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## XXI.—*Description of some* Foraminifera *from the Coast of Norway.* By W. K. Parker and T. Rupert Jones, F.G.S.

[With two Plates.]

*Introduction.*—The *Rhizopoda* form an important family of the class *Protozoa*. The *Amœba* is typical of the naked Rhizopods; the *Gromia*, of those with a membranous or coriaceous coating; and those having a calcareous shell constitute the group *Foraminifera*. *Thalassicolla* and its allies * form another related group; and the siliceous *Polycystinæ* are also regarded as members of the same family.

The *Foraminifera* present symmetrical shells, of minute size for the most part, of various patterns, and consisting either of a single chamber or of two or more connected chambers. A jelly-like mass, or "sarcode," occupies the chambers and their connecting passages; and, protruding itself both from the external aperture of the last chamber, and in many cases from the sometimes numerous perforations in the shell-walls, extends itself not only over the surface of the shell, but also into radiating contractile threads or *pseudopodia*, and into gemmule-like masses, which latter become coated over with calcareous matter, and thus form additional segments of the animal†.

* See Annals, ser. 2, 1851, vol. viii. p. 433; and Quart. Journ. Microsc. Science, vol. iv. p. 72. Much information relative to the Protozoa is contained in the two memoirs here referred to.

† Among the more important works on *Foraminifera*, reference may be made to D'Orbigny's 'Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche);' Schultze 'Ueber den Organismus der Polythalamien,' 1854; Carpenter's 'Researches on the Foraminifera,' Phil. Trans. 1856 (two memoirs). In the 'Annals' for October 1853 is a short notice and some figures of a few Foraminifera from the Chalk. For numerous illustrations of well-preserved fossil Foraminifera, reference may be made to several memoirs by Reuss and others in Haidinger's Abhandl., the Vienna Transact., and the Journal of the Berlin Geological Society.

The shell itself may be hyaline and tubuliferous, or opake and homogeneous, or arenaceous, *i. e.* made up of siliceous or other particles cemented with shell-material.

Before proceeding with the description of the Foraminifera from Norway, we think it advisable to offer a few succinct remarks upon the characters of this group of shelled Rhizopods; referring the reader to Dr. Carpenter's recent memoirs for a fuller consideration of the subject.

To arrive at a clear idea of the specific relations of the Foraminifera, we must study these creatures in large numbers; such as well-arranged and extensive collections of specimens from various seas and harbours, and from numerous fossil deposits, can alone supply. (See Carpenter, *loc. cit.* § 74.)

It must be understood that, although among the lowest orders of plants and animals—such as *Confervæ* and *Diatomaceæ*, *Infusoria* and *Rhizopoda*,—the immense numbers of mere varieties, passing by indistinguishable gradations of shape one into another, have been by some authors enumerated as so many specific forms, yet there is no real ground for the establishment of *species* on these variations of character, which are for the most part merely such differences among individuals as one finds between the several leaves of a single tree.

*Foraminifera*, indeed, are to be compared with the other lowest orders of animals and of plants in the study of their specific relations. In these several low forms of creatures we have comparatively few species, but extremely numerous individuals, with an enormous range of variety. In the higher orders of plants and animals the specific forms are more definite, there being a more complex organization, harmonizing with the special habits of each creature; and the individuals of each species are less numerous than is the case in the Protozoans and Protophytes.

These low animals, the *Foraminifera*, having great simplicity of structure, more easily adapt themselves to varying external conditions than the more complex and specialized higher animals (see Carpenter, *loc. cit.* § 76). Hence the greater immunities enjoyed by these Protozoa from the various causes of extinction acting upon the individuals of the higher classes; and the long existence of several special Foraminifera through nearly all the geological epochs, appears to be in a great degree a consequence of this adaptability to circumstances, and the resulting tenacity of existence.

As these little shelled Rhizopods live under an immense variety of circumstances as to climate, depth of the sea, and its saltness, different composition of the sea-bed, varieties of bodies to which they adhere, &c., it cannot surprise us that one and the same species should exhibit a great range in variety as to

size, thickness, ornamentation, &c. Mostly cosmopolite, they present species that have individuals both in shallow and in deep seas, in brackish and in salt water, within the Arctic Circle and at the Equator; and consequently one form will be represented by thin-shelled and by thick-shelled individuals, by smooth and rough, by convex and flat, and by infinitely small and comparatively monster specimens.

Further, to enter into details, the individual parts of a Foraminifer may be seen, in different individuals specifically allied, to have very various proportions of size. The primordial chamber may be either extremely small or largely distended,—the smallest or the largest in the whole shell: the succeeding chambers may be short and globular, or elongated and narrow: the exogenous growths of shelly matter may be delicately distributed in lines and points, or coarsely agglomerated, masking a whole surface; they may be nearly absent in one, and forming a serrated or an entire wing or keel in another: the shell may be in one group hyaline or sandy; in another, it may be white and opake, or coloured and gritty: the small shells, indeed, are usually smooth, the larger ones often coarse or sandy.

Not only do the individuals of a species present frequent differences in the relative proportions of their chambers, and in the degrees of thickness of the shell-walls, according to certain recognizable conditions of habitat, &c., but there are also to be found still further departures from a determinate type,—always, however, within certain specific limits; when, for instance, a Nautiloid form takes on a rectilinear growth; or, *vice versâ*, a Stichostegian is partially curved; or when a cycloidal growth is in part replaced by a spiral; or the opposite.

We need not here do more than allude to the interesting branch of research in the relations of these lowly-classed creatures which has reference to the representative forms which they continually exhibit, both amongst themselves and with respect to higher groups of shelled animals. Not only do the varieties of one species exhibit peculiarities of form which are more especially characteristic of other and definite species, but the *Foraminifera* present remarkable mimetic resemblances to the various *Mollusca* and Molluscan groups; thus, for instance, we see the straight and variously-curled *Cephalopoda* (including the fossil forms) markedly imitated by the *Foraminifera*.

With regard to the nomenclature of this widely-diffused group, a certain licence must be allowed in the use of binomial terms for some and not a few forms, which are physiologically varieties, however protean and distant from the specific type, and have no strict title to a separate place in the list of species. Many species, however, present such numerous varieties of form, ranging

between wide limits of size, shape, and ornament, that, for the sake of convenience, these may retain for the present the names that have been proposed for them on the supposition of their specific distinctness; especially as many of the varieties are characteristic of climatal or hydrographical habitat, or of geological range.

The materials for the following descriptions were derived from the dredgings made by Messrs. MacAndrew and Barrett in the North Sea, during the summer of 1855. One portion was received from Mr. Barrett, in small boxes, numbered, and labelled with the depths and localities of the dredgings; another portion was the sandy refuse from a jar in which specimens of Molluscs, &c., had been preserved in spirits,—this we received from Mr. Woodward; and thirdly, Mr. Bowerbank favoured us with a packet of shelly sand obtained when preparing sponges taken in the same dredgings. The latter lots of sand were manipulated and examined together; and no particular depths and localities have been noted for the specimens derived from this source. The sponge-sand was obtained from several localities between Drontheim and the North Cape, at depths varying from 30 to 200 faths.

The series of which the exact localities and depths are known comprises seven lots; these, with their characters and contents, are arranged in the following Table.

| | Locality. | Depth in fathoms. | Character of Sea-bottom, &c. | Generic and Subgeneric forms. |
|---|---|---|---|---|
| 1. | East of Rolfs Oe, or Bred Sound, Finmark ..... | 30 | gravel | Polymorphina, Anomalina, Truncatulina, Biloculina, Quinqueloculina, Placopsilina. |
| 2. | Omnoes Oe, Nordland ..... ..... | 40 | gravel | Anomalina, Truncatulina, Quinqueloculina. |
| 3. | West Fjord, Nordland ..... | 60 | sand | Dentalina, Rosalina, Truncatulina, Quinqueloculina. |
| 4. | Bodoe, Nordland . | 70–100 | sand | Anomalina, Truncatulina, Biloculina, Quinqueloculina. |
| 5. | Vigten Island (Inner Passage), Drontheim ..... | 100 | on sponge | Rosalina. |
| 6. | Finmark ..... | 150 | sand | Truncatulina, Quinqueloculina. |
| 7. | Arctic Circle, Nordland ..... | 160 | mud | Nodosaria, Dentalina, Cristellaria, Anomalina, Truncatulina, Biloculina. |
| 8. | Various localities between Drontheim and the North Cape ... | 30–200 | various | Lagena, Entosalenia, Dentalina, Polymorphina, Spirillina, Operculina, Nonionina (5 species), Polystomella, Globigerina, Rosalina, Anomalina, Truncatulina, Cassidulina, Valvulina, Bulimina, Uvigerina, Textularia, Quinqueloculina, Placopsilina. |

The species described or noticed in the sequel may be tabulated with their genera and subgenera as follow.

| | *Foraminifera from the Coast of Norway.* | 1. 30 faths. | 2. 40 faths. | 3. 60 faths. | 4. 70–100 faths. | 5. 100 faths. | 6. 150 faths. | 7. 160 faths. | 8. 30–200 faths. |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Lagena lævis, *Montagu* | ... | ... | ... | ... | ... | ... | ... | * |
| 2. | Entosalenia globosa, *Montagu* | ... | ... | ... | ... | ... | ... | ... | * |
| 3. | Nodosaria lævigata, *D'Orb.* | ... | ... | ... | ... | ... | ... | * | ... |
| 4. | Dentalina communis, *D'Orb.* | ... | ... | * | ... | ... | ... | * | * |
| 5. | Polymorphina communis, *D'Orb.* | * | ... | ... | ... | ... | ... | ... | * |
| 6. | Spirillina vivipara, *Ehrenb.* | ... | ... | ... | ... | ... | ... | ... | * |
| 7. | Operculina complanata, *Basterot* | ... | ... | ... | ... | ... | ... | ... | * |
| 8. | Nonionina crassula, *Montagu* | ... | ... | ... | ... | ... | ... | ... | * |
| 9. | —— communis, *D'Orb.* | ... | ... | ... | ... | ... | ... | ... | * |
| 10. | —— bulloides, *D'Orb.* | ... | ... | ... | ... | ... | ... | ... | * |
| 11. | —— asterisans, *Ficht.* | ... | ... | ... | ... | ... | ... | ... | * |
| 12. | —— striatopunctata, *Ficht.* | ... | ... | ... | ... | ... | ... | ... | * |
| 13. | Polystomella crispa, *Linn.* | ... | ... | ... | ... | ... | ... | ... | * |
| 14. | Cristellaria Calcar, *Linn.* | ... | ... | ... | ... | ... | ... | * | ... |
| 15. | Globigerina bulloides, *D'Orb.* | ... | ... | ... | ... | ... | ... | ... | * |
| 16. | Rosalina vesicularis, *Lamarck* | ... | ... | * | ... | * | ... | ... | * |
| 17. | Truncatulina lobatula, *D'Orb.* | * | * | * | * | ... | * | * | * |
| 18. | Anomalina coronata, *nov.* | * | * | ... | * | ... | ... | * | * |
| 19. | Cassidulina lævigata, *D'Orb.* | ... | ... | ... | ... | ... | ... | ... | * |
| 20. | Valvulina triangularis, *D'Orb.* | ... | ... | ... | ... | ... | ... | ... | * |
| 21. | Bulimina marginata, *D'Orb.* | ... | ... | ... | ... | ... | ... | ... | * |
| 22. | Uvigerina pygmæa, *D'Orb.* | ... | ... | ... | ... | ... | ... | ... | * |
| 23. | Textularia Sagittula, *Defrance* | ... | ... | ... | ... | ... | ... | ... | * |
| 24. | Biloculina ringens, *Lamarck* | * | ... | ... | * | ... | ... | * | ... |
| 25. | Quinqueloculina Seminulum, *Linn.* | * | * | * | * | ... | * | ... | * |
| 26. | Placopsilina Canariensis, *D'Orb.* | * | ... | ... | ... | ... | ... | ... | * |

The foregoing general observations on the characters and relations of the *Foraminifera* will be illustrated in several points by details of structure and habit in the following descriptions. We shall not, however, offer a general *résumé* of the relations of the genera and species here described, much less can we attempt to draw up a classification of the *Foraminifera*. Dr. Carpenter truly observes that the subject is still far too incompletely worked out for even the exact determination of the *species* and *genera*.

The following descriptions are offered as supplying materials towards a future classification; they are drawn up sometimes without reference to any already-established generic types, especially in cases where the relations of a species or genus seem to have been more or less misunderstood, or in want of clearer elucidation. To give some tangible form, however, to our observations

on the Norwegian specimens, we append an avowedly imperfect, but perhaps useful, list of genera and subgenera, showing approximately the more evident of the relations which the Foraminifera commonly met with present towards each other.

| *Hyaline (and sometimes arenaceous).* | | | | *Homogeneous (and sometimes arenaceous).* | |
|---|---|---|---|---|---|
| Lagena<br>..... | Entosalenia<br>..... | .....<br>Spirillina | Orbulina<br>..... | .....<br>Cornuspira | *Monothalamous.* |
| Nodosaria<br>Lingulina<br>Frondicularia<br>Dentalina<br>Vaginulina | Polymorphina | Rotalia<br>Amphistegina<br>Heterostegina<br>Nummulina<br>Operculina<br>Nonionina<br>Polystomella<br>Cristellaria<br>Flabellina | Globigerina<br>Rosalina<br>Anomalina<br>Truncatulina<br>Cassidulina<br>Valvulina &<br>Clavulina<br>Bulimina<br>Uvigerina<br>Verneuilina<br>Textularia &<br>Bigenerina | Hauerina<br>Vertebralina<br>Sphæroidina &<br>Dimorphina<br>Miliola (Biloculina,<br>Triloculina,<br>Quinqueloculina, &c.)<br>Fabularia<br>Amorphina,<br>(Parker, MS.)<br>Alveolina<br>Orbitolites and<br>Polytripa<br>Orbiculina<br>Peneroplis<br>Placopsilina | *Polythalamous.* |

[*Note.*—The genera and subgenera printed in small type are inserted as important members of the series, but do not occur among the specimens from the Norway coast.]

We have to express our acknowledgements for Prof. Williamson's kindness in giving us his opinion on the relations of the more important of the Norwegian specimens. Our thanks also are due to Prof. Tennant for having lent us his set of D'Orbigny's valuable models, without the free use of which we could not have satisfactorily determined the alliances of several species from the dredgings.

1. *Lagena lævis*, Walker and Montagu. Pl. XI. figs. 22 & 23.
   Var. *striata**. Pl. XI. fig. 24.
2. *Entosalenia globosa*, Montagu, sp. Pl. XI. figs. 25–29.
   Var. *marginata*. Pl. XI. figs. 28 & 29.
   Var. *striata*. Pl. XI. fig. 27.
   Var. *catenulata*†. Pl. XI. fig. 26.
   Var. *squamosa*. Pl. XI. fig. 25.

[See Mr. Williamson's Monograph on the "Recent British Species of the genus *Lagena*," Annals of Nat. Hist. ser. 2. vol. i. pp. 1–20, pl. 1 & 2.]

Figs. 22 to 29 represent a series of forms of minute mono-

* The striated varieties of the flask-shaped *Lagenæ* supply five species in D'Orbigny's Voyage Amér. Mérid. vol. v. part 5. pl. 5. f. 4–12.

† *Oolina Melo*, D'Orb. *ib.* f. 9.

thalamous Foraminifera selected from the Norway dredgings, and here figured, for the purpose of showing the wide variations of shape and size presented by these shells, and every gradation between which is met with among specimens from this and other sources, including recent and tertiary deposits.

Fig. 22 presents the long-necked, flask-like, typical form of *Lagena**; and figs. 23 & 24 are two of its varieties: in fig. 23, the convexity is less than in fig. 22, the base is elongate, and the neck is rimmed: in fig. 24, the body of the "flask" is still more cylindrical, the neck is shorter, the surface has several parallel ribs, and the base is perforate. This extreme variety of form (fig. 24) is related, by endless intermediate variations (including fig. 23), with the gibbous form, fig. 22. Fig. 27 is a ribbed *Entosalenia*, and is vastly more gibbous than fig. 24, being almost globular; it is numerously and deeply ribbed, and is thickened around the aperture with a frill of four equal obtuse angles. Fig. 26 differs from the last in having its less numerous ribs united by small transverse ridges, and in having its neck less thickened and shorter. In fig. 25 the superficial ornament is formed of hexagonal meshes, as if the transverse and longitudinal ridges had been equalized and combined into a reticulation. These three forms (figs. 25 to 27) are also in every respect linked together by numerous recent and fossil varieties, and gradually pass, by insensible gradations of external character, into the elongate varieties of *Lagena*, such as figs. 22–24.

Figs. 28 and 29 represent the common, somewhat flattened, margined, round and oval varieties of *Entosalenia*†, which, by losing their keels, becoming globose‡, and being provided with an external instead of an internal tube, closely represent the flask-shaped *Lagena* represented by fig. 22. They are very subject to ornamentation of riblets and reticulation (figs. 25–27), and, excepting by means of the characteristic usual internal tube, are scarcely divisible from *Lagenæ*. Still, however, there is a peculiarity in the setting-on, as it were, of the tubular neck in the externally-tubed individuals referred to, which appears to permanently distinguish *Entosalenia* from *Lagena*. From the very minutely-marked gradation of differences between individuals, even in the same sample of sea-sand (recent or fossil), it is extremely difficult to speak of anything like specific characters among the endless varieties of *Lagenæ* and *Entosaleniæ* presented to the observer.

Marine sands from Shetland, Skye, Pegwell Bay, Eastbourne, Australia, Bombay Harbour, &c., also the post-tertiary clay be-

* *Oolina clavata*, D'Orb. For. Foss. Vien. pl. 1. f. 2, 3.
† *O. compressa*, D'Orb. Voy. Amér. Mérid. vol. v. part 5, pl. 5. f. 1, 2.
‡ *O. globosa*, D'Orb. *ib.* f. 3.

neath the Lincolnshire fens, and the Grignon tertiary beds, have been the chief sources for these observations.

The figured specimens illustrate the chief varieties of these shells, which are tolerably numerous in the Norway dredgings.

In registering the Norwegian forms of these two interesting and variable species, we have taken the trivial term *lævis*, which indicates the first in the series of *Lagenæ* described by Mr. Williamson, as the most convenient appellation for the typical form; and *globosa* as the best and earliest for *Entosalenia*. The varieties are almost as numerous as the individuals; non-essential characters only occurring as guides for us in the classification of the innumerable forms.

We must refer the reader to Williamson's admirable and careful exposition of the nature and characters of *Lagena* and *Entosalenia*; merely observing that, for reasons above alluded to, we regard the forms here figured as referable to a single species either of the one or of the other genus*.

### 3. *Nodosaria lævigata*†, D'Orb. Pl. X. figs. 6–9.

Soldani, Testac. et Zoophyt. pl. 101. f. *kk*; pl. 105. f. Q. R; pl. 118. fig. E. (smooth); pl. 96. f. N. O. P. Q. R. S. (striated).

*Nodosaria* (subgen. *Glandulina*) *lævigata*, D'Orb. Ann. des Sc. Nat. vol. vii. p. 252. no. 1. pl. 10. f. 1–3.

*Nodosaria* (*Gland.*) *glans*, D'Orb. *ib.* no. 2; Modèles, no. 51. 3 livr. [finely ribbed variety of *N. lævigata*].

*Glandulina lævigata*, D'Orb. Foram. Vien. p. 29. pl. 1. f. 4, 5; *G. ovula*, ib. f. 6, 7; *G. angulata*, ib. f. 8, 9.

*Nodosaria humilis*, Roemer, Verst. Nordd. Kreid. p. 95. pl. 15. f. 6.

*Nodosaria cylindracea*, *N. conferta*, *N. oligostegia*, Reuss, Verst. Böhm. Kreid. i. p. 25–29. pl. 13. f. 1, 2, 10, 19, 20.

*Glandulina rotundata*‡, *G. tenuis*, *G. major*, *G. laguncula*, and *Orthocerina pupoides*, Bornemann, Liasform. Göttingen, p. 31. pl. 2. f. 1–5, p. 35. pl. 3. f. 14, 15.

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* As Mr. Williamson truly remarks, Walker was the first to give the name "Lagena" to these flask-like Foraminifera.

† In this instance we have taken some trouble to collate the figures and descriptions of numerous varieties of this shell from those works which are at present accessible to us. This is done to indicate the wide extent of variation in this species; and it also shows its great range both in time and space. Many of the named varieties in this list are doubtlessly characteristic of the individuals, and useful to geologists; but we decline the task of pointing out which should be preserved. Nor do we propose to supply similar lists of synonyms for the other species which will here come under notice.

‡ The varieties of *Nodosaria* figured by Bornemann (*op. cit.*) from the Lias of Göttingen, present an instructive series of gradations of form in one species. The smooth forms (above enumerated) have from three or four to six chambers, and vary considerably, both in general size and in the relative proportions of their chambers. Several ribbed forms are also figured

*Dentalina brevis*, D'Orb. Foram. Foss. Bass. Vienne, p. 48. pl. 2. f. 9, 10.
*Glandulina cylindrica*, *G. ovalis*, and *G. subconica*, Alth, Haidinger's Abhandl. iii. p. 270. pl. 13. f. 30, 31, 32.
*Glandulina pygmæa*, *G. manifesta*, *G. cylindracea*, *Nodosaria proboscidea*, *Dentalina marginuloides*, Reuss, Haid. Abh. iv. p. 22. pl. 2. f. 3–6, 12.
*Glandulina discreta*, Reuss, Denksch. k. Akad. Wiss. Wien, i. p. 366. pl. 46. f. 3.
*Glandulina concinna*, Reuss, Zeitschrift Deutsch. Geol. Gesell. vii. p. 263. pl. 8. f. 1.
*Glandulina inflata*, *G. lævigata*, *G. elongata*, Bornemann, *ib.* p. 320. pl. 12. f. 6–9.

Shell smooth and hyaline; varying from acutely pyriform and spindle-shaped to subcylindrical and pupa-like; usually circular in cross-section, but sometimes slightly oval; formed of about six chambers in a single row, closely fitting and somewhat overlapping each other; chambers usually rapidly increasing in size after the early ones (fig. 6), but sometimes the later chambers retain a nearly uniform width (fig. 9), in which case the sutures are more or less constricted. A slight variation from a straight line in the long axis of the shell is occasionally observable (fig. 9, *Dentalina brevis*, D'Orb.). Aperture small, central, either round or slightly oval and transverse (fig. 7), somewhat projecting, and surrounded by about thirty radiating fissures, more or less distinct.

About thirteen specimens, exhibiting several variations of form, were dredged from a muddy bottom at 160 fathoms, within the Arctic Circle (Finmark).

This *Nodosaria* has been found in the tertiaries of Italy and Austria; it abounds in the London Clay, presenting several of the intermediate forms connecting figs. 6 and 9. It is common also in the Lower Chalk of Kent and Germany; and is one of the most common Foraminifera in the Kimmeridge Clay near Aylesbury, and in the Lias of Göttingen* and of Ilminster†.

*Nod. lævigata* lives in the Adriatic. We have not yet found this species recent elsewhere than in these Norway dredgings, where it is larger than the fossil specimens above referred to.

The compressed pupa-like variety of this "Nodosaria," passing into "Lingulina," may be compared with the *Lingulinæ* of

by Bornemann (*loc. cit.*), which are evidently of the same specific type as the smooth, and present a steady gradation in the setting-on of the riblets, 5, 6, 7, 8, 9, 11, in individual *Nodosariæ* which have nothing essentially characteristic in shape, size, or structure, to enhance the trivial value of this ornamentation. In Bornemann's figs. 19 & 21 (pl. 3, *loc. cit.*) there are smooth Linguline forms, nearly related, on the one hand, to the above-mentioned *Nodosaria*, and on the other, to the smooth and the ribbed *Frondiculariæ* figured on the same plate. See also the ribbed Linguline form of *N. lævigata* (*L. costata*, D'Orb.), pl. 3. f. 1–5, Foss. Foram. Vien.

* Bornemann, *op. cit.*

† Mr. C. Moore's Collection.

the Chalk, the tertiary *Lingulinæ* of San Domingo, and the recent ones of the Canaries†.

4. *Nodosaria* (*Dentalina*) *communis*, D'Orb. Pl. X. figs. 3, 4, 5.

*Nodosaria* (subgen. *Dentalina*) *communis*, D'Orb. (Ann. des Sc. Nat. vii. p. 254. no. 35.)

Shell hyaline, elongate, tapering, somewhat bent, circular in section, composed of several chambers; sutures more or less constricted; aperture produced, small, round, central or excentric.

Fig. 3 was dredged at 160 fathoms on the Finmark coast; figs. 4 and 5 represent an individual from 60 fathoms at West Fiord, Nordland.

This form is of frequent occurrence in the Chalk and the Tertiary deposits; and is found also, but usually of a small size, in the recent sea-sands.

The infinite varieties presented by these delicate, tapering, arcuate *Nodosariæ* (or *Dentalinæ*, as they are usually termed) have, as far as authors have been able to figure them, received name upon name; and it will require much research to arrange the varieties under normal specific types.

4*. *Nodosariæ*. Pl. XI. figs. 1, 2.

*Nodosaria* (*Dentalina*) *communis*, var. fig. 1.
*Nodosaria* (*Vaginulina*?) ? fig. 2.

These are fragments (figured upside down) of two stichostegian shells, with oblique, closely-set chambers.

Fig. 1 has its chambers somewhat separated by sunken sutures, and its section transversely is nearly round. It belongs to the same type as *D. communis*.

The other (fig. 2) is not constricted at the junctions of the chambers; it is elliptical in cross-section, and is ornamented with slight, irregular, longitudinal riblets. [The apparent aperture in fig. 2 arises from the first chamber having been broken open.] One other fragmentary specimen occurred, consisting of the base or first few chambers, similar in character to fig. 2, but having a large primordial chamber and a faintly helical arrangement of the two next chambers, before the axis of the shell takes the straight direction; thus approaching the so-called "Vaginulinæ" and "Marginulinæ" in the mode of growth of the early segments, in the nearly uniform size of the chambers, and their elliptical transverse sectional area.

These nearly straight, obliquely-chambered *Nodosariæ* have numerous representatives, both in the recent and the fossil state.

† Hist. Nat des îles Canaries, Foram. p. 124. pl. 1. f. 5, 6.

5. *Polymorphina communis*, D'Orb.
Pl. X. figs. 25, 26, 27; Pl. XI. figs. 30–34.

*Polymorphina* (*Guttulina*) *communis*, D'Orb. Ann. Sc. Nat. vii. p. 266. no. 15. pl. 12. figs. 1–4; Modèles*, no. 62.

Figs. 30 and 31 (Pl. XI.) exhibit an early condition of *Polymorphina*, in which we see an *Entosalenia*, slightly modified, playing the part of the primordial chamber of this form. This Entosalenian condition of *Polymorphina* is nearly always apparent in specimens sufficiently small or unadvanced to leave the early chambers translucent and open to examination. The exceptions to this are chiefly individuals in which the aperture is lengthened outwards and produced into an irregular, ramified, or stag-horn system of tubes; and here, as in those *Entosaleniæ* in which the aperture is externally tubular, the inner tube becomes obsolete. As they advance in growth, the individual *Polymorphinæ* are invested with additional chambers after a type peculiar to themselves, but in a very irregular manner as regards the capacity and shape of the chambers. The typical arrangement of the chambers is best shown in fig. 25. Pl. X. (*P. ovata*, D'Orb. Vien. Foram. pl. 13. fig. 1), in which they are seen to be set-on angularly and alternately (not quite equally on the two flatter surfaces of the shell), pointing backwards and outwards at an acute angle with the axis of the shell, the later chambers considerably overlapping the earlier ones: in this case they compose a compressed ovate shell; but other and innumerable varieties in the form and relative size of the chambers result, on the one hand, in the production of short, globular forms, like fig. 32. Pl. XI. (*Polymorphina gibba*, D'Orb.), and, on the other, of narrow, elongate shells, like fig. 33 (*Vermiculum lacteum*, Montagu; *Arethusa lactea*, Fleming; *P. compressa*, D'Orb.). The intermediate forms so gradually pass one into the other, scarcely two individuals being identically alike, that it is impossible to regard the extreme forms here indicated (as well as many others, both smooth and ornamented, figured by authors under the names of *Polymorphina*, *Guttulina*, and *Globulina*) as really belonging to more than one specific type.

The "stag-horn" condition of the aperture (or, rather, the permanent calcareous tubing of the chief pseudopodia) occurs very frequently†; it has supplied some authors with materials

* By comparing the models, nos. 23, 29, 30, 61, 62, and 63, a good idea may be formed of the variations in the development of the chambers in this species. See also plates 12, 13, and 14 of D'Orbigny's Foram. Foss. Vienne.

† Soldani, Testac. et Zoophyt. pl. 109, 110, 111.

for new names, and is sometimes even distinguished as a generic character*.

Fig. 34. Pl. XI. represents a loose specimen of the cervicorn tube. Fig. 25. Pl. X. shows the *Polymorphina* from which this branched calcareous appendage was broken. It is to be remarked that the terminal and some of the preceding chambers opened laterally into the overlapping base of the tube by more than one aperture, whilst the chief aperture has become plugged up (excepting perhaps its radiating slits) with calcareous matter, as is not uncommonly the case with adult specimens of other species. (See also fig. 5. Pl. X.)

*Polymorphina* is for the most part smooth externally, but not unfrequently scabrous or roughish, tuberculate or aciculate, and occasionally bears fine, parallel, shortish riblets (Australia). The superficial aciculæ or points appear sometimes to be minute exserted tubules. None of these exogenous characters can be regarded as of specific value, and they may or may not be present on any variety of form.

This shell occasionally loses its usual translucency or hyaline character, and becomes more or less opake; but we have never recognized it in a sandy condition†. The common forms vary extremely in size.

We have found *Polymorphina* represented by its chief varieties in the Chalk-marl, and more rarely in the Chalk. It is extremely plentiful in very many of the Tertiary deposits (Grignon, Tours, Bordeaux, Palermo, &c.), also in the post-tertiary clays of Lincolnshire, and in the recent sea-sand from every coast.

The Norway specimens are undistinguishable from numerous individuals from the European and other coasts, and even from Southern Australia.

### 6. *Spirillina vivipara*, Ehrenberg. Pl. XI. fig. 46.

*Spirillina vivipara*, Ehrenb. Berlin Trans. 1841, pl. 3. f. 41; *ib.* 1847, pl. 2. f. 82?

*Cornuspira perforata*, Schultze, Organ. Polyth. p. 41. pl. 2. f. 22.

Shell flat, spiral, like a minute *Planorbis*; not presenting any internal subdivisions, but being monothalamous. The little, elegant, discoidal shell here figured is hyaline, and perforated with rather large pseudopodian passages‡.

There are at least two other discospiral monothalamous Fora-

* Hence "Aulostomella" of Alth, Haid. Abhandl. iii. p. 263. pl. 13. fig. 17.

† Schultze's so-called *Polymorphina silicea* (Ueber den Organ. Polyth. pl. 6. fig. 10) appears not to belong to the *Polymorphinæ*.

‡ See Williamson "on some Mud from the Levant," &c., Mem. Manch. Phil. Soc. viii. p. 45. pl. 2. f. 34.

minifera met with in recent sea-sands. One of these, though composed of a clear substance, has no apparent surface-foramina, but only ornamental depressions*; the other is opake in its homogeneous, non-arenaceous substance, and is probably related to the *Miliolæ*. Schultze has figured both the perforated hyaline form† (*Spirillina*, Ehrenb.) and the opake shell‡. He places both in his new genus *Cornuspira*, which can only refer to the latter §.

There are other more or less nearly allied forms, though probably distinct, both discoidal and irregular in the arrangement of their whorls; and some also not truly monothalamous, but beginning at least with one, two, or more well-defined chambers.

The *Spirillinæ*, *Cornuspiræ*, and their allies are excessively common in the present seas and in a fossil state, and are usually minute. They are frequent in the Tertiaries (for instance, Grignon, Tours, Bordeaux, London Clay); also in the Chalk, Lias, and Magnesian Limestone||.

7. *Operculina complanata*, Basterot, sp. Pl. XI. figs. 3, 4.

*Lenticulites complanata*, Basterot, Mém. Géol. Bass. Bordeaux, p. 18.
*Operculina complanata*, D'Orb. Ann. des Sci. Nat. vii. p. 281. no. 1. pl. 14. f. 7–10.
*Planulina Ariminensis*, D'Orb. *ib.* p. 280. pl. 14. f. 1–3, and Modèles, no. 49.

The shell here figured is discoidal, flattened, and somewhat square at the edges; spire exposed; chambers about nineteen, in three whorls, slightly overlapping, subquadrate in side-view; septa and edges thickened and elevated; the outer margins of the chambers melting into the marginal border of the shell; the inner margins irregularly thickened, and giving rise to coarse granulations. Shell smooth, shining, hyaline, finely perforate; surface sometimes granulated about the central portion of each surface, and along the edges of the septa and borders of the chambers.

This is an exact miniature of some of the younger specimens of the large *Operculinæ* which we have from New Zealand¶ and from the Philippines**. It also closely resembles the fossil *Operculinæ* of the Tertiary deposits, being sometimes granulated

* Also fossil at Bordeaux.

† Schultze, Organ. Polyth. pl. 2. f. 22. ‡ Schultze, *op. cit.* pl. 2. f. 21.

§ Some fossil forms of these planodiscoid Foraminifera have been described and figured as *Operculinæ* by Reuss and Czjzek in Haidinger's Abhandlungen and elsewhere (such as *O. cretacea*, *O. angigyra*, *O. involvens*, *O. punctata*, *O. striata*, *O. plicata*).

|| See Mr. T. R. Jones's observations on *Spirillina* in King's "Monograph of the Permian Fossils," Palæont. Soc. 1850, p. 18, and in Journ. Geol. Soc. Dublin, vol. vii. part 2. p. 73.

¶ Through the kindness of Mr. Woodward.

** Communicated by Dr. Carpenter.

like *O. granulosa*, sometimes strongly ribbed like *O. canalifera*, and sometimes approaching the smoothness of *O. ammonea* and *O. complanata**; there being indeed apparently no essential specific difference between our minute specimens, the broad recent forms of the Philippines, &c., and the large fossil varieties above mentioned from France, Italy, Varna, and India.

The little *Operculina* under notice occurs abundantly in some localities of the North British coasts (Shetland, Skye, &c.). It is one of the most common forms in the Norway dredgings.

*Planulina Ariminensis*, D'Orb., is evidently referable to this species, the model No. 49 exactly representing our specimens. Some slight differences, however, may be recognized between D'Orbigny's figures and both his model and our shells, especially in the aperture, which is rather excentric in his figure.

8. *Nonionina crassula*, Montagu, sp. Pl. XI. figs. 5, 6.

*Nautilus*, Walker†, Test. Min. pl. 3. f. 69 & 70.
*Nautilus umbilicatulus* and *N. crassulus*, Montagu, Test. Brit. vol. i. p. 190; iii. p. 78. pl. 18. f. 1, 2, and perhaps *N. depressulus*, ib. f. 9.
*Nautilus incrassatus*, Ficht. & Moll, p. 38. pl. 4. fig. *a*, *b*, *c*.
*Nonionina incrassata*, D'Orb. Ann. des Sc. Nat. vii. p. 293. no. 6.
*Nonionina crassula*, D'Orb. *ib.* p. 294. no. 7.

Shell hyaline, discoidal, nautiloid, somewhat depressed, edge rounded; chambers from about eight to sixteen in the outer whorl, triangular in side-view and faintly curved, more or less overlapping the upper and lower surfaces of the former whorls; septa somewhat excavated, especially between the later chambers; umbilicus deep, but sometimes filled up. Aperture varying from

* The beautiful Foraminifer from Malta figured and noticed in the Annals Nat. Hist. 2 ser. vol. xv. p. 275. pl. 7. f. 4, as "Lenticulites complanatus," is the *Heterostegina depressa*, D'Orb.

† Mr. Walker's figures, like many of the old illustrations of the Foraminifera, are of little aid in the recognition of specific forms. Still, as monuments of the labours of earlier naturalists, they necessarily command respect; and, whenever possible, they are regarded as points of reference for known species. Col. Montagu refigured the Sandwich specimens, and added others (chiefly from drawings supplied by Mr. Boys). Walker's figures and descriptions would certainly be of very little value to us without Montagu's subsequent remarks and illustrations. But even in these later and far superior engravings, much is wanting in the definition of important characters in these minute shells. Mr. Walker should not be quoted as the authority for the specific appellations chosen by Montagu for the Sandwich and other Foraminifera, certainly first figured and diagnosed by Walker, but left unnamed by him in accordance with his avowed intention of not giving his new specimens trivial (Linnæan) names.

We take this opportunity of stating that some of the Foraminifera collected by Boys and Walker at Sandwich, Sheppey, &c., and figured by Walker and Montagu, are undoubtedly fossil specimens washed from the cliffs: particularly figs. 66 & 73, Walker; and pl. 14. figs. 4, 5, & pl. 19. figs. 1, 2, 3, 5, Montagu.

a small arch-shaped notch to a transverse slit across the base of the chamber, where it touches the former whorl.

Common in the Norway dredgings; also at Skye and Shetland, and elsewhere on the British coasts.

*Nonionina Soldanii*, D'Orb., and several other varieties closely resemble the above; indeed it is merely the presence of non-essential characters, such as the filling-up of the umbilicus, and the varying proportions of size and shape, that divide many of the *Nonioninæ* of authors.

9. *Nonionina communis*, D'Orb. Pl. XI. figs. 7 & 8.

*Nonionina communis*, D'Orb. Ann. des Sc. Nat. vii. p. 294. no. 20; For. Foss. Bass. Vienn. p. 106. pl. 5. f. 7, 8.

Shell hyaline, subovate, nautiloid, spire much hidden by the overlapping of the outer whorl; chambers long-triangular on side-view, rapidly increasing in size, but preserving the same relative shape. Aperture a transverse semilunar slit at the base of the chamber.

This *Nonionina* is not unfrequent at Norway; and is common in the recent seas both of warm and of temperate climates, and also in very many of the Tertiary deposits, especially at Grignon, Bordeaux, Palermo, and Turin.

10. *Nonionina bulloides*, D'Orb. Pl. XI. figs. 9 & 10.

*Nonionina bulloides*, D'Orb. Ann. des Sc. Nat. vii. p. 293. no. 2; For. Foss. Bass. Vienn. p. 107. pl. 5. f. 9, 10.

Shell hyaline, subglobular; chambers much overlapping, so that only five or six are apparent externally. Aperture a semicircular slit, variable in length, across the base of the chamber.

Occurs in the Upper Tertiaries of Palermo, Italy, and Austria: it is rare in the Norway dredgings.

11. *Nonionina asterisans*, Ficht. & Moll, sp. Pl. XI. figs. 20, 21.

*Nautilus asterisans*, F. & M. Test. Microsc. p. 37. pl. 3. figs. *e, f, g.*
*Florillus stellatus*, Montfort, Conch. p. 134.
*Placentula asterisans*, Lam. & Blainv.
*Pulvinulus asterisans*, Lam. Enc. Méth. pl. 466. f. 10.
*Nonionina asterisans*, D'Orb. Ann. des Sc. Nat. vii. p. 294. no. 22.

Shell thinner than that of *N. crassula*, but of denser and more hyaline tissue; discoidal, rounded at the edge; chambers more or less triangular on side-view, rather gibbous, overlapping the older whorl. The aperture is a very narrow curved slit at the base of the chamber. Umbilicus of each surface occupied by a star-shape growth of shelly matter, partially filling up or overlapping the triangular interstices between the umbilical extremities of the chambers. This radiating mass originates in the

growth of calcareous matter from the free edges of the umbilical portion of each chamber, which do not here quite touch each other at their contact with the older whorls; therein differing from the habit of other *Nonioninæ*. Occasionally this overgrowth extends further up between the chambers (*N. stellifera* and *N. limba*, D'Orb.), especially in the larger individuals, nearly filling the sunken sutures throughout; and the central mass is often roughened and granular.

In some specimens obtained at Pegwell Bay and Eastbourne, this exogenous growth is traceable from a simple fringe on the free edges above mentioned, to an overlapping, penthouse-like, narrow plate, similar to what is seen on one surface in some asterigerine *Rosalinæ*.

This form is not common in the Norway dredgings. It approaches *N. crassula* in its general shape, but the umbilical slits between the chambers and the accompanying astral overgrowth give it characteristic peculiarities. These *Nonioninæ*, having their chambers thus partially disconnected, form a link with others, having minute pittings along the septa, towards constituting passage-forms into *Polystomella**.

The asterigerine *Nonioninæ* occur in the Mediterranean and the Atlantic (Canaries), and are fossil at Grignon, Bordeaux, and elsewhere.

### 12. *Nonionina striato-punctata*, Ficht. & Moll, sp.

*Nautilus striatopunctatus*, F. & M. Test. Microsc. p. 61. pl. 9. fig. *a–c*.
*Nonionina striatopunctata*, D'Orb. Ann. des Sc. Nat. vii. p. 294. no. 21.

This interesting form with a pitted condition of the septa (referred to above) occurs in the Red Sea (Fichtel and Moll), and is common in the West Indies. We have found it also in the Norway dredgings, but it was inadvertently omitted in the drawings.

### 13. *Polystomella crispa*, Linn. sp. Pl. XI. fig. 19.

*Nautilus crispus*, Linn. Syst. Nat. 12 ed. p. 1162.
*Polystomella crispa*, D'Orb. Ann. des Sc. Nat. vii. p. 283. no. 1; Williamson, Trans. Microsc. Soc. vol. ii. p. 159. pl. 28; Schultze, Organ. Polyth. p. 62. pl. 4, &c.

This well-known shell is not common in the Norway dredgings. It is here represented by a small obtusely-edged and somewhat gibbous form, which has not, however, much thickening at the umbilicus of either surface.

The *P. crispa* is a very protean Rhizopod, yielding numerous varieties named by authors. Sometimes it is thick, and bears

* *Polystomella* is also frequently Nonionine in the character of its aperture.

large convex umbilici; and sometimes thin, and either margined with a sharp jagged edge and prickles, or unkeeled and rounded at the edge. The fenestration of the surface appears to be a better specific guide than the shape, size, or spinosity of the shell, or even than its comparative solidity or tenuity. The habitat of individuals, according to depth of water and its estuarine or marine conditions, is well indicated by the relative convexity, strength, and coarseness of their shells. The estuarine variety is generally extremely thin-walled, round-edged, and keelless.

14. *Cristellaria Calcar*, Linn. sp. Pl. X. figs. 10–12, and figs. 1 & 2 (var.).

*Nautilus Calcar**, Linn. Syst. Nat. 12 ed. p. 1162; Gmel. p. 3370.
*Nautilus Calcar*, varr. *a*, *β*, *γ*, *δ*, *ε*, *ζ*, *η*, *θ*, *ι*, *κ*, *λ*, *μ*, Fichtel & Moll, Testacea Microscopica, &c., pp. 69, &c. pl. 11, 12, 13.
*Nautilus papillosus*, Fichtel & Moll, *ib.* pl. 14. figs. *a*, *b*, *c*.
*Robulus cultratus*, Montfort, Conchyl. p. 214.
*Robulina cultrata* †, D'Orb. Ann. Sc. N. vii. p. 287, no. 1 (*Ficht.* varr. *β*, *ζ*, *η*, *λ*).
*Robulina Calcar*, D'Orb. Ann. Sc. N. vii. p. 289. no. 12 (*Ficht.* varr. *γ*, *δ*, *ι*).
*Robulina costata*, D'Orb. Ann. Sc. N. vii. p. 289. no. 13 (*Ficht.* var. *ε*).
*Robulina aculeata*, D'Orb. Ann. Sc. N. vii. p. 289. no. 14 (*Ficht.* varr. *a*, *θ*, *κ*?, *μ*).
*Robulina cultrata*, D'Orb. For. Foss. Bass. Vienn. p. 96. pl. 4. f. 10–13.
*Lenticulites rotulata*, Lamarck, Annal. Mus. v. p. 188. pl. 62. f. 11.
*Nummulina rotulata*, D'Orb. *loc. cit.* p. 296. no. 8.
*Cristellaria rotulata*‡, D'Orb. Mém. Soc. Géol. Fr. iv. p. 26. pl. 2. f. 15–18.

Shell hyaline, lens-shaped, spiral, involute, nautiloid; chambers slowly increasing in size, varying from about four to ten in the outer whorl, subtriangular in side-view, their inner or umbilical angular portions overlapping the two surfaces of the former whorl; sutures sometimes slightly sunken, sometimes marked by variable linear costæ, either partial, entire, or granular, and

* Linnæus included, and not without reason, the compressed form of *Cristellaria* (Ledermuller, Micr. pl. 8. fig. *d*), now known as *C. Cassis*, under this appellation. *C. Cassis* is not specifically separable from the thicker and more regularly circular *C. Calcar*; but, for the sake of a useful, though artificial, distinction, we here refer to the synonyms of *C. Calcar* (proper) only.

† To the numerous synonyms recognized by D'Orbigny for this species, and enumerated in the "Tableau des Céphalopodes" here quoted, must be added many more from his subsequent list of "species" both of "Robulina" and "Cristellaria." Very numerous varieties of this shell have been figured and named by authors; for example, the series of *Robulinæ* and *Cristellariæ* in the Zeitschrift deutsch. geol. Gesell. vol. iii. pl. 4. and vol. vii. pl. 13–15; and nearly all the *Robulinæ*, and several of the *Cristellariæ*, in the Foram. Foss. Bass. Vienn. (pl. 4. f. 1–7, 10–27; pl. 5. f. 1–4).

‡ See D'Orb. *loc. cit.*, and Morris's Catal. Brit. Foss. 2nd edit. p. 33, for further synonyms.

frequently uniting at the umbilicus to form a central disc or group of granules. External edge of the chambers frequently bordered by a keel of exceedingly variable character. Surface of the chambers usually smooth, occasionally granulated.

The specimens here figured are smooth and subcarinate, but the condition of their keel is very inconstant; they are prominent at the umbilici, but have no thickened umbilical discs; nor are the septa thickened or raised, though (as usual) visible externally.

Aperture at the upper angle of the chamber, somewhat produced, and variable; sometimes presenting a round hole, surrounded by numerous slight fissures (as in fig. 1); sometimes the round aperture is slit on the lower side, and becomes ovato-triangular, or even roughly spade-shaped, as in fig. 12.

This variability of the form of the aperture, which is also observable in many of the individuals figured by authors, and among the *Cristellariæ* of the London Clay and other deposits, destroys the presumed generic, or even specific, value of "Robulina."

The very beautiful series of figures in Fichtel and Moll's *Testacea microscopica aliaque minuta*, &c. (1803) present well-marked individuals of the chief varieties of this delicate and symmetrical shell. Numerous conditions of surface are here apparent: polished and granulate; smooth and costate; smooth-ribbed and granular-ribbed; keeled, partially keeled, and keelless; serrate-keeled, tooth-keeled, and merely spined without a keel,—these are the variable and interchanged characters, the several groupings of which in individuals these authors recognized in their varieties *a* to *μ*; and by which D'Orbigny endeavoured to arrange these varieties into specific groups. Well might the former despair of finding a specific character distinctive of these varieties*; and, although some of D'Orbigny's binomial terms are not without an incidental value, yet, as far as the specific relations of this shell are concerned, we prefer to follow Fichtel and Moll in reverting to Linnæus's decision, who, seizing the most characteristic variety†, invested it with the

* "Forma hujus speciei ita comparata est ejusque varietates tam multiplices, ut fere impossibile videatur characterem specificum erui posse, quo hæc species a reliquis congeneribus distingueretur et tamen nulla varietas excluderetur. . . . . Ad evitandam omnem, quæ exinde exoriri posset, ambiguitatem et confusionem, optimum nobis visum est, ex multifariis varietatibus præcipuas eligi, earumque unam, secundum quam Linnæus sine dubio nomen suum composuerit, quoad omnes proprietates primum describi, atque reliquas solummodo quatenus afferri, quatenus quælibet a ceteris discedat."—*Op. cit.* pp. 69 & 70.

† The acceptance of the tooth-keeled and rowel-like (or the most developed) form as the most characteristic variety, appears to us to be quite correct.

appropriate trivial name; and in regarding the other forms as varieties, often worthy of some distinctive mark, number, or even name.

Figs. 1 and 2 (Pl. X.) represent an elongate, somewhat arched, flattened, keeled, sheath-like shell, with a produced, marginal, round aperture. It is similar in all essential characters to the lenticular *Cristellaria* above described, fig. 10, excepting in the almost total absence of spirality. It is indeed the non-coiled form of *Cristellaria rotulata*. Such a condition is of very frequent occurrence wherever *Cristellaria* is a common shell*. The gradations of form from the closed-up nautiloid shell to the elongate form ("Marginulina" of authors) are very numerous in the London Clay and other Tertiaries†, in the Chalk, Gault, Kimmeridge-clay, and the Lias‡.

In fig. 1 we may observe an instance of a small intercalary chamber,—the result of injury or of a temporary stunted growth.

The Norway dredgings afforded about twenty specimens of the rotulate *Cristellaria*, and two of the marginuliform specimens (all from Nordland, at 160 fathoms).

This *Cristellaria* is common in the recent state (but of very small size) at Margate; and still smaller at Skye§ and Shetland‖, and in Australia. This shell, of equal size with the Norway specimens, but rather flatter in shape, is found fossil in San Domingo; nor does it appear possible to separate it (except as a conveniently distinguished variety) from the large and keeled forms (*Cristellaria Cassis*) common in the pliocene beds of Spain (Malaga), Italy, and Austria.

The rotulate *Cristellaria* is common in the Tertiary deposits, the Chalk, Chark-marl, Gault, and in some of the Oolites.

### 15. *Globigerina bulloides*, D'Orb. Pl. XI. figs. 11, 12.

*Globigerina bulloides*, D'Orb. Ann. des Sc. Nat. vii. p. 277. no. 1; Modèles, no. 17 & no. 76; Foss. For. Bass. Vienn. p. 163. pl. 9. f. 4–6.
*Globigerina cretacea*, D'Orb. Mém. Soc. Géol. Fr. iv. p. 34. pl. 3. f. 12–14.

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* An analogous companionship of the rotulate *Cristellaria* and a marginuliform variety is to be found in Prof. Bailey's "Microscopical Examination of Soundings made by the U. S. Coast-survey off the Atlantic Coast of the U. S.," Smithsonian Contributions to Knowledge, vol. ii. 1851. In this case the two forms (*Robulina D'Orbignii* and *Marginulina Bacheii*, Bailey) accompany each other in the soundings of from 51 to 90 fathoms.

† See Foss. Foram. Bass. Vienn. pl. 3 : compare f. 9–15 and f. 24, 26, 28, 37; also f. 22, 34, and 36.

‡ Bornemann, Liasformat. Göttingen, pl. 4.

§ We have to thank Prof. Williamson for numerous interesting Foraminifera from this locality.

‖ Both Prof. Williamson and Mr. Bowerbank have kindly favoured us with specimens and sea-sand from Shetland.

*Globigerina concinna, G. diplostoma,* and *G. triloba,* Reuss, Vienna Trans. i. p. 373. pl. 46. f. 8–11.

This well-known and extremely common species, essentially a deep-sea shell, and of a fine rose-colour when fresh (*G. rubra,* D'Orb.), is extremely variable in size and shape, though easily recognizable. It affords several species to authors.

It is excessively abundant in the Chalk (*G. cretacea,* D'Orb.), rarer in the Gault, and abundant in nearly all Tertiary beds of deep-sea origin, especially muddy deposits. It is the common form in the deep-sea dredgings of the North Atlantic (Submarine Telegraph); and we have it from Crete (at 360 fathoms), and from the coasts of North Britain. It appears to be rare in dredgings from shallow water and in sponge-sands.

16. *Rosalina vesicularis,* Lamarck, sp. Pl. X. figs. 22–24; Pl. XI. figs. 13, 14.

*Ammonia,* Soldani, Sagg. Orittos. p. 104. pl. 3. f. 25.
*Discorbites vesicularis,* Lamarck, Annal. Muséum, vol. v. p. 183, vol. viii. pl. 62. f. 7; Defrance, Dict. Sc. Nat. pl: f. 2.
*Rotalia* (*Discorbis*) *Gervilii,* D'Orb. Ann. Sc. Nat. vii. p. 274. no. 36; Modèles, no. 72.

Shell hyaline and finely perforate, discoidal, plano-convex, exhibiting its spire more on the raised than on the flat surface; chambers overlapping to the umbilicus on the latter surface; on the former, the chambers of the last whorl extending only half-way over the earlier whorl; chambers curved on side-view; varying from triangular to subquadrate, on one surface, with the later ones lobular; on the other, long subtriangular, with an angular bend in the middle; 16 apparent on the convex, and 11 on the flat surface. Aperture a slit at the base and terminal edge of the chamber, combined with open slit-like spaces between the lengthened inner corners of the chambers on the flat surface. These converging angles of the chambers are bordered, along the posterior edge of each, with irregular growths of shell-matter, varying from slight valvular laminæ to coarse granular accumulations; in the latter case this overgrowth, extending around and over the umbilicus, connects the umbilical processes of the chambers and their little penthouse laminæ into a roughened mass perforated by irregular passages.

One specimen of this fine large species of *Rosalina* with an asterigerine umbilicus (fig. 24) was obtained in sand at West Fiord (Nordland) from 60 fathoms depth; and eight specimens occurred on sponge from 100 fathoms at Vigten Island, Inner Passage (Drontheim).

Figs. 13 and 14, Pl. XI., are young forms of this species, and are not uncommon in the miscellaneous sand of the dredgings.

We have met with a small *Rosalina* similar to the above in the Calcaire grossier of Grignon, where Lamarck's *Discorbites vesicularis* was also procured. D'Orbigny quotes it as fossil at Valognes.

D'Orbigny's model, No. 72, is a close representation of our large specimens, excepting in the form of the umbilical astral overgrowth, which in the former case presents neat elongate-ovate lobules, instead of the less regularly defined and granulated mass occurring in the old shells from Norway.

17. *Truncatulina lobatula**, A. D'Orb. Pl. X. figs. 17–21.

*Nautilus*, Walker, Test. Minut. pl. 3. f. 57.
*Serpula lobata*, Montagu, Test. Brit. p. 515, and Suppl. p. 160.
*Serpula nautiloides*, Schrötter, N. Litterat. 3. p. 283. pl. 3. f. 22, 23; Gmel. Syst. Nat. p. 3739.
*Lobatula vulgaris*, Fleming, Brit. Anim. p. 232.
*Truncatulina tuberculata*, Sold. sp., D'Orb. Ann. Sc. Nat. vii. p. 279. no. 1; Modèles, no. 37.
*Truncatulina lobata*, D'Orb. Hist. Nat. Canaries, Foram. p. 134.
*Truncatulina lobatula*, D'Orb. For. Foss. Bass. Vienn. p. 168. pl. 9. f. 18–23.

Shell discoidal, plano-convex, spire unequally shown on the two surfaces, the chambers (in the typical form) overlapping on one side and not on the other. Chambers broadly triangular on the convex surface, subquadrate on the other, not increasing rapidly in size, and subject to much variation in their proportions. Aperture a slit at the base of the chamber, not reaching along the overlapping portion of the chamber, but most open towards the truncate or flattened face of the shell, and sometimes continuous with the persistent apertures of some of the preceding chambers along this face. Shell thickish, reddish or livid when fresh, usually white in dead specimens, semi-diaphanous, and punctured with large pseudopodian apertures.

The specimens here figured are large individuals, preserving greater regularity in the arrangement of their chambers than is usually met with in specimens of their size; yet even here the outline of the shells is much affected by the varying development of the segments of the animals.

*Truncatulina lobatula* supplies many named varieties in memoirs both on fossil and recent Foraminifera.

In shallow and rough water this species soon takes on an irregularity of growth; the whorls first becoming unsymmetrical by intercalary and misplaced or overlapping chambers, and then

* This form appears to be entitled to Schrötter's unfit appellation "nautiloides," by the right of priority. We here propose, however, to accept A. D'Orbigny's adaptation of Turton's name "lobatula," used by Maton and Racket (Linn. Trans. vol. viii. p. 117), and well known to collectors.

losing themselves in a wide-spread flat form, consisting of numerous chambers, sometimes with somewhat of a cyclical mode of growth (*Planorbulina**), at others with a very variable arrangement of the chambers† (*T. variabilis*, D'Orb.). In both of these flat forms (*Truncatulina* and *Planorbulina*) the shell is affixed to fronds of sea-weeds and to shells.

In another condition of growth also (*Acervulina*‡, including perhaps *Rosalina globularis*, D'Orb.) it enwraps small stalks of sea-weeds and polyparians.

This is a world-wide species: it is common in the Tertiary deposits; and is found also in the Chalk. It is numerous in all the Norway dredgings.

18. *Anomalina*§ *coronata*, nov. sp. Pl. X. figs. 15, 16.

This shell has the general aspect and bearing of the common *Truncatulina*; but it is not depressed, and affects a bilateral symmetry, the two surfaces being often nearly equal. The umbilici are deeply and broadly sunken; the convexity of the chambers forming an almost ridge-like corona on each face of the shell. The aperture is a transverse chink at the base of the chamber (as in *Nonionina*), being an extension of the slit-like aperture of *Truncatulina lobatula* in accordance with the increased width of the chamber on the side which is undeveloped in the latter flattened form.

In the texture of shell, sunken umbilici, and almost symmetrically nautiloid form, this shell is an *Anomalina*, D'Orb.

The specimen figured (figs. 15, 16) is the most symmetrical of the individuals collected; others approach more nearly to the common *Truncatulina*.

This is a very common form in the Norway dredgings; being comparatively numerous at 30, 40, 70–100, and 160 fathoms. Elsewhere we have only found it in two deposits of the French Tertiaries; and there it appears to be of great rarity, though even larger in size than the Norway specimens.

* *Serpula concamerata*, Montagu; *Lobatula concamerata*, Fleming; *Planorbulina nitida* and *P. Mediterranensis*, D'Orb. Ann. Sc. N. vii. p. 280.

† Soldani, Testac. et Zooph. pl. 75–93.

‡ *Acervulina*, a genus instituted by Schultze (Organ. Polyth. &c.), but to be taken in a larger sense than intended by that author, appears to form a very typical group of species which, after developing a certain number of chambers as *Rosalinæ*, become more or less cyclical in their growth; each chamber developing new segments from one, two, or three funnel-shaped apertures on its periphery. *Truncatulina* may be said to be an *Acervulina* arrested at its Rosaline stage of growth.

§ For the sake of convenience we retain the subgeneric names *Truncatulina* and *Anomalina* instead of the more comprehensive term *Acervulina*.

19. *Cassidulina lævigata*, D'Orb. Pl. XI. figs. 17, 18.

*Cassidulina lævigata*, D'Orb. Ann. Sc. Nat. vii. p. 282. pl. 15. f. 5 & 6.

Shell suborbicular, smooth, hyaline; the Norway specimens are rather flattened and have the edge of the shell sharp. Chambers more or less oblong, alternating in a double series along an axial line, and the whole arranged irregularly on a spiral plan, so that the earlier-formed chambers are at intervals trespassed upon and partially overcrossed by succeeding chambers formed at a very different angle from that of their predecessors; hence some of the chambers appear as if they were small and intercalated. In the Norway specimens about 8 to 11 chambers are apparent. Aperture a narrow curved slit towards the spire and parallel with the lower edge of the chamber, the terminal face of which is flat and oblique. The aperture has a partial projecting valve-like lip.

This *Cassidulina* is excessively abundant in Shetland, where it runs into a thickened and nearly orbicular form (*C. crassa*, D'Orb.); also at Skye, Whitehaven, &c. It occurs fossil at Turin, Palermo, and Bordeaux; and indeed usually accompanies *Nonioninæ*.

20. *Valvulina triangularis*, D'Orb. Pl. XI. figs. 15, 16.

*Valvulina triangularis*, D'Orb. Ann. Sc. Nat. vii. p. 270. no. 1; Modèles, no. 25.

Shell opake and arenaceous, red with rust-coloured particles with which it is studded. In the young state, circular and conical; cone broad at the base, and somewhat concave both at sides and base; basal edge sharp; apex of cone formed of the relatively large globular first chamber, and almost separated from the rest by a slight constriction. Cone formed of 7 or 8 flattish, almost semicircular chambers, increasing rapidly in size, arranged in a spiral manner; three chambers completing each circuit of the spire; and three being exposed at the base of the cone (youngest portion of the shell). Aperture an irregular slit, under the central two-thirds of the edge of chamber, and accompanied by a slightly raised lip or "opercular valve."

This form is small and rare in the Norway dredgings; but it occurs of larger size in Australia, and comparatively gigantic in some of the French Tertiaries (Hautville, &c.). It is common also in the West Indies. The cone in these instances varies considerably in its relative proportions, but always retains its characteristically globular apex (first chamber). A more highly developed form of the species (which always presents an arenaceous condition of shell) occurs in company with the conical form in Australia and the West Indies, and also in the French

Tertiaries. In this case, numerous individuals exhibit a gradual replacement of the cone by a trihedral (Verneuilina-like) series of chambers, which are ultimately produced collaterally and unequally in a spiral (Bulimina-like) arrangement, and exhibit a terminal fold-like aperture protected by an opercular tongue (as in *Valvulina*).

This interesting species, which is a trochiform Textularian *Rosalina* in its young state (figs. 15 & 16), and presents a combination of *Verneuilina* and *Bulimina* in its advanced growth, appears to have only the Valvuline condition of its aperture as a permanent character throughout*.

D'Orbigny's *V. triangularis* (illustrated by his Modèle, no. 25) is this form at an intermediate stage, when the *Verneuilina* has prevailed over the *Rosalina*, and begins to lose its triangularity previously to being superseded by the *Bulimina*.

### 21. *Bulimina marginata*, D'Orb. Pl. XI. figs. 35–40.

*Bulimina marginata*, D'Orb. Ann. Sc. Nat. vii. p. 269. no. 4. pl. 12. f. 10–12.
*Bulimina ovula*, D'Orb. Voy. Am. Mérid. Foram. pl. 1. f. 10, 11.
*Bulimina caudigera*, D'Orb. *ib.* p. 270. no. 16; Modèles, no. 68.

Shell varying from ovate to fusiform, formed of numerous chambers arranged alternately on a ternate plan, and affecting somewhat a spiral arrangement. The earlier chambers much less in size than the later ones, and sometimes obscured by their excessive backward overlapping (as in figs. 36 & 37; still more so in *B. caudigera*, D'Orb.). The larger and later chambers are subglobose or somewhat oval in their external outline. The aperture is distinctively a little loop-shaped niche, formed, as it were, by the folding-over and convergence of the two halves of the extremity of the chamber; it is sometimes provided with a little, narrow, internal, tubular neck.

The shell, in the small varieties here figured, is hyaline and very diaphanous. In larger individuals the shell becomes thicker, coarser, and densely studded with sand-grains. The external ornament appears to be generally confined to the fringing of the posterior portion of some or all of the cells with prickles of variable size, and of very inconstant occurrence on nearly all the varieties. In figs. 39 & 40, this fringing is well shown, and the shell of this most-prickled variety is stronger than the others; whereas in the ovate and elongated forms (figs. 35 & 36) the shell is of extreme tenuity; certainly as thin as in any Foraminifera we have yet examined. The emaciated variety, fig. 35, does not put on prickles.

* *Clavulina* appears to afford an analogous interchange of structural types; but it ultimately takes on a Nodosarian, instead of a Bulimina-like growth; retaining a Valvuline aperture.

The extremely elongate form, with small cells, fig. 35, is well linked to the gibbous large-celled varieties by gradual intermedia, although the numerous *Buliminæ* of the Norway dredgings have not supplied so many of these links as we find in the Skye sands and in some Tertiary deposits. This elongate form is usually of very small growth, and apparently in a starved or arrested condition.

The varieties above referred to are common in the Tertiary deposits of San Domingo, and in other Tertiaries; and occur recent* at Bombay Harbour, Skye, Shetland, &c. The gibbous form, fig. 36, is abundant in the London Clay.

22. *Uvigerina pygmæa*, D'Orb. Pl. XI. figs. 41, 42, 43.

*Uvigerina pygmæa*, D'Orb. Ann. Sc. Nat. vii. p. 269. pl. 12. f. 8 & 9; Modèles, no. 67.

This shell is usually elongate, frequently trihedral, with the faces somewhat concave; it is composed much in the style of *Bulimina*, but with the spiral arrangement less marked. It is hyaline, but thick; usually ribbed; sometimes partially ribbed, or bristled with little aciculæ, or even quite smooth. The aperture is produced, instead of being sunken; and it is tubular, and sometimes neatly rimmed.

The larger varieties have the most globose chambers, more especially representing the shape of a grape-bunch (whence the name). The typical form seems to be of this well-grown variety.

Neither the variations of shape, size, or ornament† appear to us to be sufficient distinctions for the separation of the varieties into species. The gradual setting-on of riblets is well shown in pl. 11. For. Foss. Vienn., where *U. pygmæa* and its allies are figured.

*Uvigerina* is abundant on every coast, and in very many Tertiary deposits. It is not rare in the Norwegian dredgings.

23. *Textularia sagittula*, Soldani, sp. Pl. XI. figs. 44 & 45.

*Polymorphium Sagittulum*, Sold. Testac. ii. p. 120. pl. 133. fig. T.
*Textularia Sagittula*, Defrance, Dict. Sc. Nat. pl. . f. 5; D'Orb. Ann. Sc. Nat. vii. p. 263. no. 20.
*Textularia aciculata*, D'Orb. Ann. Sc. Nat. vii. p. 263. no. 15. pl. 15. f. 1–4.
*Textularia pygmæa*, D'Orb. Ann. Sc. Nat. vii. p. 263. no. 13; Modèles, no. 7.

Shell usually more or less triangular in outline, varying from

* *Bulimina auriculata* and *B. turgida*, Bailey (Smithson, Contrib. vol. ii. figs. 36–38), evidently represent the form we have here figured; and are also accompanied by the emaciated form (*B. compressa*, Bailey).

† These exogenous growths of riblets, spines, &c., evidently representing permanently the folds or points of the enveloping sarcode, are not of a specific character.

a compressed form, like an arrow-head, to a thickened wedge-like shape. The chambers, which are arranged in two rows, one on each side of the long axis of the shell, and placed alternately, imitate the folds of a braid or plait. Shell generally flattened, but sometimes rounded and conical (as in *T. trochus* of the Chalk). Chambers more or less depressed and oblong, set on at various angles in different individuals: in fig. 44 (*T. Sagittula*) they are horizontal or transverse, at a right angle to the axis of the shell; in fig. 45 (*T. aciculata*) they are at an angle of about 60°. These are nearly extreme varieties; the intermediate gradations are numerous and gentle. The thicker varieties have the greater horizontality, and the flatter or thinner forms more angularity in the arrangement of the chambers. In the former the chambers are sometimes globose (*T. gibbosa*, D'Orb.); in the latter the edge of the shell becomes a very sharp lamina, sometimes produced, and even jagged or dentate, passing into *T. Pala*, Czjzek (Haidinger's Abhandl. ii. p. 148. pl. 13. f. 15, 16), and *T. carinata*, D'Orb. (For. Foss. Vienn. pl. 14.* f. 32–34). The aperture is constant in its character of a transverse semilunar slit on the inner edge of the chamber (as in *Nonionina*).

In the smaller forms of *Textularia*, the shell is hyaline and perforated with numerous passages for pseudopodia; but the clear substance of the shell becomes opake as the individuals increase in size, until the original structure is almost lost to view, by foreign particles (such as minute *Foraminifera*, sand, or prismatic cells of Molluscan shells) becoming agglutinated into the substance of the shell.

*Textularia* is represented by a vast variety of forms, most of which are cosmopolitan in their range, and traceable far back in geological age, even to the palæozoic periods. It is difficult to divide these varieties into specific groups. The specimens here figured, however differing in size and form, occur, with a full complement of intermediate gradations, in the Tertiary beds of Palermo, and are not specifically distinct. Similar forms are common in the British, Mediterranean, Australian, and other sea-sands. The Norwegian individuals are numerous.

*Miliola et Miliolites*, Lamarck. Pl. X. figs. 28–37.

24. *Biloculina ringens*, Lamarck, sp. Pl. X. figs. 28–33.

*Miliolites ringens*†, Lam. Ann. Mus. v. p. 351; ix. pl. 17. f. 1.
*Biloculina ringens*, D'Orb. Ann. Sc. N. vii. p. 297. no. 2.

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* This plate affords an interesting series of these varying forms of *Textularia*.

† The specimen figured by Lamarck has lost its outer chamber, the laminar tongue of which remains in place, and appears as an appendage to the shell.

*Biloculina bulloides*, D'Orb. Ann. Sc. N. vii. p. 297. no. 1. pl. 16. f. 1–4; Modèles, no. 90.
*Pyrgo lævis*, Defr. Dict. Sc. Nat. pl. 88. f. 2.
*Biloculina lævis*, D'Orb. Ann. Sc. N. vii. p. 298. no. 8.
*Biloculina aculeata*, D'Orb. Ann. Sc. N. vii. p. 298. no. 3; Modèles, no. 31.
*Biloculina depressa*, D'Orb. Ann. Sc. N. vii. p. 298. no. 7; Modèles, no. 91.

Shell ovate, gibbous or compressed, white, opake, smooth or sometimes delicately striate (fig. 32), sometimes roughened by fine granulation; externally showing two loculi or chambers, the larger (last) one overlapping the edges of the penultimate chamber; the internal chambers formed on the same plan. Chambers few (six to nine), disposed parallel to the long axis of the shell, regularly alternating on one side and the other, cochleate, of a more or less ovate outline and convex externally, resembling the bowl of a spoon with the edges strongly incurved; the edges of each chamber fitting over the edge of the shell constructed by earlier chambers. The chambers have no inner wall of their own*. The aperture is a transverse terminal slit, modified and encroached upon by a tongue-like lamina on its inner side.

This shell varies from the striking globosity of the finely striated variety (figs. 32 & 33) to the flatter and oval form (figs. 30 & 31): a much greater degree of flatness obtains in specimens collected from other sea-sands (*B. depressa*, D'Orb.); and, on the contrary, a lateral compression gives rise to another extreme form in *B. contraria*, D'Orb. Occasionally, from the varying amount of overlapping of the outer chamber, either full or meagre at the edges, the general outline is variable. In fig. 30 the shell is subquadrate in outline, and almost three-lobed on one of its surfaces, owing to the deficiency of one part (base) of the last chamber, and the swollen condition of its two overlapping edges. In fig. 31 we have a side-view of a form intermediate, by its partially-swollen sides, between figs. 28, 29, & 30. (*B. clypeata*, *B. simplex*, and *B. inornata*, D'Orb., are varieties amongst these Norwegian *Miliolæ*.) Fig. 32 differs by its greater globosity and by its striation from the other *Biloculinæ* here figured; the latter character is rare in *Biloculina*: judging, however, from the uncertainty of ornamentation in other *Foraminifera*, especially *Quinqueloculina*, this character of striation is scarcely available for specific value.

*Biloculina* is very common in the recent and the Tertiary sea-sands, and has supplied numerous so-called "species" to authors. The forms, for instance, figured by D'Orbigny in his 'Foram. Foss. Bass. Vienne,' pl. 15 & 16, may be advantageously studied in this light.

* The tongue-like plate in the aperture of the shell is apparently the only representative (or homologue) of the inner wall of each segment.

In the Norway dredgings the common *Biloculinæ* (such as figs. 28. 29, 31) are numerous from 30 fathoms, and amongst them there were two distorted specimens (such as fig. 30); three specimens of similar smooth *Biloculinæ*, but larger in size, came from the 70–100 faths. dredging; and three specimens of the globular and striate variety (figs. 32, 33) occurred at 160 faths.

25. *Quinqueloculina Seminulum*, Linn. sp. Pl. X. figs. 34, 35, 36.

*Serpula Seminulum*, Linn. Syst. Nat. ed. 12. p. 1264.
*Vermiculum intortum*, Montagu & Fleming.
*Quinqueloculina Seminulum*, D'Orb. Ann. Sc. N. vii. p. 303. no. 44.
*Quinqueloculina secans*, D'Orb. *ib.* p. 303. no. 43; Modèles, no. 96.

*Triloculina*? *oblonga*, Montagu, sp. Pl. X. fig. 37.

*Vermiculum oblongum*, Montagu, Test. Brit. p. 522. pl. 14. f. 5; Fleming, Wern. Mem. iv. p. 565. pl. 15. f. 4.
*Triloculina oblonga*, D'Orb. Ann. Sc. Nat. vii. p. 300. no. 16; Modèles, no. 95.

Shell more or less oval or ovate, and compressed; resembling *Biloculina* in the whiteness and opacity of its substance, and in its mode of building-up, except that the chambers are not set on regularly on one plane, nor overlap so completely at their edges; the chambers not being expanded, as is usual in *Biloculina*, but narrow and crescentic; and the overlap of their edges being greater on one side than on the other. This asymmetry gives rise to the exposure of parts of either the edges or faces of the earlier chambers on the two surfaces of the shell; and generally one more chamber is visible on one surface than on the other;—as many as six or five on one, and five or four on the other (*Quinqueloculina*), or as few as three and two (*Triloculina*).

The aperture is semioval, with a tongue-like internal lobe, which is frequently bifurcate.

*Quinque-* and *Tri-loculinæ* are excessively variable shells*, both as to shape and ornament, and are amongst the most common Foraminifers in all latitudes and depths.

We have no genuine *Triloculina* in the Norway dredgings. Fig. 37 is the so-called *Triloculina oblonga* of authors; but it is rather a contracted ill-grown *Quinqueloculina* than a true *Triloculina*. It usually abounds with the *Q. Seminulum*.

The *Miliolæ* were as common in the Tertiary seas as at present; they appear to be rare in the Chalk; but are not unfrequent (as *Quinqueloculina*), though of small size, in the Gault. Various individuals are common in one or other of the Norway dredgings. Fig. 34 is from 30 fathoms; figs. 35 & 36 from

* The plates 16–20 of the 'For. Foss. Bass. Vienne' offer a large series of Milioline forms for study.

160 fathoms; and similar forms occur at 40, 60, and 70–100 fathoms. Fig. 37 is from 30 fathoms, and was accompanied by two similar specimens.

26. *Placopsilina Canariensis*, D'Orb., sp. Pl. X. figs. 13, 14.

*Free.*
- *Nucleus minusculus limosus*, &c., Soldani, Saggio orittograf. p. 99. pl. 1. f. 10.
- *Nonionina Canariensis*, D'Orb. Hist. Nat. Canaries, p. 128. pl. 2. f. 33, 34.
- *Spirolina æqualis, S. lagenalis, S. irregularis*, Roemer, Nordd. Kreid. p. 98. pl. 15. f. 27–29.
- *Spirolina irregularis*, Reuss, Böhm. Kreid. i. p. 35. pl. 8. f. 62–66, 75.
- *Spirolina agglutinans*, D'Orb. For. Foss. Vienn. p. 137. pl. 7. f. 10–12.
- *Spirolina Humboldti*, Reuss, Zeitsch. deutsch. geol. Ges. iii. p. 65. pl. 3. f. 17, 18.
- *Nonionina silicea*, Schultze, Müller's Archiv f. Anat. 1856, p. 171. pl. 6 B. f. 4–6.

*Fixed.*
- *Œufs de Mollusques**, Cornuel, Mém. Soc. Géol. France, 2 sér. iii. pl. 4. f. 36.
- *Placopsilina scorpionis*?, D'Orb. Prodrome Paléont. i. p. 259. no. 283.
- *Placopsilina Cenomana*?, D'Orb. *ib.* ii. p. 185. no. 758.
- *Placopsilina Cenomana*, Reuss, Vienna Transact. vii. p. 71. pl. 28. f. 4, 5.

In our figured specimen the shell is discoidal, obtuse at the margin, sunken at the umbilicus on each surface; chambers triangular on side-view; increasing slowly in size; about nine in number in the outer whorl; slightly overlapping the former whorls. Shell rusty in colour, opake, arenaceous, the calcareous material small in proportion to the imbedded sandy matter, which is considerable in quantity.

One large individual (figs. 13 & 14; from 30 fathoms, Finmark) and a few small ones have occurred in the Norway sands. We have also found this Foraminifer in a few other dredgings from the northern seas. Sometimes it is more depressed than the specimen figured.

The Nonionina-shaped shell here figured belongs to the same genus as the crosier-shaped and Spirolina-like shells known as *Spirolina*† *irregularis*, &c., as well as the more irregular and attached Foraminifers to which the term *Placopsilina*‡ is more especially adapted. In all these the shell is arenaceous; the chambers are more or less closely set, usually increase very gradually in size, and commence in a spiral arrangement, but sooner or later go off in a straight direction, with much irregu-

* Together with these are figured (*loc. cit.* fig. 37) some *Webbinæ*. As *Webbina* is probably distinct from *Placopsilina*, we leave it for future consideration.

† The *Spirolinæ* of Lamarck (*S. cylindracea* and *S. depressa*) are contracted varieties of *Peneroplis*, with the typical forms of which *Spirolina* is united by *Dendritina*. All these retain their homogeneous shell-substance without becoming arenaceous; they have also other peculiarities of structure.

‡ D'Orbigny, Cours Élément. Paléont. vol. ii. p. 199, 1852.

larity. The aperture in the nautiloid forms is usually near the lower part of the chamber, but occasionally almost central; it is large, usually transverse and semilunar; frequently jagged in outline or irregularly lobed, and occasionally compound (therein approaching that of *Lituola*, which, with its divided chambers, is to *Placopsilina* * as *Orbiculina* is to *Peneroplis*).

The aperture in the straight part of the crosier-shaped individuals is central and usually round. In all cases the aperture is faintly lipped.

The chambers (as usual in the non-hyaline Foraminifera) are set one on another by their edges, like tents or inverted cups, not like bladders or bottles; and, when the animal grows in the fixed condition and is flat, the chambers are more or less deficient of substance on the attached side. In the attached form it is Truncatulina-like at first, but passes off into an irregular serial growth of transversely broad but unequal chambers.

A characteristic of the recent specimens is the yellow or ferruginous tint† of the shell, arising from the colour of the sandy particles which enter so largely into its composition.

Either in the nautiloid or the crosier-like forms, this shell is known to us in the Oxford Clay, Gault, Chalk-marl, and Chalk; and authors quote it from the Chalk of Europe, the Tertiary of Coroncina (Italy), of Hermsdorf (near Berlin), and from existing seas. The fixed forms occur abundantly in the Jurassic‡ and Cretaceous deposits.

## EXPLANATION OF PLATES X. AND XI.

### PLATE X.

[All the figures (except fig. 12) are magnified about 12 times linear.]

*Fig.* 1. *Cristellaria Calcar*; attenuated variety. 2. The same; edge-view of last chamber.

*Fig.* 3. *Dentalina communis*; fragment. 4. Last chamber of another specimen. 5. The same; external aperture.

*Fig.* 6. *Nodosaria lævigata.* 7. The same; external aperture.

*Figs.* 8, 9. *Nodosaria lævigata*; varieties.

*Fig.* 10. *Cristellaria Calcar.* 11. The same; edge-view. 12. The same; external aperture; more highly magnified.

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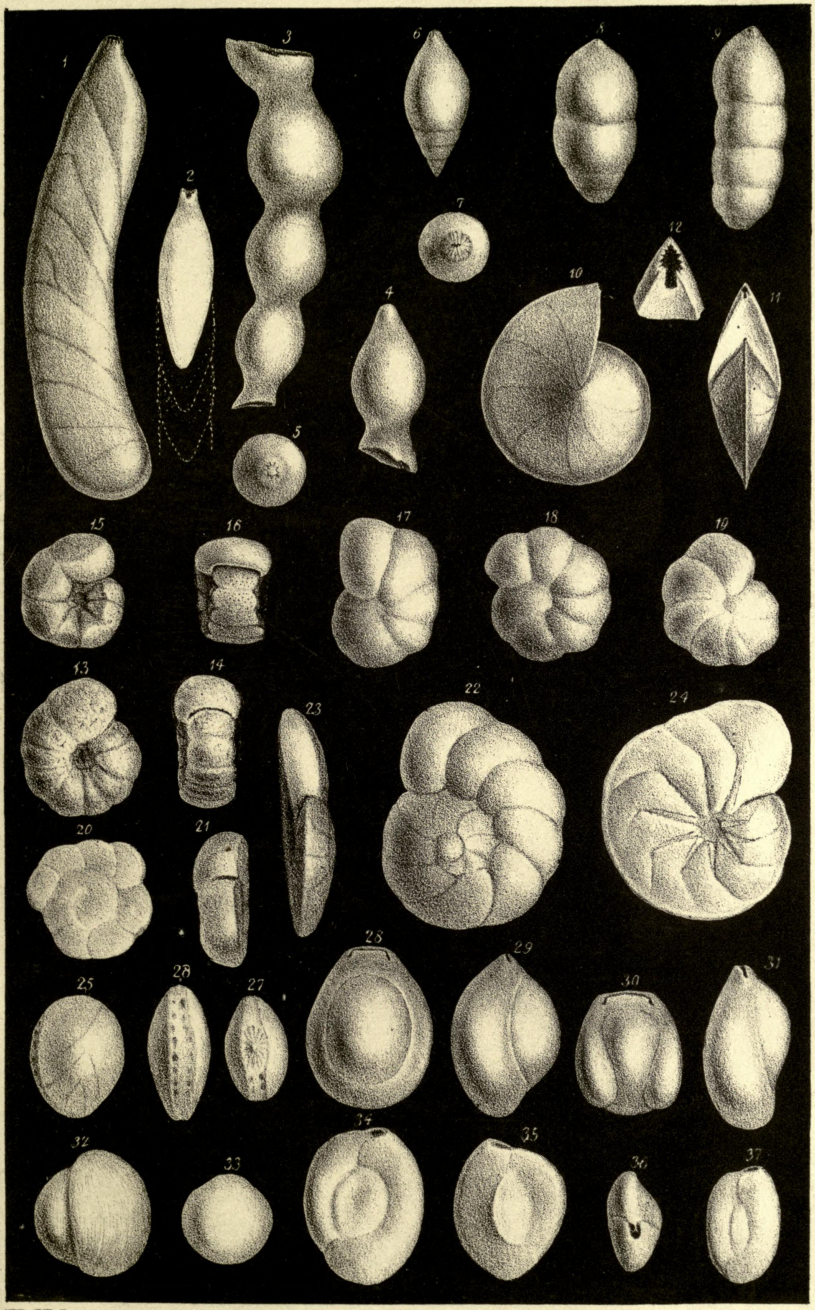
* *Placopsilina* may be said to represent, among the non-hyaline Foraminifera, the *Acervulina* among the hyaline forms.

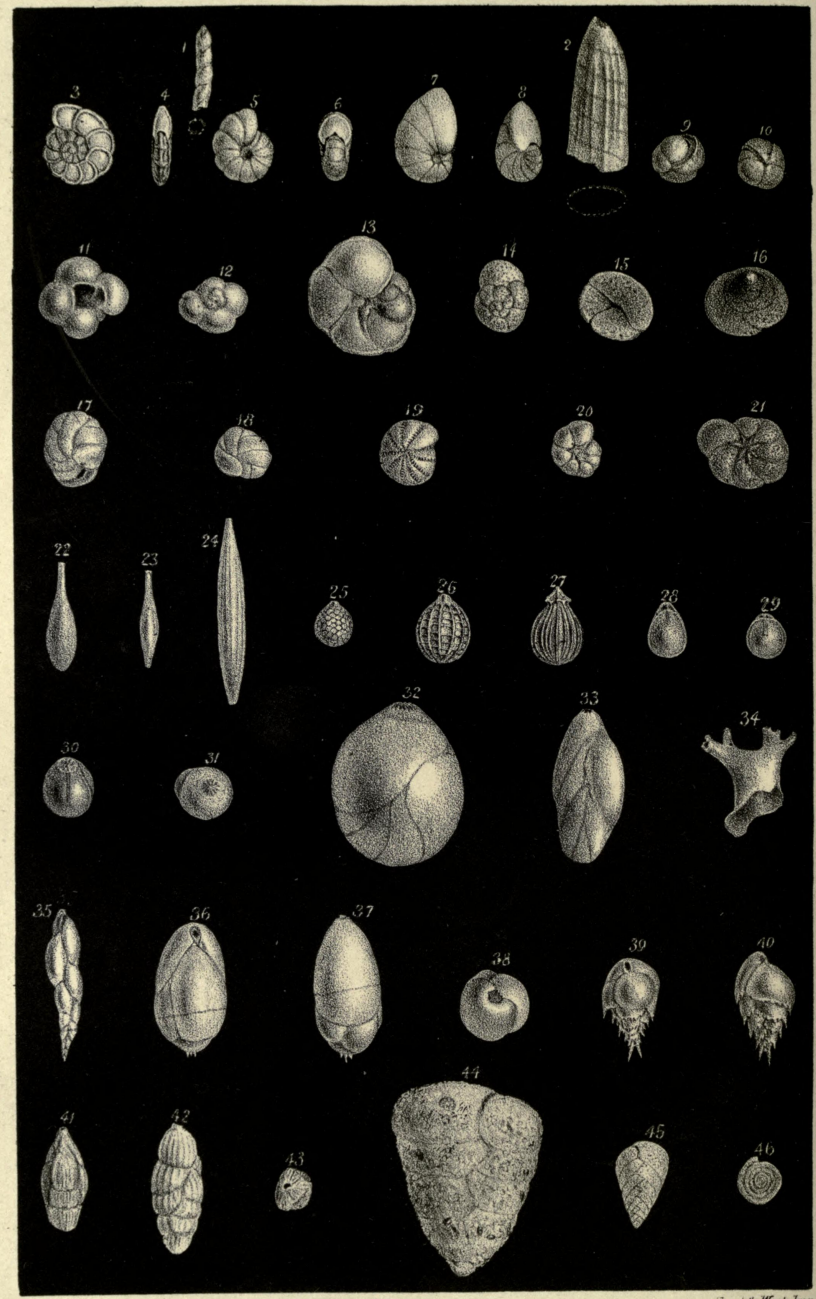
† This yellow tint characterizes also the so-called *Nonionina pelagica*, D'Orb. (Voyage Amér. Mérid. vol. v. part 5. pl. 3. f. 13, 14), which is apparently closely allied to *P. Canariensis*, but far more gibbous, with inflated and rapidly enlarging chambers.

‡ It is abundant on the *Ostræa Marshii* of the Inferior Oolite near Peterborough.




T.R.J.Del. Geo. West lith Ford & West Imp

*RHIZOPODA from the Coast of Norway.*




W. K. Parker, del. Geo. West, lith. Fora. & West, Imp.

*RHIZOPODA from the Coast of Norway.*

*Fig.* 13. ***Placopsilina Canariensis.*** 14. The same; edge-view (somewhat obliquely placed).

*Fig.* 15. *Anomalina coronata.* 16. The same; edge-view.

*Figs.* 17, 18, 19. *Truncatulina lobatula.* 20. The same; flat surface or base. 21. The same; edge-view (somewhat obliquely placed).

*Fig.* 22. *Rosalina vesicularis.* 23. The same; edge-view. 24. The same; flat surface, or base.

*Fig.* 25. *Polymorphina communis.* 26. The same; edge-view, showing the additional lateral apertures. 27. The same; terminal aperture.

*Fig.* 28. *Biloculina ringens.* 29. The same; edge-view. 30. A distorted individual. 31. The edge-view of a somewhat depressed form. 32. The edge-view of a finely striated variety. 33. The surface of outer chamber of young individual of the striated var.

*Fig.* 34. *Quinqueloculina Seminulum.* 35. Another individual. 36. The end-view of another. 37. The contracted variety.

## Plate XI.

[The figures are magnified about 12 times linear.]

*Fig.* 1. *Dentalina communis*, var. Fragment. [Drawn upside down.]

*Fig.* 2. *Vaginulina*? Fragment. [Drawn upside down.]

*Fig.* 3. *Operculina complanata.* 4. The same; edge-view.

*Fig.* 5. *Nonionina crassula.* 6. The same; edge-view.

*Fig.* 7. *Nonionina communis.* 8. The same; edge-view (oblique).

*Figs.* 9, 10. *Nonionina bulloides* (obliquely placed).

*Fig.* 11. *Globigerina bulloides*; lower surface, or base. 12. The same; upper surface.

*Fig.* 13. *Rosalina vesicularis* (young); lower surface. 14. Another individual; upper surface.

*Fig.* 15. *Valvulina triangularis* (young or trochoid form); base. 16. The same; apex (obliquely placed).

*Figs.* 17, 18. *Cassidulina lævigata.*

*Fig.* 19. *Polystomella crispa.*

*Figs.* 20, 21. *Nonionina asterisans.*

*Figs.* 22, 23, 24. *Lagena lævis*, varieties.

*Figs.* 25–29. *Entosalenia globosa*, varieties.

*Figs.* 30, 31. *Polymorphina communis*; young form. 32. Gibbous form (*P. gibba*). 33. Attenuate form (*P. lactea*). 34. External staghorn tube.

*Fig.* 35. *Bulimina marginata*; attenuate variety. 36, 37. Overlapping variety. 38, 39, 40. Aciculate variety.

*Figs.* 41, 42, 43. *Uvigerina pygmæa.*

*Fig.* 44. *Textularia Sagittula.* 45. The same; var. *aciculata.*

*Fig.* 46. *Spirillina vivipara.*

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