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[SECOND SERIES.]

" ..... per litora spargite muscum,
Naiades, et circùm vitreos considite fontes :
Pollice virgineo teneros hìc carpite flores :
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas ;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo."

N. Parthenii Giannettasii Ecl. 1.

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I.—*On the Recent British species of the genus* Lagena.

By W. C. WILLIAMSON, Esq.

[With two Plates.]

WHILST I was engaged upon a memoir on the microscopic character of the Levant mud and other recent and ancient oceanic deposits (printed for the forthcoming volume of the Memoirs of the Manchester Literary and Philosophical Society), my friend W. Reckitt, Esq. of Boston placed in my hands some sand obtained on excavating a well near that place, which I soon found to abound in specimens of *Lagenæ**. Subsequently

* This interesting deposit can scarcely be called *recent*, being probably several thousand years old, and yet its geological character is not such as to justify its organisms being introduced into the category of fossils; being merely a beach which has been left permanently dry by the tide. When I wrote the memoir above referred to, I stated " that a considerable portion of the Fen district was once an estuary, which has undergone considerable changes even since the time of the Roman invasion; the old sea-bank having, at that comparatively recent period, been much further inland than at present " (Memoirs of the Manchester Literary and Philosophical Society, vol. viii. p. 56). This estuary has been gradually filled up, the elevation of the coast or the recession of the ocean causing the sandy debris, once forming the bed of the latter, to be converted into dry land, and afterwards covered over with a layer of vegetable mould. Mr. Reckitt's specimen was obtained from a depth of seven feet below the surface, where he found a very fine sand containing carbonaceous fragments, and a large number of the Foraminifera and other microscopic organisms still characteristic of our existing sea-beaches, including many of the rarest as well as the most

Dr. Mantell supplied me with specimens from a similar accumulation at March in Cambridgeshire, equally rich in the same elegant organisms. On comparing these with such published drawings and descriptions of *Lagenæ* as were available to me, it was very evident that both the one and the other were exceedingly incomplete, the drawings being for the most part unrecognizable caricatures, and the descriptions not comprehending half the forms that had come under my notice. Contemplating the production of a brief monograph on the subject, I wrote to J. Gwyn Jeffreys, Esq. of Swansea, soliciting his valuable aid, knowing that he possessed an excellent series of these interesting objects from various British localities. In reply he informed me, that in 1828 he had laid before the Linnæan Society a memoir on the same genus, which memoir the Council of the Society ordered to be published in their 'Transactions.' Mr. Jeffreys however, not being satisfied on some points connected with the natural history of these animals, declined publishing the memoir until he had carried out further investigations, and consequently it was not printed.

This memoir, embodying his views of the genus up to that comparatively early period, he has kindly placed in my hands, and also, with that generous liberality which characterizes the true philosopher, he has forwarded to me his entire collection of *Lagenæ* to be used as I thought proper.

Under these circumstances I resolved upon a revision of the genus, giving figures of all the known British species, believing that the monograph would be neither useless nor uninteresting to the students of these microscopic organisms. The Boston and March deposits have enabled me, from their productiveness, to compare an immense number of specimens, and the two collections of Mr. Jeffreys and Mr. Bean of Scarborough have afforded

common of our British species. The specimen from March, which Dr. Mantell has placed in my hands, confirms my view as to the extent of this marine deposit. I have little doubt that it extends over the greater part of the Fen district, and probably it will be found to be continuous with the existing beaches of the coasts of Lincolnshire and Norfolk. The most curious feature of the deposit, as it exists at Boston and March, is the young state of nearly all the organisms found in it. The specimens of *Rotalina Beccarii*, *Polystomella crispa* and *Quinqueloculina seminulum* rarely exceed the $\frac{1}{80}$th of an inch in diameter, which, with their highly translucent aspect, shows them to be in a very young state. The same remark applies, though in a less degree, to the *Lagenæ*: does not this most strikingly illustrate the sifting power of aqueous currents, and explain the way in which such differences have been produced in rocks, which, like the chalk, have been entirely formed by an accumulation of Foraminifera and other small organisms, which in some localities are exceedingly minute, forming very fine-grained strata, whilst in others they are *comparatively* large, forming deposits of coarse texture?

me the opportunity of verifying the present existence of the same forms on various parts of the British coasts.

The earliest notice of any forms of *Lagenæ* which has come under my observation is in the 'Testacea Minuta Rariora' of Mr. Walker, published in 1784. He describes a number of British species which he arranged amongst the *Serpulæ*, distinguishing them however by the subgeneric name of *Lagena*.

In 1789 and 1791 Soldani figured some forms from the Adriatic, in his 'Testaceographiæ et Zoophytographiæ, parvæ et microscopicæ,' &c., tab. 120.

In 1803 Montagu republished Walker's species in his 'Testacea Britannica,' adding a few others which had been discovered by Mr. Boys of Sandwich. Montagu followed Walker's plan of arranging them with the *Serpulæ*, making them a part of his genus *Vermiculum*.

In 1808 Denys de Montfort introduced the genus into his 'Conchyliologie Systématique,' under the French and Latin generic names of *Lagénules* and *Lagenula*, classing them amongst his *Univalves cloisonnées*, or group of *Nautili*, in which group, like his predecessors Soldani, Plancus, and Fichtel and Moll, he comprehended all the Foraminifera.

In 1815 Dr. Fleming separated them from the *Serpulæ*, and, carrying out the intimation of Walker, gave them the rank of a genus in the article Conchology, published in the 'Edin. Ency.' vol. vii. p. 68. He applied to them the generic name of *Lagena*, very properly adopting the *subgeneric* term given to them by Walker, to whom certainly belonged the credit of pointing out the necessity for distinguishing them from any existing genus. It is to be regretted that Dr. Fleming subsequently abandoned this name for that of De Montfort.

In 1826 M. Dessalines D'Orbigny published his classification of the Cephalopoda*: in this arrangement he followed the views of preceding naturalists, regarding most of the Foraminifera as cephalopodous; but he separated three of the genera, *Lagenula*, *Discolites* and *Chelibs*; having anticipated Ehrenberg's subsequent discovery of the zoophytic character of *all* the Foraminifera, by determining that *these three* must be arranged with the true Polypifera.

At the same time Dr. Fleming, in his work on 'British Animals,' was arranging the genus "*Lagenula*" amongst the Foraminifera, regarding them as Cephalopoda, but with evident misgivings as to his correctness; for he observes, "The place of this genus is far from being satisfactorily determined, and the mi-

* Tableau Méthodique de la Classe des Céphalopodes; Annales des Sciences Naturelles, vol. vii. p. 96.

nuteness of the species composing it presents a great obstacle to an accurate examination."

The more recent writers have followed in the steps of those who preceded them, with two exceptions.

Professor MacGillivray, in his work on the 'Molluscous Animals of Scotland,' &c., made the first attempt to classify the British Foraminifera according to the comprehensive system of D'Orbigny, and at the same time reunited the *Lagenæ* to those organisms from which D'Orbigny had separated them.

In 1839 Ehrenberg laid before the Academy of Sciences at Berlin the brilliant results of his investigations into the structure and relations of the Foraminifera. He completely exploded the long-received opinion that they were Cephalopoda, and proved beyond doubt that they were zoophytic, being in fact Bryozoa allied to *Flustra*, *Eschara*, *Cellepora*, &c. In his classification of the Bryozoa according to his new views, of which a copy was published in the 'Annals and Magazine of Natural History' for 1841, vol. vii. p. 302, he places some of the *Lagenæ* at the head of the list of Foraminifera, under the name *Miliola*; apparently considering them the most simple and rudimentary form of that curious group. This is I believe the last published notice of the genus, except what is to be found in Thorpe's 'British Marine Conchology' (which contains no more than had been previously given by Dr. Fleming and other conchologists), and a few remarks in the memoir before alluded to on the microscopic character of the Levant mud.

On subjecting the *Lagenæ* from the Boston and March deposits to a close examination, and especially by adopting Ehrenberg's plan of mounting them in Canada balsam and viewing them as transparent objects by means of transmitted light, I soon observed some interesting facts which had apparently escaped the notice of our British conchologists. One of the first was, that these objects, the whole of which consist invariably of one isolated cell or chamber, require, nevertheless, to be divided into two distinct groups or genera; the one characterized by a long *external* neck or tube, with a small patulous orifice at the free extremity, projecting from the upper part of the cell (see Pl. I. figs. 1, 6, 9 & 10.); whilst in the other there exists a very similar tube, only occupying a reversed position. Instead of projecting *externally*, it descends into the *internal cavity*; still taking its rise from the upper portion of the cell, towards the lower part of the interior of which, the patulous orifice of the tube presents itself when it attains its full length (see Plate II. figs. 14, 16 & 22).

A little time after making this discovery, I received from Dr. Bailey of New York, specimens of *Lagena striata* (which is one of those having an external tube), and attached to it was the

name of *Miliola ficus*; which name had been given to it by M. Ehrenberg. Along with these were specimens of *Lagena globosa* (one of the species characterized by an *internal* tube), to which was affixed by Ehrenberg the very expressive name of *Entosolenia miliaris*? Hence it was evident that the great Prussian naturalist had observed the same peculiarity of structure in the species exhibiting the internal tube, and had given to the objects characterized by it the very expressive name of *Entosolenia*, which name it is my intention to retain, in separating the existing genus *Lagena* into two distinct groups

Beyond all doubt, Ehrenberg, MacGillivray and Fleming are correct in classing the *Lagenæ* near the Foraminifera instead of separating them as was done by Dessalines D'Orbigny. Several of the species, when mounted in Canada balsam and examined under a high magnifying power* as transparent objects, show the whole of the calcareous parietes of the cell to be crowded with innumerable minute perforations; a structure identical with that of *Rotalia Beccarii* and many other well-known Foraminifera, when examined under similar circumstances. Some species exhibit traces of much larger foramina; but whether these are normal or have been the result of accident, I am as yet undecided. The above fact however is sufficient to prove, that in their external microscopic structure there is a close affinity between the *Lagenæ* and the other Foraminifera.

As regards the soft animal of *Lagena*, I have not been able to ascertain that anything has been done, or that any one has hitherto examined it in a living state. This probably arises from the fact that all collectors have obtained their specimens from dried sea sand. Still however some little light may be thrown upon it from the affinity of these objects to the other Foraminifera.

Ehrenberg has investigated the nature of the soft parts of some of the latter group of organisms with considerable success. He considers that each cell of a Foraminifer, except the two first, which he found to contain a transparent substance, is filled with two differently coloured organs, which he regards as the thick alimentary canal; and some granular masses, which he suggests may be ovaries†. He also found that the animals had the power of pro-

* One of one-fourth of an inch focus will suffice.

† In none of the numerous specimens I have examined have I found anything analogous to ovaries. Many of them contain a great abundance of oil-globules, which in the dried specimens become inspissated and hardened, adhering to the sides of the cells, and which on decalcification present an aspect very like that of ova. I suspect that the small round objects found by Dr. Mantell in connexion with the fossilized animal bodies of *Rotaliæ* from the Folkstone chalk may be nothing more than these. At least they are undistinguishable from the recent specimens in my cabinet. See Philosophical Transactions, Part 4 for 1846, tab. 21. figs. 5, 10 & 11.

truding through the foramina in the calcareous cell, long extensile tentacula or pseudopodia; great bundles of filaments, which projected from the surface, and especially from the umbilical region. These tentacula had also been noticed by M. Alcide D'Orbigny (see the Voyage dans L'Amérique Méridionale, tome v. p. 29).

In some further investigations into the structure of these curious creatures, in the memoir above alluded to (which is already printed), I have come to the conclusion that a more or less dense but elastic membrane lines the interior of each cell of the compound Foraminifera allied to *Rosalina globularis*, *Rotalina Beccarii* and the *Textillariæ*, upon which my observations were chiefly made, prolongations of which membrane, injected from within (like the processes which the Echinodermata push through the ambulacral pores), constitute the pseudopodia observed by Ehrenberg and Alcide D'Orbigny; since, however large and distinct may be the foramina in the external calcareous portion of each cell, no trace of these foramina can be found in the membrane which continuously lines the calcareous portions of the cells, when the latter have been removed by acid. This internal membrane appears to have been filled with gelatinous matter, having apparently very little organization—a condition noticed by M. Dujardin, and which led him to regard the Foraminifera as little more than an animated slime encased in an external calcareous shell, and to associate them with the Pseudopodian *Amæba* amongst the Infusoria. When the outer shell is removed by acid, we often find that the different sacs of the inner membrane contain numerous small siliceous organisms, which the animal appears to have swallowed, but which are scattered indiscriminately over the whole of the cell in which they occur, and not confined to any one line, which would have been the case had there been any restricted portion, confined within special and narrow limits, performing the functions of an intestinal canal. Hence it appears probable, that, as in the case of the *Hydra* and some of the lower infusorial animals, the whole cavity of the organism was one sacculated digestive organ, the various cells or divisions of which, in those compound forms which are allied to *Rosalina* and *Rotalina*, are connected together by one or more tubular necks; channels of communication passing through the septa, and along which the food received could pass from one cell to another. How the rejecta-menta made their escape is doubtful; possibly, as is the case with the Hydraform Polypifera and many other lower animals, the oral orifice may be at once both mouth and anus.

It will be understood, that, according to these views, the animal membrane which is left after the removal of the calcareous portion is in reality an exact cast of the interior of the latter.

The above opinions are at variance with those of M. Ehrenberg, who considers that the calcareous case of the Foraminifer is merely the dried skin of the animal, containing dendritic calcareous particles, which on the contraction of the skin closes and conceals orifices through which the food is received. His observations which led to the above conclusions were chiefly made upon the curious little *Sorites orbiculus*, Ehr., the *Nummulina nitida* of D'Orbigny. However much this organism may support his opinion, certainly the *Rotalina Beccarii* and similar genera do not. We have no evidence that the *external* parietal foramina have an extensile and contractile property; and even if the large orifices of *Rosalina globularis* had any such power, we have demonstrative proof that the orifices do not penetrate the lining membrane, into the interior of which the food would have to find its way. M. Ehrenberg rests his argument upon the discovery of small siliceous organisms in the interior of the cells. It is possible that the *oral*? orifice may be capable of some degree of extension, allowing the transmission of objects of this kind. In *Membranipora*, *Eschara* and other allied groups, the analogous parietal foramina are obviously employed for no such purpose as the transmission of food, which is received through the large orifice at the extremity of the cell. Though the fact that these latter objects are furnished with true polypes may make a difference, still is it not probable that there may be a resemblance in the functions of such closely corresponding foramina in objects so nearly allied? At the same time I may observe, that I have never found siliceous organisms of any size in the *smaller internal* chambers of *Rosalinæ*, *Rotalinæ*, &c., though the frustules of *Cocconeis*, *Grammatophora* and *Navicula* are not uncommon in the larger cells, where the communicating apertures are proportionately large.

One of M. Ehrenberg's results is much more analogous in some respects to those obtained by Milne Edwards, in his investigations into the structure of *Eschara*. The latter observer has clearly shown that the cells of *this* animal are thickened by external additions of calcareous matter, and that, consequently, the soft animal membrane does not line the internal cavity, but pervades the whole substance of the calcareous cell; the calcareous atoms not being developed *upon*, but *in* the skin of the animal. From this it is evident, that very different modes of growth and development are to be found in animals otherwise closely allied.

I have found that M. Ehrenberg's remarks on the soft animals of the Foraminifera apply strikingly to that of *Rosalina globularis*, but scarcely to any other of those that I have examined. In this species, the animal membrane, lining the smaller cells of what in a shell would be called the spire, is of a rich brown co-

lour, becoming of a paler hue as we approach the larger cells; the terminal ones being almost colourless. In *Rotalina Beccarii* this difference is scarcely to be observed, all the cells being nearly transparent; and in *Polystomella crispa*, the animal portions filling the innermost and outermost cells appear to exhibit no differences of transparency or colour. A slight deepening of the colour is observable in the young cells of *Quinqueloculina seminulum*.

It is from *Rosalina globularis* that the best specimens of the decalcified animal membrane are to be obtained, and from *Rotalina Beccarii* the next; these two, especially the former, preserving their contour the best, owing to the greater density of the lining membrane. In *Polystomella crispa*, and in the *Quinqueloculinæ*, this membrane is so exceedingly thin, and the contained animal matter in such a thoroughly fluid state, that less of a definite form is left on drying the decalcified animal than would result from submitting *Paramecium aurelia*, or many others of the Polygastric Infusoria, to a similar process, corroborating M. Dujardin's observations, though not the inferences which he deduced from them.

On treating various species of *Lagena* with dilute nitric acid, in the same way that I had done the other Foraminifera, the results were of a precisely opposite character to those I had previously arrived at, but analogous to those obtained by Milne Edwards in operating upon *Eschara*. I found a strong animal membrane, which, had the organism not been dried, would evidently have been flexible; not lining the cavity of the cell, but retaining all its external form. This was obtained most easily from *L. lævis*, var. *Amphora* (fig. 3), and *L. striata* (fig. 5), in old specimens of which the decalcified membrane was of considerable thickness. In *L. striata* the membrane was very thin and transparent along the costæ, but in old specimens thick and opake in the intervening spaces, the latter portions being easily separated in the form of long shreds. The same transparency in the membrane was observable in the translucent reticulations separating the areolæ of *Entosolenia squamosa*, the areolæ being opake.

The only species which I have hitherto had the opportunity of examining in a fresh state is the *Lagena* (*Entosolenia*) *marginata*, which was rather abundant amongst the branches of an *Antennularia*, which Mr. Jeffreys sent to me from Falmouth, whilst still moistened with sea-water. In these specimens, no trace of organisation was observable in the soft animal; each cell being filled with a perfectly transparent gelatinous fluid, like that contained in the outermost cell of a *Rotalina*, but even still more completely colourless.

The existence of foramina in many of the species, implying

the presence of pseudopodia, renders it probable that the animal of all the *Lagenæ* will eventually be found to be like that of other Foraminifera, viz. a gelatinous substance capable of projecting minute filaments, used probably as organs of progression, and also of receiving foreign bodies into its interior by means of the tubular orifice, by which substances it is nourished. Whether in any species the orifice at the extremity of the tube be furnished with a ciliobrachiate polype like that of the *Eschara* or not, is doubtful. The peculiarity in the structure of the membranous part of the cell, resembling that of *Eschara* and differing from the *Rotalinæ*, would indicate the possibility of some resemblance in this point, but my observations on *Lagena marginata* render it scarcely probable.

The existence of the internal tube of the *Entosoleniæ*, though so different from what generally occurs amongst the Foraminifera (in which all siphuncular appendages usually project anteriorly and not retrally, as has been already observed by M. Ehrenberg), constitutes no real difficulty in the way of classing them together; since in an elegant species of *Polymorphina*, not uncommon in the Boston deposit, and sometimes occurring on our own coast, the outermost cell is furnished with a precisely similar internal prolongation of the terminal oral? orifice, and which I have not hitherto seen noticed by any observer.

As regards the mode of growth of the *Lagenæ* one thing is certain, viz. that in the young state the cell is very thin, vitreous and transparent, whilst it becomes more and more opake with age. Here again we have another resemblance to *Eschara*, in which the gemmule after fixing itself to some object first covers itself with a very thin calcareous case, which it gradually thickens by the addition of calcareous particles. In *L. striata* the young cells, *which are comparatively small*, are perfectly transparent, whilst the large specimens commonly found in the cabinets of collectors are strong and quite opake* excepting along the costæ. From an examination of an immense number of specimens, it soon became evident to me that the animal must have possessed the power of enlarging and thickening its cell with increasing age. This fact first led me to suspect that in its structure it would approach nearer to *Eschara* than to *Rosalina*; an induction which subsequent investigation confirmed. Owing to its form, the cell could not have been so enlarged if it had been merely a calcareous secretion from an internal membrane. It is only in young specimens of the true *Lagenæ* that the long external neck is found perfect. On older specimens it is almost always worn off: this is especially the case with *L. striata*.

* In some instances this opacity arises from the deposition of calcareous matter, in others from a thickening of the membrane.

If then the *Lagenæ* be true Foraminifera, the next question is, what relationship do they bear to the other organisms of the same group? I apprehend that most if not all the Foraminifera, like other Bryozoa, however large and complicated they ultimately become, commence their existence as single isolated cells, upon or around which others are subsequently built; some linearly, as in *Nodosaria* and *Glandulina*; others spirally, as in *Rotalina*, *Truncatulina*, *Polystomella*, &c.; whilst others again present various modifications of these two types, as *Marginulina*, *Cristellaria*, *Spirulina*, *Quinqueloculina*, &c.

The most simple of the above structures belong to the genera *Nodosaria* and *Dentalina*, and consist only of a few smooth cells piled one upon another with connecting necks. Now a *Lagena*, in its perfect and matured form, must closely resemble the isolated germinal cell of one of these, exhibiting a phænomenon, of which analogues occur in every department of the organic world. It becomes then the most simple and primitive type of the Foraminifera; bearing in this respect the same relationship to the more complex forms that the globule of the *Torula* or Yeast-plant does to *Nostoc*, *Anabaina*, &c. amongst the Confervæ, and that *Eunotia* does to *Fragillaria* and young states of the *Diatomæ* amongst the Diatomaceæ. It is another instance of the *gradation*, so admirably distinguished by Mr. Lyell and Mr. Miller *, from the erroneous and recently abused doctrines of development and progression.

At the same time that the analogy of form and external contour thus links the *Lagenæ* with *Nodosariæ* and *Dentalinæ*, the structure of the cell already described appears to indicate a connexion between them and the genus *Eschara* and its allies. This affinity shows that there are great difficulties in the way of receiving any of the existing linear arrangements of these objects, and that a new classification will be required, based on a much more extended series of observations upon the physiological characters of all the genera than we as yet possess. This subject presents a wide and interesting field of inquiry for those who reside on the sea-coast and have access to these objects in a living state.

The only general fact which remains to be noticed respecting the *Lagenæ*, is the extraordinary capacity for variation which they exhibit in different states and ages. Extreme forms which appear to be very distinct from one another may be connected together by specimens of an intermediate aspect to an extent only to be believed by those who examine a large series of specimens side by side. I am well aware that the synthetical plan which I have

* 'Old Red Sandstone,' by H. Miller, Esq., p. 52.

followed will not suit the views of many of my conchological friends, who would have preferred my multiplying the number of species to a far greater degree than I could approve. I have however endeavoured to compromise the matter with them by giving names to what I consider to be merely varieties, but which some would regard as good species. Those who prefer the latter view can act upon it if they choose, by adopting these names as specific ones. This capacity for variation is probably a characteristic of very many of the lowest forms of animal and vegetable organizations, and is a source from which more or less of difficulty will always arise in attempting to classify objects so small in their dimensions and so obscure in their nature. In the present case it would scarcely be a difficult task to exhibit every intermediate form between *Lagena lævis*. var. *Amphora* to *L. striata* and *L. substriata*, rendering it possible that they may be all varieties of *one* species.

The *Lagenæ* are usually found in dried sea-sand, free and detached, though Prof. MacGillivray observed *Lagena lævis* to be adherent to Fuci and the byssus of a *Modiola*; and amongst the branches of an *Antennularia* sent to me from Falmouth by Mr. Jeffreys were numbers of the *Entosolenia marginata* along with *Rosalina globularis* and *Polystomella crispa*.

In dividing the objects comprehended by Dr. Fleming, in De Montfort's genus *Lagenula*, into two groups, I have retained for the first of these Walker's term *Lagena*. Though the latter did not make them into a new genus, separate from *Serpula*, yet he distinctly indicated the necessity for a division, pointing out certain well-marked forms, and giving them a distinguishing name. In this he accomplished more than was subsequently effected by De Montfort; hence, in raising them to the rank of a genus, priority gives his name of *Lagena* the right to a preference before that of *Lagenula*. The adoption of the latter by English conchologists was owing to its introduction by Dr. Fleming into his 'British Animals,' where he employed it, I understand, because of its being more euphonious than *Lagena*, notwithstanding that, as has been already mentioned, he had previously adopted Walker's very expressive term for the genus in the 'Edinb. Encyclopædia' (vol. vii. pl. 1. p. 68, art. Conch. 1815). A slight improvement in the sound, or even expressiveness of a name, does not justify its displacing an older one, and hence throughout this memoir I have retained that of *Lagena* in preference to *Lagenula*.

Genus Lagena, *Flem. Edin. Enc.*

Serpula (*Lagena*), Walker. *Serpula*, Turton. *Vermiculum*, Mon-

tagu. *Lagenula*, De Montfort, Fleming, MacGillivray. *Miliola*, Ehrenberg.

Cell calcareous, single, globular, ovate or cylindrical, with a long produced external tubular neck projecting from the upper extremity. Internal cavity simple.

1. *Lagena lævis*. Pl. I. figs. 1, 2.

Serpula (*Lagena*) *lævis ovalis*, Walker, Test. Min. Rar. p. 3. t. 1. fig. 9.
Vermiculum læve, Mont. Test. Brit. p. 524.
Serpula lævis, Turton, Conch. Dict. p. 157.
Lagenula lævis, Flem. British Animals, p. 235; MacGillivray, Molluscous Animals of Scotland, p. 38.

Cell ovate or claviform, sometimes narrow and much elongated, having a long slender tubular neck somewhat contracted near its apex, surmounted by a narrow rim, surrounding a small circular oral ? orifice, smooth and shining, sometimes white, but more frequently transparent and hyaline, or with a delicate tint of bluish white: under a high magnifier its surface appears crowded with very minute foramina.

In its usual form, with the exception of the terminal rim, this delicate object bears the closest resemblance to a Florence flask. Fig. 2 represents a longitudinal section.

Long.	Diam.	Long.	Diam.
$\frac{1}{30}$	$\frac{1}{220}$	$\frac{1}{100}$	$\frac{1}{230}$ *
$\frac{1}{88}$	$\frac{1}{187}$	$\frac{1}{107}$	$\frac{1}{250}$

Scarborough, very rare, W. Bean, Esq. Swansea, Sandwich, J. G. Jeffreys, Esq. "Adhering to Fuci, and among the byssi of *Modiola barbata*, on the Girdleness at Aberdeen," Prof. MacGillivray. Boston, Lincolnshire; March, Cambridgeshire.

L. lævis, var. *a. Amphora*, nob. Figs. 3, 4.

Cell elongated, cylindrical; some examples having the form of *L. lævis*, with the addition of a long tapering mucro at the base; others being much more lengthened and fusiform, as in the figure. The majority of specimens exhibit a medium form, the greatest diameter being at the lower third of the cell. Neck long, slender, tapering, surmounted by a small rim surrounding the circular orifice. Texture and hue like *L. lævis*, of which I believe it to be only a variety, as I have found almost every in-

* In order to give a correct view of the variable dimensions of these objects, I have selected several specimens and given the length and breadth of each individual in fractional portions of an inch. The dimensions of all the species, as described by preceding writers, are very much larger than in any examples which have come under my notice and are surely inaccurate.

tervening form between the figures 1 and 3. It is one of the most elegant of the *Lagenulæ*.

Long.	Diam.
$\frac{1}{40}$	$\frac{1}{180}$
$\frac{1}{66}$	$\frac{1}{170}$
$\frac{1}{45}$	$\frac{1}{200}$

Oxwich, Sandwich, Oban, J. G. Jeffreys, Esq. Boston; March.

2. *Lagena gracilis*, nob. Pl. I. fig. 5.

In form this species bears a very close resemblance to the *L. lævis*, var. *Amphora*, from which it differs chiefly in having its surface marked by longitudinal striæ, which are well defined over the greater part of the cell, becoming less distinct towards the upper portion. If we consider this as only another variety of the *Amphora*, it will become necessary to regard all the forms of *L. striata* merely as states of *L. lævis*, of the propriety of which view a suspicion has more than once crossed my mind when examining some specimens of the var. *β. semistriata*. For the present I have thought it better, having seen several specimens of it, to give it a distinct name. If this suspicion should ultimately prove to be correct, *L. gracilis* will bear the same relation to *L. striata* and its var. *perlucida* that the var. *Amphora* does to *L. lævis*.

Long. $\frac{1}{55}$; diam. $\frac{1}{380}$.

Boston: very rare.

3. *L. striata*. Pl. I. figs. 6 & 8.

Serpula (Lagena) striata, Walker, p. 2. tab. 1. fig. 6.
Vermiculum striatum, Mont. Test. Brit. p. 523.
Serpula striata, Turton, Conch. Dict. p. 157.
Lagenula striata, Fleming, p. 234.

Cell ovato-claviform or spherical, with numerous parallel longitudinal costæ or lamellæ, which generally run nearly from one extremity to the other, only not usually reaching the apex inferiorly but terminating abruptly, forming a small circular coronal (see fig. 7). These costæ are sometimes very thin and lamelliform, but more commonly obtuse and rounded. The cell surmounted superiorly by a long tubular neck terminated by a narrow rim encircling the small round oral ? orifice.

Nothing can be much more variable than the conditions under which this species presents itself. In small young specimens alone is the tubular neck found perfect, and these are usually either transparent and hyaline or of a pale bluish white. On the other hand, the specimens usually seen in the cabinets of conchologists are strong, globular, of an opake dirty white, the rounded costæ alone remaining semitransparent, and with very imperfect

traces of a neck, which appears to wear away with age. Between this common form and that previously described, which I consider to be the perfect type, every modification exists. In some forms the costæ terminate abruptly near the base of the neck, the superior portion being smooth. This condition obviously connects the *L. striata* with the var. *β. semistriata*. In others the costæ are continued longitudinally along the neck, whilst in a few elegant specimens in the cabinets of Messrs. Bean and Jeffreys they were wound spirally around it. In some examples I have noticed that the neck appeared to be atrophied and wasting, having lost its brittleness and become membranous, as if it were only of use in the early condition of the animal. The character of the decalcified membrane of this species has been already described (p. 8).

Long.	Diam.	Long.	Diam.
$\frac{1}{50}$	$\frac{1}{60}$*	$\frac{1}{80}$	$\frac{1}{160}$
$\frac{1}{50}$	$\frac{1}{100}$		

"Reculver, Sheppey, Mr. Walker. Devonshire," Montagu. Exmouth, — Clarke, Esq. Swansea, Rossilly, Manorbeer, Tenby, Oxwich, Caswell Bay, Sandwich, Oban, Kyleakin; Roundstone, Connemara; Mr. Jeffreys. Scarborough, Mr. Bean. Boston; March. Fossil in a miocene tertiary deposit at Petersburg, U. S.†, Dr. Bailey; also in the English crag, Mr. Searles Wood.

L. striata, var. *α. interrupta*, nob. Fig. 7.

Like *L. striata*, only the costæ are more irregular; sometimes they bifurcate, at others they are not continued over more than the half or two-thirds of the cell, no two being exactly the same length. The specimen figured represents a common form of the neck when half-gone.

Swansea, Rossilly, Manorbeer, Tenby, Oxwich, Caswell Bay, Sandwich, Oban; Roundstone, Connemara; Kyleakin. Scarborough, Mr. Bean. Boston; March. Not uncommon.

Lagena striata, var. *β. semistriata*, nob. Pl. I. figs. 9, 10.

Similar in most respects to some young states of *L. striata*, only the costæ arising from the base terminate, some at the lower third, others at the middle, and in one specimen towards the uppermost third of the cell. What has been already said of the smooth neck found in some specimens of *L. striata* convinces me that this is only a variety. I have seen one specimen with a mucro at the base approaching the form of *L. lævis*, var. *Amphora*.

Long. $\frac{1}{100}$; diam. $\frac{1}{226}$.

* In this specimen nearly the whole of the neck is worn away.

† The same deposit has also furnished examples of *Entosolenia globosa*, *Arethusa lactea*, Flem., *Renoidea oblonga*, Brown (both species of *Polymorphina*. D'Orbigny), and what I believe to be young specimens of *Rotalia Beccarii*.

Manorbeer near Tenby, very rare, Mr. Jeffreys. Scarborough, one specimen, Mr. Bean. Boston.

Lagena striata, var. *perlucida*. Pl. I. fig. 11.

Cell usually globular, sometimes broadest at the base, at others ovate. Marked with longitudinal costæ, which are very distinct at the lower portion, but gradually lose themselves as they approach the long, elegant, tapering neck. In this it differs from the last var., in which the striæ terminate abruptly at the upper part. Cell exceedingly thin and fragile, beautifully hyaline and pellucid, sometimes of a pale milky tint, but more commonly transparent as the purest glass.

I believe this to be the *Vermiculum perlucidum* of Montagu: his figure represents a highly depressed form of cell, furnished with a small umbo at the base; but as Montagu had never seen the specimen, but only copied a drawing sent to him by Mr. Boys, I suspect that some error exists. I have often seen the projecting base of the central costa give the appearance of an umbo, and as regards form I have observed very great differences. The number of the ribs varies considerably. Some specimens, like Montagu's *V. perlucidum*, have not more than seven or eight, whilst in others they increase in number so as to merge this variety in the ordinary forms of *L. striata*, of which species I believe it to be one of the young states. Its most common aspect is precisely that of the ordinary fluted water-bottle used at the dinner-table. Sometimes the striæ are so short and indistinct as to render the specimen almost undistinguishable from *L. lævis*; indeed in some few specimens the striæ are only represented by a small circle of minute tubercles forming a coronal at the base of the cell.

Long.	Diam.
$\frac{1}{66}$	$\frac{1}{120}$
$\frac{1}{88}$	$\frac{1}{185}$
$\frac{1}{110}$	$\frac{1}{240}$.

Swansea, Tenby, Manorbeer, Sandwich, Kyleakin, Mr. Jeffreys. "Seasalter, Mr. Boys." Montagu. Boston; March.

4. *L. substriata*, nob. Pl. II. fig. 12.

Cell oval, sometimes considerably elongated and cylindrical, furnished with a long tubular neck. Surface marked with numerous exquisitely delicate parallel longitudinal striæ.

At first I thought that this rare object was an extreme variety of *Lagenula striata*, but after examining at least twenty specimens I am nearly satisfied that it is a distinct species, as the lines vary so little either in their number, strength, or distance apart. The general form of the cell also is much more ovate and elongated.

The drawing represents a specimen that is the least so. It is an exceedingly delicate and beautiful species.

Long.	Diam.
$\frac{1}{63}$	$\frac{1}{150}$
$\frac{1}{66}$	$\frac{1}{200}$.

Swansea, very rare, Geo. Barlee, Esq. Boston.

Genus Entosolenia, *Ehrenberg*.

Serpula (*Lagena*), Walker, Adams, Turton. *Vermiculum*, Mont. *Lagena* and *Lagenula*, Fleming. *Lagenula*, MacGillivray, Thorpe.

Cell calcareous, globose or ovate, sometimes compressed, furnished with a tube arising from the upper extremity and projecting downwards into the cavity of the cell. Oral? orifice opening into the tube.

1. *E. globosa.* Pl. II. figs. 13, 14.
   Serpula (*Lagena*) *lævis globosa*, Walker, p. 3. tab. 1. fig. 8.
   Vermiculum globosum, Mont. p. 523.
   Serpula globosa, Fleming, p. 235.

Cell ovato-globose, smooth, not compressed, projecting slightly at the upper extremity, in the centre of which projection is the small rounded orifice opening into the internal tube, which is slender, patulous at the extremity, and sometimes reaching nearly to the bottom of the cell.

When examined under a very high power, this object, like *L. lævis*, is found to be densely perforated with minute foramina, through which in all probability pseudopodia were protruded.

In very many cases I am satisfied that specimens of my *E. lineata* have been mistaken for this very rare form.

The cabinet of Mr. Bean of Scarborough contains one example of this species, in which two separate cells are united together at the lower part, having each a central aperture at the opposite end. The *Lagenula globosa* of Thorpe's 'British Marine Conchology' is obviously not the *L. globosa* of Fleming. It is described as having a long slender neck and is marked with opake longitudinal lines.

Long.	Diam.
$\frac{1}{100}$	$\frac{1}{160}$
$\frac{1}{166}$	$\frac{1}{170}$
$\frac{1}{166}$	$\frac{1}{214}$.

"Sandwich, Mr. Walker," Montagu. Scarborough, Mr. Bean. Portsmouth, Swansea, Mr. Jeffreys. Mindanao, Philippine Islands, and fossil in a miocene tertiary stratum, Petersburg, U.S., Dr. Bailey. Boston, March, the Levant. A rare species on the British coasts.

2. *Entosolenia marginata.* Pl. II. figs. 15, 16.

Serpula (Lagena) marginata, Walker, p. 3. tab. 1. fig. 7.
Vermiculum marginatum, Mont. p. 524.
Lagenula marginata, Thorpe.

Cell nearly orbicular, compressed, transparent or translucent, especially in a young state, having a slight projection at the upper extremity, towards the end of which is the orifice communicating with the internal tube. The cell is surrounded by a thin marginal lamella, which is continued as far as the oral orifice; within this margin, in old shells, is occasionally a thickened opake portion shaped like a horse-shoe, with the concavity and interrupted part directed upwards, the circumscribed central portion being more transparent. The lower extremity of the cell is sometimes furnished with a small external mucro. The internal tube, which is somewhat patulous, is rarely straight, except at the upper portion, the remainder being usually arcuated, following the curvature of one of the lateral parietes of the cell. Fig. 15 represents a section of the cell, with the tube cut across where the curvature commences.

This is the most common of our English species. At the Falmouth habitat it was comparatively abundant, adhering to a species of *Antennularia,* along with young forms of *Polystomella crispa*, *Rosalina globularis* and some others.

The *L. marginata* of Dr. Fleming is a concamerated shell; the *Rimula marginata* of some authors, and belonging to D'Orbigny's genus *Biloculina.*

Long.		Diam.
$\frac{1}{100}$	. . . .	$\frac{1}{110}$
$\frac{1}{166}$	. . . .	$\frac{1}{214}$
$\frac{1}{200}$	. . . .	$\frac{1}{210}$

Swansea, Rossilly, Manorbeer, Portsmouth, Sandwich, Oban, Kyleakin, Mr. Jeffreys. Scarborough; Lamlash Bay, Ayrshire; Mr. Bean. "Reculver," Walker. Boston, March, Falmouth, the Levant.

E. marginata, var. *lucida,* nob. Pl. II. fig. 17.

Cell elongated, somewhat pyriform, compressed, smooth and shining, surrounded by a marginal ring, which instead of being a thin lamina as in the ordinary type, is usually thickened and somewhat rounded. It is occasionally scarcely visible, especially towards the base, where however it often projects in the shape of a mucro. This margin, with the upper and central portions of each of the lateral parietes, are generally transparent, whilst the remainder of the cell is usually of a clear shining white; internal tube generally straight.

I was much disposed to have regarded this as a distinct spe-

cies, but I found many orbicular specimens of the true *E. marginata* in which the margin was obviously somewhat thickened and rounded, and others which, as already mentioned, showed the horseshoe-like white portion within the margin, nearly surrounding the transparent centre, so that I have no doubt of this being merely a variety of the same. It is often mistaken by collectors for a form of *E. globosa*, to which it sometimes approximates very closely, but from which it may be distinguished by its compressed form.

I have seen one specimen which was trilocular, having three transparent margins instead of two.

Long.		Diam.
$\frac{1}{63}$	. . . .	$\frac{1}{160}$
$\frac{1}{80}$	. . . .	$\frac{1}{133}$
$\frac{1}{100}$	. . . .	$\frac{1}{160}$

Swansea, Rossilly, Manorbeer, Portsmouth, Sandwich, Kyleakin, Mr. Jeffreys. Scarborough, Lamlash Bay, Mr. Bean. Boston ; March.

3. *Entosolenia lineata*, nob. Pl. II. fig. 18.

Cell ovate, broadest towards the base, more or less truncated at the upper extremity, which is sometimes furnished with a very small projecting neck, of variable length, in which is the oral ? orifice ; once only I have found it equal to the entire length of the cell. The base, which is rounded, has generally appended to it a small mucro, which is sometimes affixed obliquely, and occasionally wholly wanting. Texture translucent, of a pale dull bluish white ; the surface covered with exceedingly numerous longitudinal lines, so fine as to be visible only under a good microscope. Internal tube straight, patulous, reaching nearly to the base of the cell.

The dull leaden hue of this species appears to be a constant characteristic ; I have usually been able to identify it at a glance from this feature alone.

It is possible that the *Vermiculum urnæ* of Montagu may have been a short stumpy specimen of this form. Montagu only saw a drawing of it.

Long.		Diam.
$\frac{1}{113}$	. . . .	$\frac{1}{214}$
$\frac{1}{128}$	. . . .	$\frac{1}{200}$

Sandwich, Mr. Jeffreys. Boston ; March : very rare.

4. *E. squamosa*. Pl. II. fig. 19.
Vermiculum squamosum, Mont. p. 526. tab. 14. fig. 2.
Serpula squamosa, Turt. p. 158.
Lagenula squamosa, Flem. p. 235.
Lagenula reticulata, MacGillivray, p. 28.

Cell ovato-globose, with a slight projection superiorly, at the extremity of which is the small circular oral ? orifice. Surface beautifully ornamented with numerous, small, white, concave, irregular, areolar spaces, separated by elevated, transparent, reticular lines of demarcation. These arcolæ are irregular in form and distribution, being sometimes nearly round or oval, but more usually exhibiting a marked tendency to become hexagonal, the lower ones being usually the most elongated. Occasionally the areolæ are transparent and the reticulations milky. In this state it appears to be the *L. reticulata* of MacGillivray : one part of his description alone does not agree with my specimens ; he speaks of its being "considerably compressed." This however may have been an accidental circumstance, as all the species, both of *Entosolenia* and *Lagena*, are liable to a considerable degree of deformity. Internal tube patulous, usually shorter than in *E. globosa*, and generally with a small dilatation or spherical cavity a little below the oral ? orifice. The base of the cell is sometimes, though rarely, furnished with a small umbo.

In the figure of this exceedingly variable species, given in the Supplement to Montagu's 'Testacea Britannica,' the areolæ are made to represent scales overlapping each other. This appearance, though not natural, is easily obtained, by viewing the object obliquely and by throwing the microscope a little out of focus, and I have no doubt would be the aspect presented by the object when viewed under the imperfect instruments used in the time of Mr. Walker. Dr. Fleming considers these areolæ to be "parietal cells." They are however merely concavities in the exterior of the cell. They are usually to be traced in the form of opake spots in the decalcified membrane.

I possess one curious abnormal double specimen of this species, like that of *E. globosa* already described. There are *two* cells, united inferiorly, and having each one *central* oral ? orifice at the opposite extremity.

Long.	Diam.
$\frac{1}{100}$	$\frac{1}{133}$
$\frac{1}{113}$	$\frac{1}{150}$
$\frac{1}{166}$	$\frac{1}{190}$

"Seasalter, Mr. Boys," Montagu. Torbay, Swansea, Mr. Jeffreys. Lamlash Bay, Ayrshire, Scarborough, Mr. Bean. "Bay of Aberdeen," Prof. MacGillivray. Boston ; March : rare.

Entosolenia squamosa, var. *a. catenulata*. Pl. II. fig. 20.
Lagenula catenulata, Jeffreys MSS.

Cell ovato-globose, usually hyaline and transparent ; areolæ very small and numerous, square or hexagonal, arranged in perpendicular rows, having parallel horizontal divisions, which are

sometimes straight and at others arcuated. This form is merely the *E. squamosa* with the areolæ in perpendicular rows instead of being irregularly distributed over the surface. Sometimes these areolæ exhibit a tendency to assume the ordinary white opake appearance of the common form. I have seen specimens in which one side exhibited the arrangement in fig. 19, and the opposite one that of fig. 20; thus showing the identity of the two forms.

Long. $\frac{1}{100}$; diam. $\frac{1}{144}$.
Swansea, Sandwich, Mr. Jeffreys. Boston: very rare.

Entosolenia squamosa, var. *β. scalariformis*, nob. Pl. II. figs. 21, 22.

Closely resembling the last in the distribution of its areolæ, only they are very large and few in number; usually square or hexagonal, the horizontal lines of division being most frequently a little arcuated. The texture of this variety is highly hyaline, and commonly occurs amongst the young states of *E. squamosa*. As in the preceding example, I have seen specimens in which one side exhibited the arrangement of the areolæ, characterising the present form, whilst the opposite one presented that of the succeeding variety.

Long.	Diam.
$\frac{1}{100}$	$\frac{1}{144}$
$\frac{1}{133}$	$\frac{1}{200}$

Kyleakin, Mr. Jeffreys. Lamlash Bay, Ayrshire, Mr. Bean. Boston; March: very rare.

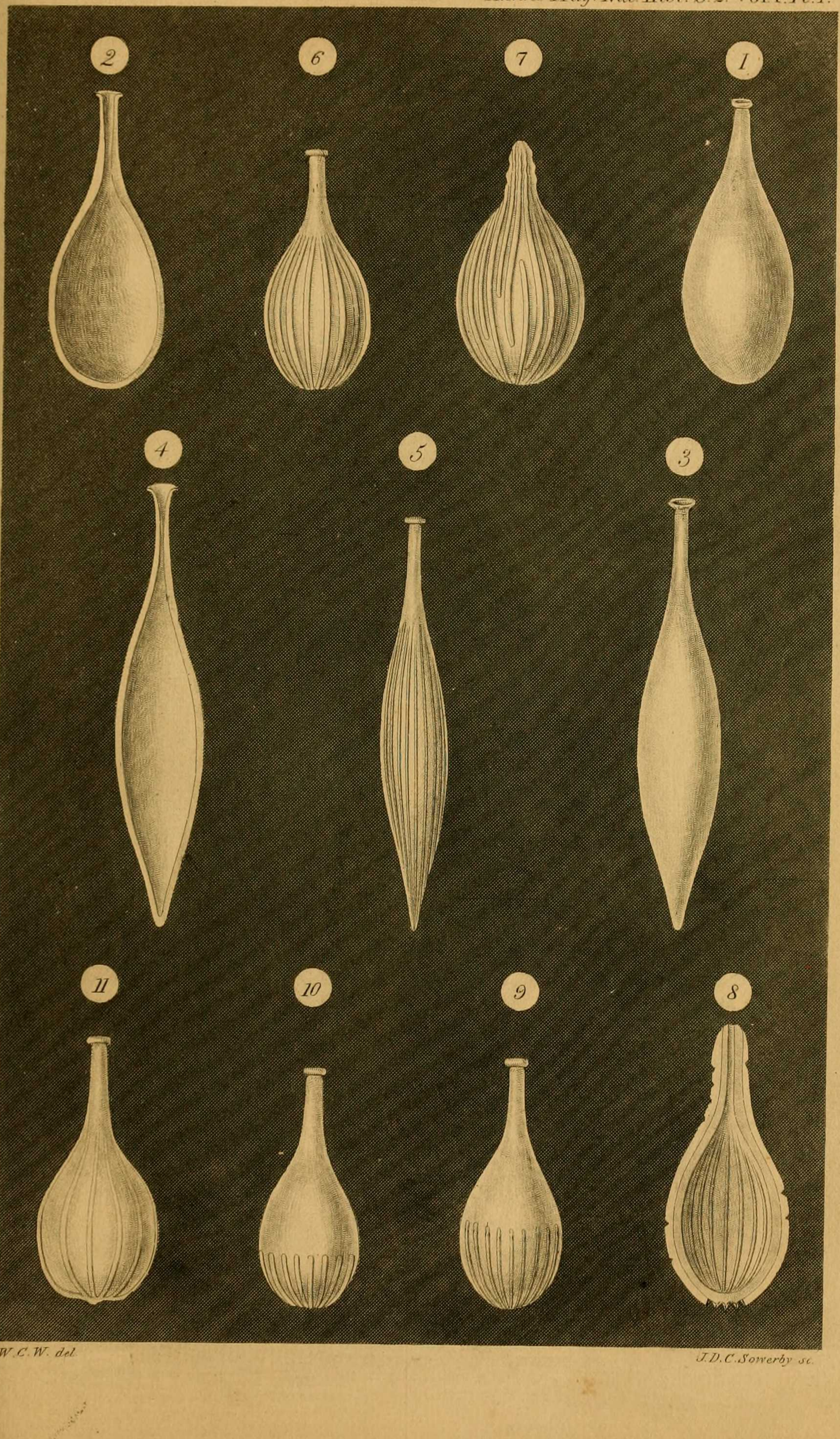
E. squamosa, var. *γ. hexagona*. Pl. II. fig. 23.

Areolæ large, hexagonal, concave, not arranged in well-marked perpendicular rows. The cell is often more conical, opake, and of a browner aspect than in the other forms, but numerous intermediate specimens link them all together, both as regards the colour, form and arrangement of the areolæ.

Long. $\frac{1}{133}$; diam. $\frac{1}{200}$.
Oban, Kyleakin, Mr. Jeffreys. Lamlash Bay, Scarborough, Mr. Bean. Boston; March: very rare.

The *Vermiculum lacteum* of Montagu is not a *Lagena*, but the *Arethusa lactea* of Fleming, a species of *Polymorphina* of D'Orbigny. *Vermiculum retortum*, Mont., is a very young state of one of D'Orbigny's family of *Agathistègues*, probably the *Vermiculum bicorne*, Mont. *Vermiculum urnæ* of Montagu, as I have already stated, I believe to be the same as my *Entosolenia lineata*. Mr. Jeffreys suspects it to have been the ovary of a coralline. The *Lagenula marginata* of Fleming belongs to D'Orbigny's genus *Biloculina*.

Manchester, June 25, 1847.



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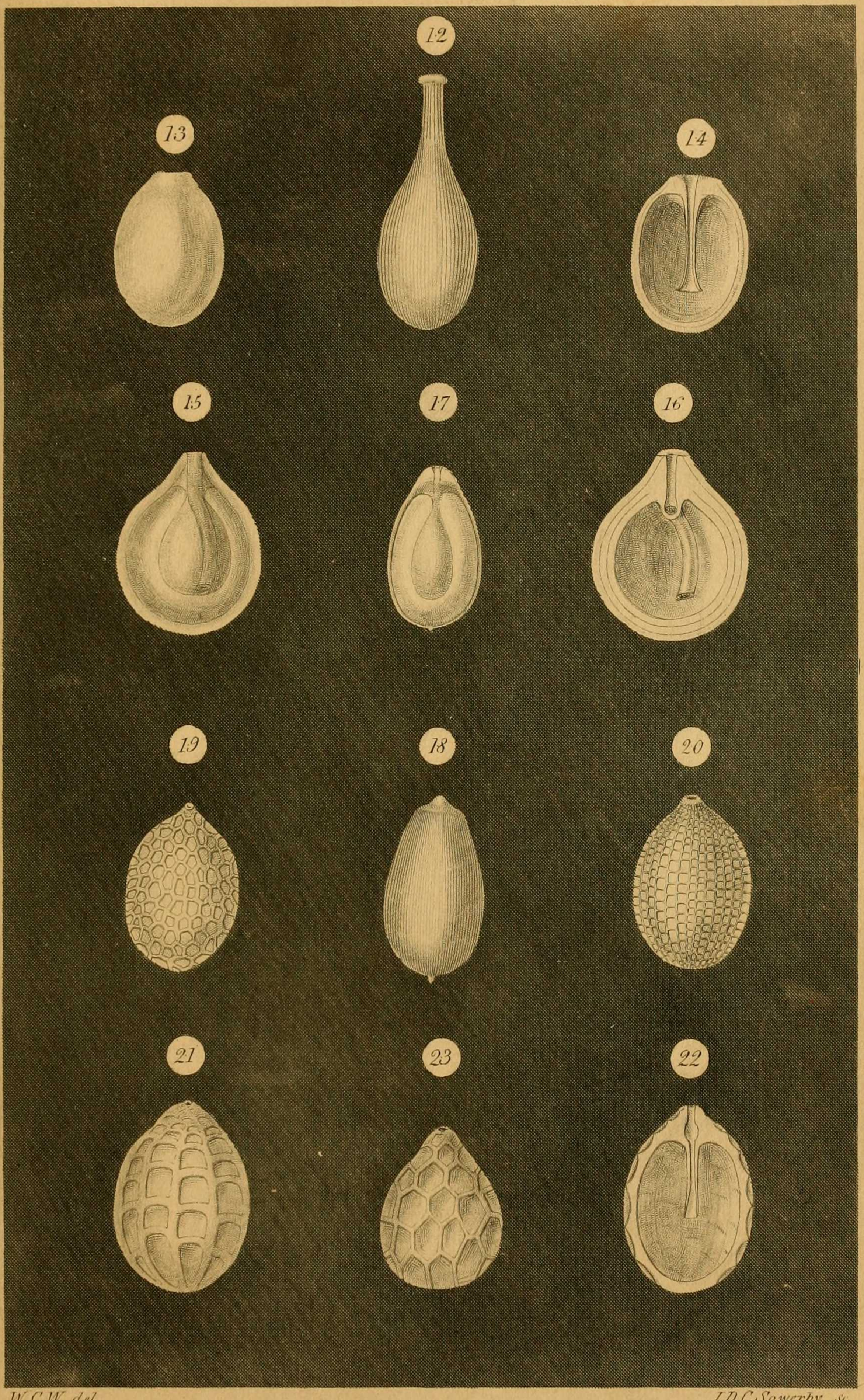

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