de Marseille. Tomes I. and II.
2. Archiv des Vereins der Freunde der Naturgeschichte in Mecklenburg. Jahr: XXXVI.—XLII.
3. Archives Néerlandaises des Sciences exactes et naturelles. T. XXI. et XXII. T. XXIII., 1re et 2me livr.
4. The Australian Museum. Descriptive Catalogue of the Sponges. By R. v. Lendenfeld. Presented by the Australian Museum, Sydney.
5. Berichte der naturforschenden Gesellschaft zu Freiburg i. B. Band: I. and II.
6. Berichte der Oberhessischen Gesellschaft für Natur- und Heilkunde. Nos. 18—26.
7. Bericht über die Senckenbergische naturforschende Gesellschaft in Frankfurt a. M. 1887 and 1888.
8. Berichte über die Verhandlungen der königl. sächsischen Gesellschaft der Wissenschaften zu Leipzig. 1886—88. 1889, I.
9. Bijdragen tot de Dierkunde, uitgegeben door het genootschap Natura Artis Magistra, Amsterdam. Jaarg. V., No. 1.—Afl. 10—14; 16, and Feest-No. 1888.

10. Bulletin de la Société Impériale des Naturalistes de Moscou. Année 1888, No. 1—4.
11. Bulletin of the Museum of Comparative Zoology at Harvard College, Cambridge, U.S.A. Vols. XII. and XIII. Vol. XVI., Nos. 2 and 3. Vol. XVII., No. 1. Annual Report for 1887–88.
12. Bulletin of the United States Fish Commission, Vols. I.—VI., and Commissioner's Report of the United States Commission of Fish and Fisheries, 1883-85.
13. Bulletin Scientifique du Departement du Nord, 1880-87, and Bulletin Scientifique de la France et de la Belgique, 3me série, 1re année.
14. La Cellule, Recueil de Cytologie et d'Histologie Générale. T. II. et III. Presented by Dr. Drysdale.
15. Circulare des Deutschen Fischerei-Vereins. 1886-88.
16. Fishery Board for Scotland. Sixth Ann. Report (1887).
17. Journal of the Marine Biological Association of the United Kingdom. Nos. 1, 2 and (New Ser.) No. 1.
18. Life-Lore : a Monthly Magazine of Natural History. July, 1888—July, 1889.
19. The Liverpool Naturalist's Journal. 1866 and 1867. Presented by Mr. A. O. Walker.
20. Mathem. und naturwissensch. Mittheilungen aus den Sitzungsber. der königl. preuss. Akademie der Wissenschaften zu Berlin. Januar, 1887—Mai, 1889.
21. Meddelanden fran Stockholms Högskola. Nos. 1—50.
22. Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Tome XXIX., 2me partie. Tome XXX., 1re partie.
23. Mémoires de la Société Zoologique de France, 1er volume, 1re and 2me parties; and Bulletin de la Société Zoologique de France, T. XIII., Nos. 1—9.
24. Nachrichten von der königl. Gesellschaft der Wissenschaften zu Göttingen. 1887-88.

25. The Nudibranchiate Mollusca of the Estuary of the Mersey and the Dee. By C. Collingwood. Presented by Mr. A. O. Walker.
26. Proceedings and Transactions of the Natural History Society of Glasgow. Vol. I. (N.S.), Vol. II., part 1.
27. Proceedings of the Academy of Natural Sciences of Philadelphia. 1887 pts. 1—3, and 1888 pts. 2 and 3.
28. Proceedings of the Birmingham Philosophical Society. Vol. V., part 2.
29. Proceedings of the Canadian Institute, Toronto. III. Series, Vol. VI.
30. Proceedings of the Royal Physical Society, Edinburgh. Sessions 1885-86 and 1886-87.
31. Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H.M.S. "Alert," 1881-82. Presented by the British Museum.
32. Scientific Transactions of the Royal Dublin Society, Vol. III. (Series II.), and Vol. IV., part 1; and Proceedings of the Royal Dublin Society, Vol. V. (N.S.), and Vol. VI., parts 1 and 2.
33. Transactions, &c. of the Manchester Microscopical Society. 1883—1888.
34. Untersuchungen aus dem Gesammtgebiete der Mykologie. Von Oscar Brefeld. VII. Heft. Presented by Dr. Drysdale.
35. Verhandlungen der kaiserlich-königl. zoologisch-botanischen Gesellschaft in Wien. Jahrgang 1888.
36. Verhandlungen des naturhistorischen Vereines der preussischen Rheinlande. Jahrg. XLIV. und XLV.
37. Videnskabelige Meddelelser fra naturhistorisk Forening i Kjobenhavn. 1887-88.
38. Det Videnskabelige Udbytte af Kanonbaaden "Hauchs" Togter. Part I. and Atlas.

THE LIVERPOOL BIOLOGICAL SOCIETY,

Dr. IN ACCOUNT WITH ISAAC C. THOMPSON, HON. TREASURER. Cr.

1889.	£	s.	d.
To Use of Rooms, University College	6	0	0
,, Tea and Attendance at Meetings	4	3	1
,, Printing and Stationery, Turner, Routledge & Co.	69	19	11
,, Do. Parker & Coward	4	3	0
,, Do. Various	1	1	11
,, New Bookcase, Library	6	6	8
,, Postages and Carriage	5	13	9
,, Collector's Commission	0	8	0
,, Balance in hand, 30th June, 1889	46	1	1
	£143	17	5

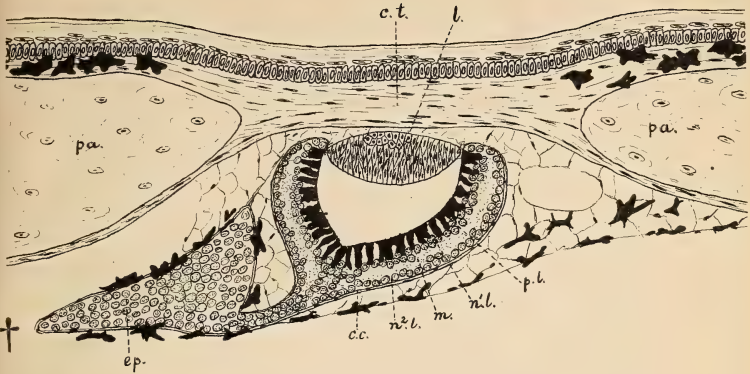
1889.	£	s.	d.
By Balance, 30th September, 1888	66	1	11
,, 8 Members' Entrance Fees @ 10s 6d	4	4	0
,, 13 Student Members' Entrance Fees @ 2s 6d	1	12	6
,, 57 Members' Subscriptions @ 21s	59	17	0
,, 42 Student Members, Subscriptions @ 5s	10	10	0
,, Sale of Proceedings	1	12	0
	£143	17	5
By Balance in hands of Treasurer	£46	1	1

ISAAC C. THOMPSON,
HON. TREASURER.

Audited and found correct,
ALFRED LEICESTER.
NATHANIEL CAINE.

LIVERPOOL, 30*th June*, 1889.

Fig. 1.



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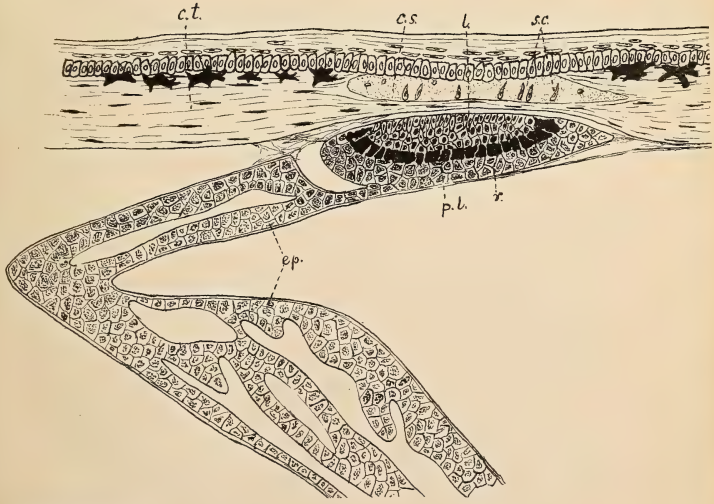
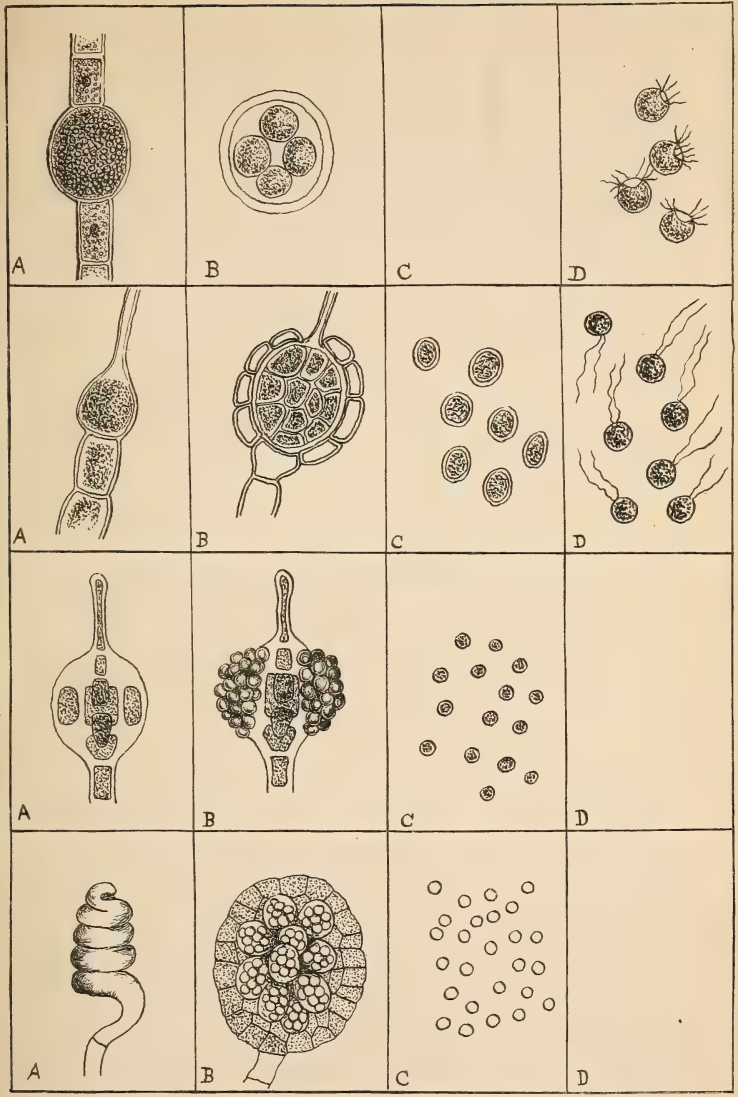


R. Hanitsch, del.

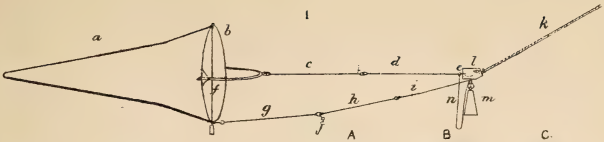
ANGUIS FRAGILIS.

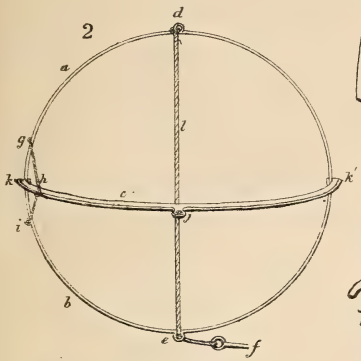


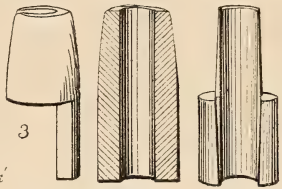
R.J.H.G. del.

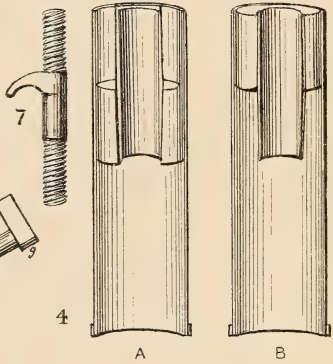
I. ÆDOGONIUM. III. SPERMOTHAMNIUM.

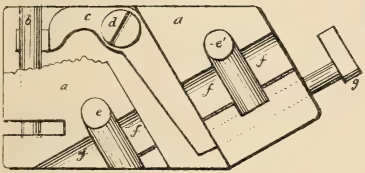
II. COLEOCHÆTA. IV. EUROTIUM.

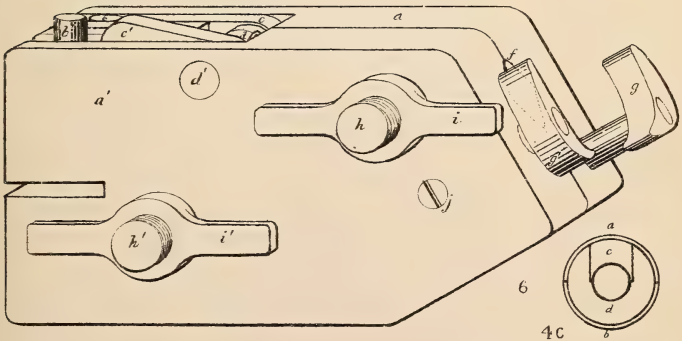












W.E.H. del.

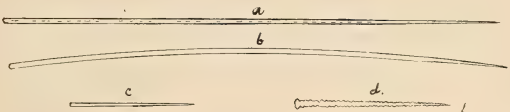
DEEP SEA TOW-NET.

LYMPH-SCHEMA.

F. C. Larkin del

Fig. 1.

Fig. 2.



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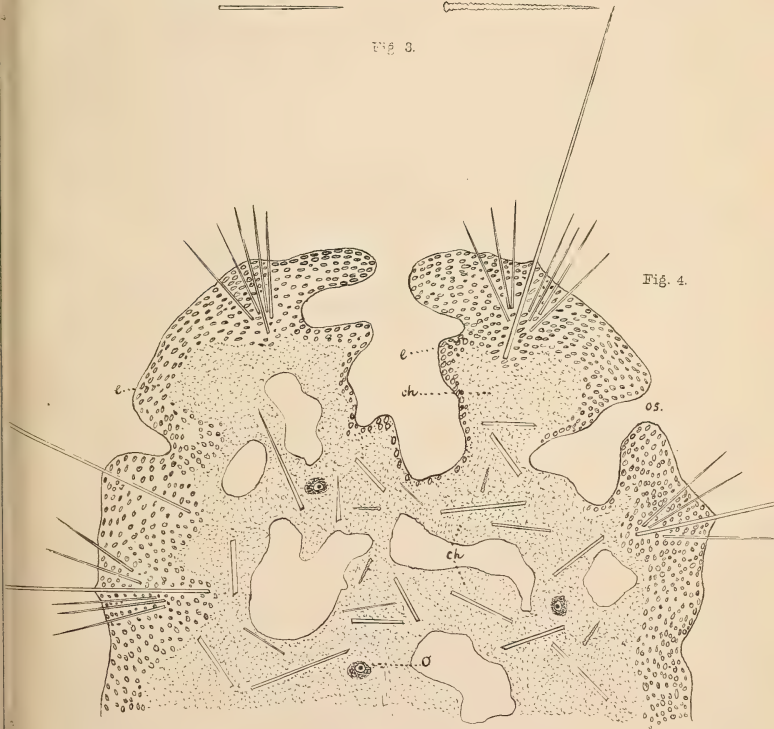


Fig. 4.

R. Hanitsch, del.

RASPAILIA STELLIGERA, Schmidt.

RASPAILIA VIMINALIS, Schmidt.

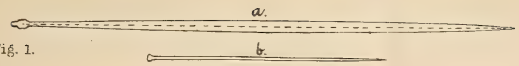


Fig. 1.

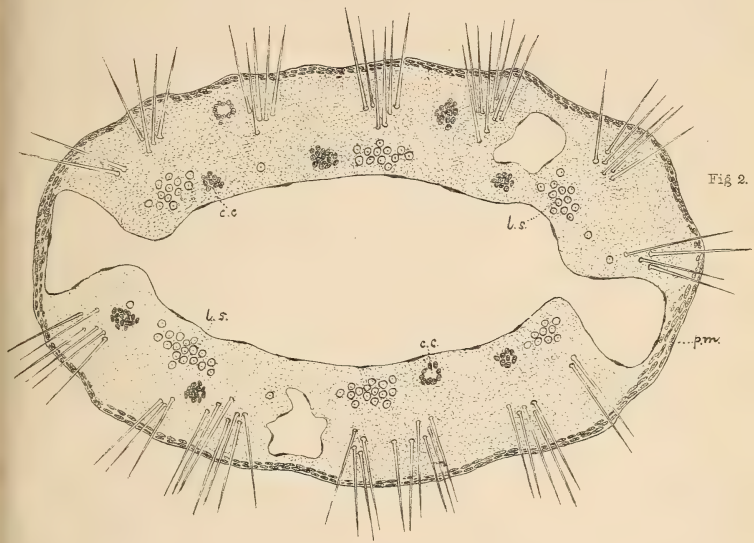


Fig. 2.

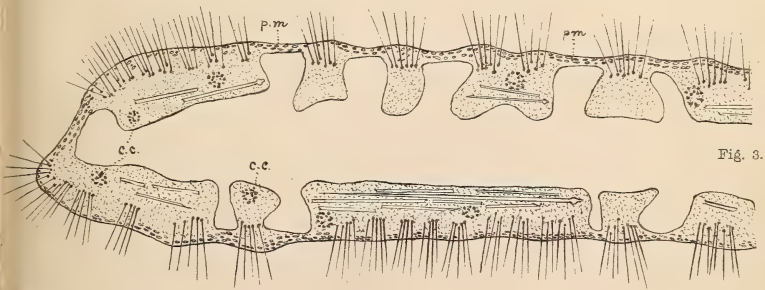


Fig. 3.

R. Hanitsch, del.

POLYMASTIA MAMMILLARIS, Johnston.

Fig. 1.

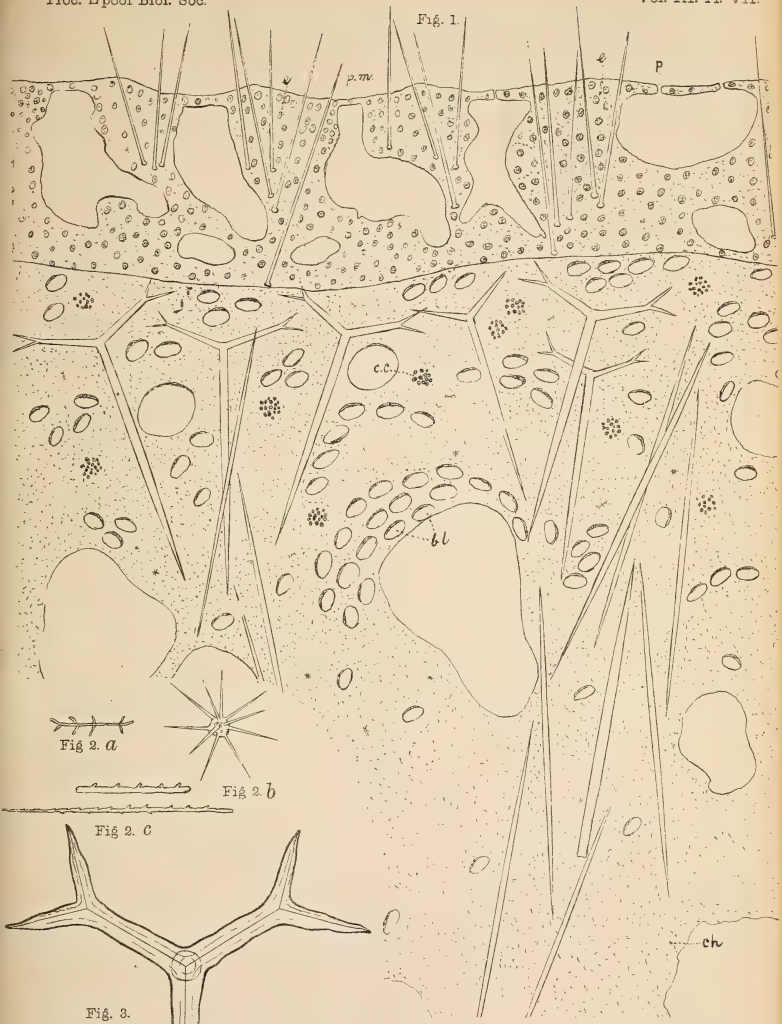


Fig. 2. *a*

Fig. 2. *b*

Fig. 2. *c*

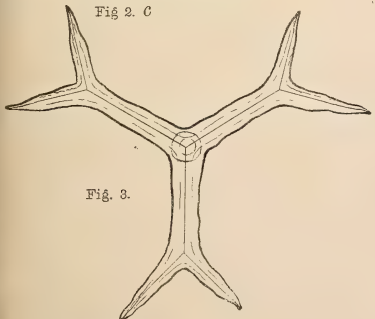


Fig. 3.

R. Hanitsch, del.

SEIRIOLA COMPACTA, n. sp.

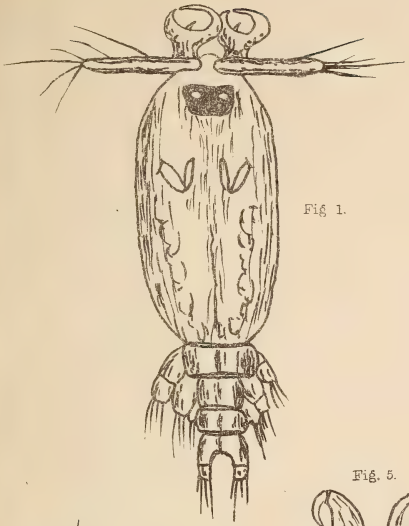


Fig. 1.

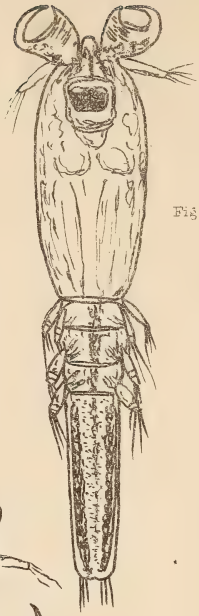


Fig. 6.

Fig. 5.

Fig. 4.

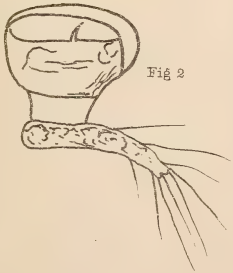


Fig 2

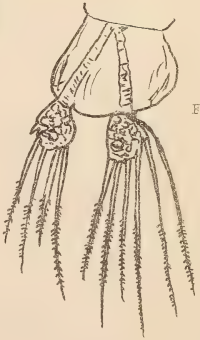
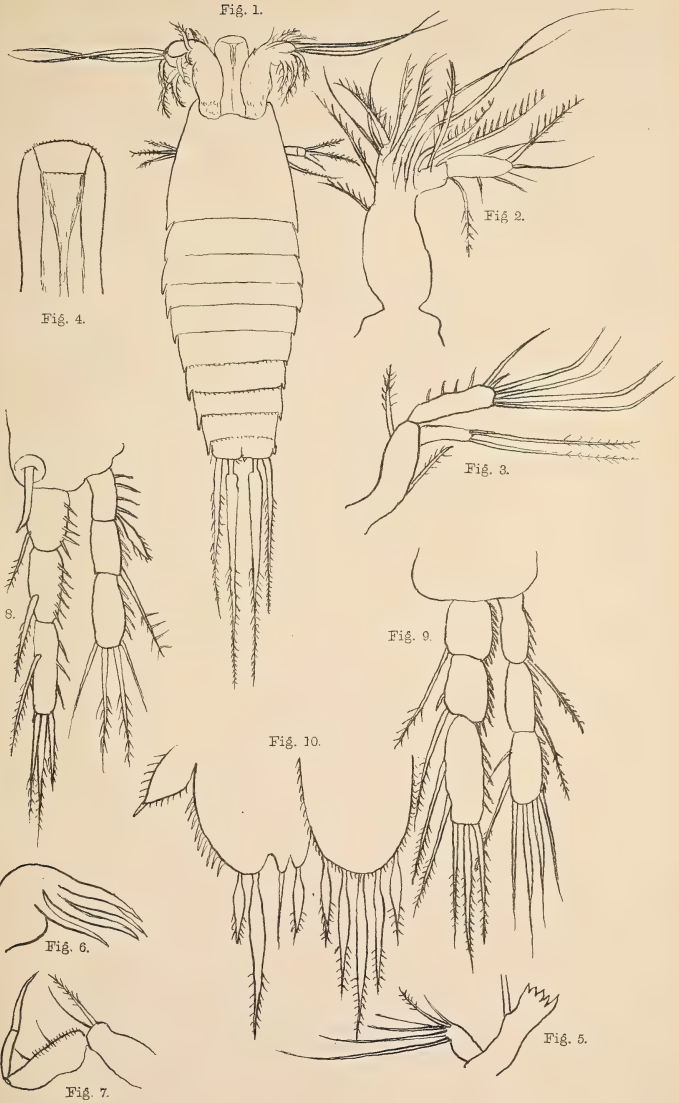


Fig. 3.

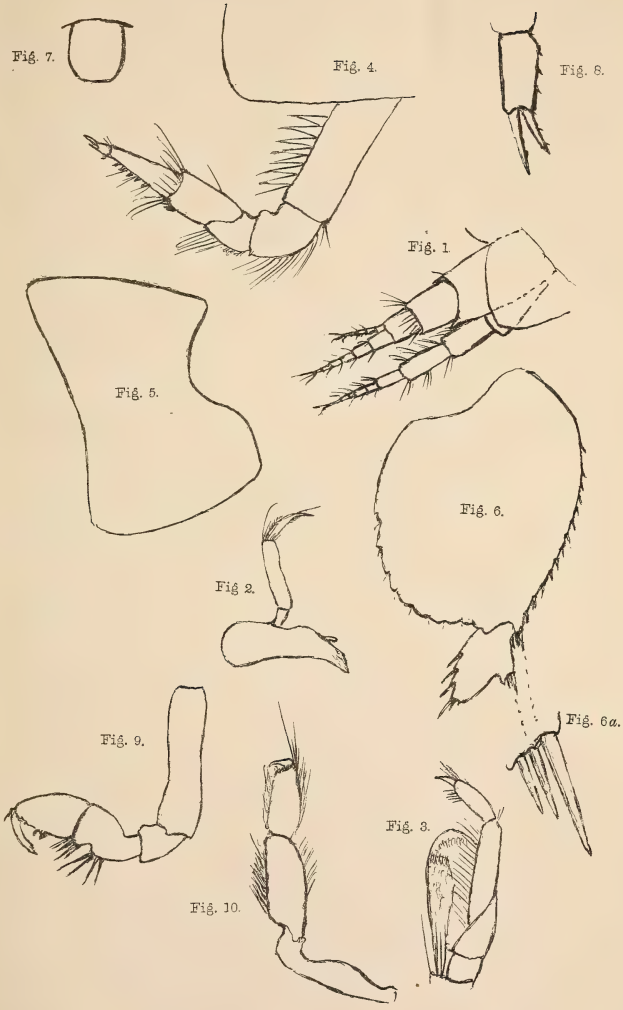
J. C. Thompson, del.

LERNÆA BRANCHIALIS, Linn.



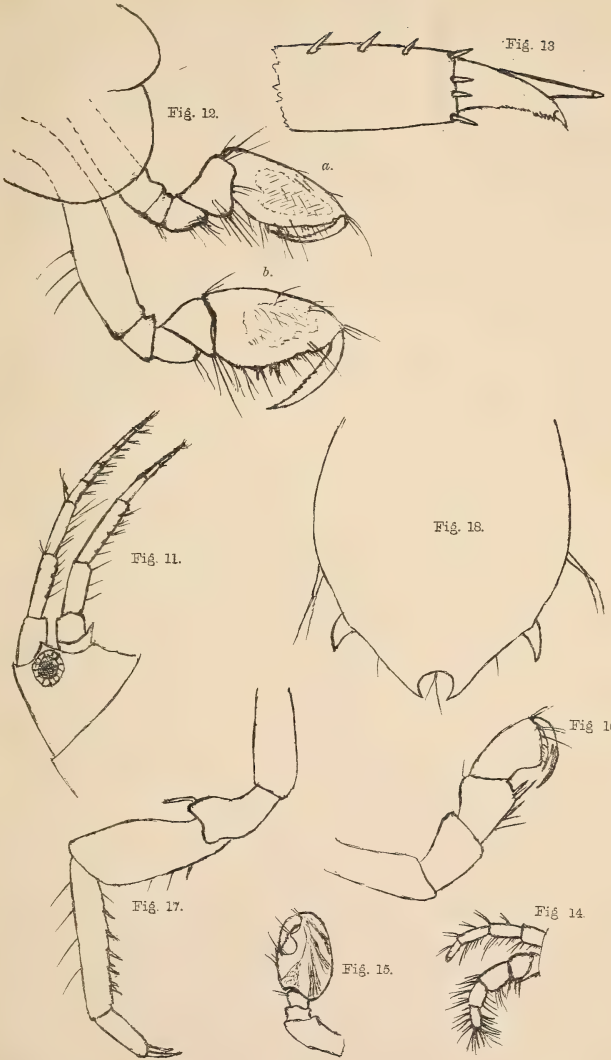
I. C. Thompson. del.

JONESIELLA HYÆNÆ, n. sp. Figs. 1 to 10.



A. O. Walker, del

LYSIANAX CERATINUS, n. sp. Figs. 1 to 8.
LYSIANAX (?) AUDOUINIANUS (Sp. Bate). Figs. 9 and 10.



A. O. Walker, del

PODOCERUS ISOPUS, n. sp. Figs. 11 to 13
PODOCERUS CAPILLATUS (Rathke) Figs. 14 and 15.
MUNNA FABRICII (Kroger) Figs. 16 to 18.

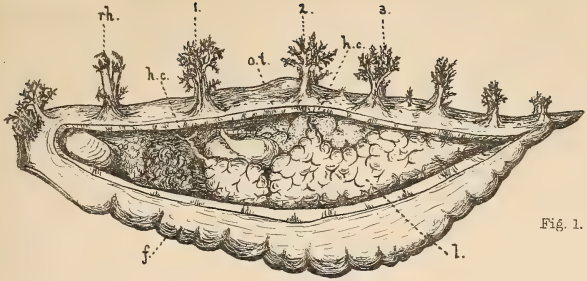
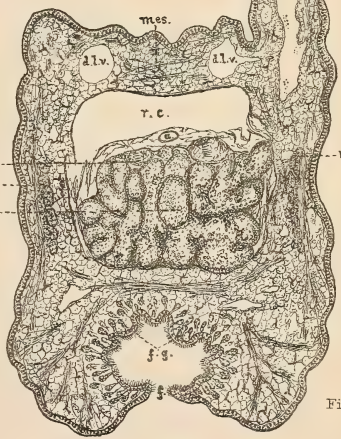


Fig. 1.

Fig. 4.

Fig. 3.



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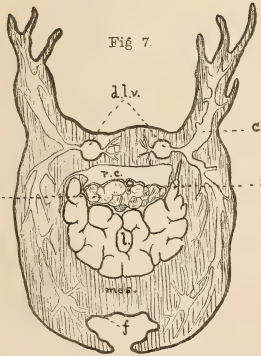


Fig. 2.

Fig. 5.

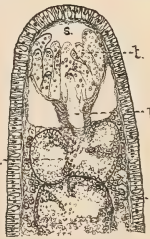


Fig. 6.

W.A.H. and J.A.C. del.

Fig. 1.

Fig. 2.

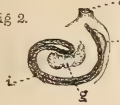


Fig. 3.

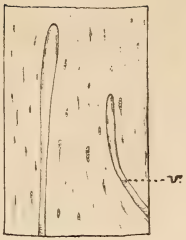
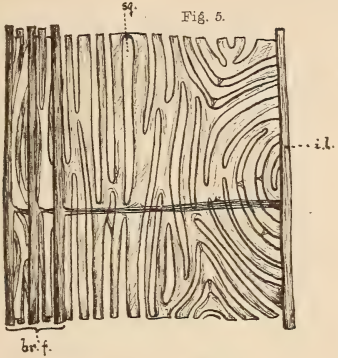


Fig. 4.

Fig. 5.



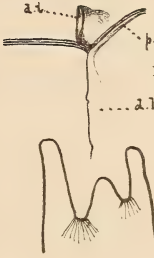


Fig. 6.

Fig. 13

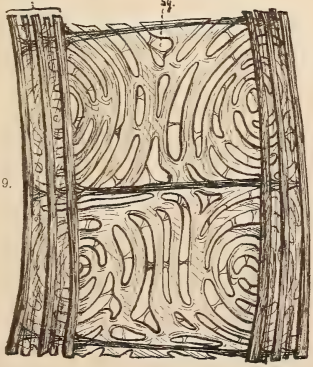
Fig. 14.

Fig. 7.

Fig. 8.

Fig. 10

Fig. 9.



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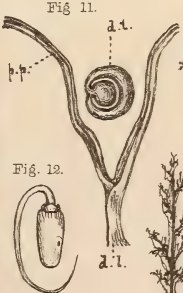

Fig. 12.

W.A.H. del.

TUNICATA.

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