section, which shows rocks and characters entirely differing from those of the Tultcha range. We have here an upper member of the same group, if of the same age: or it belongs to a newer formation.

Fig. 6.—Section of the Promontory eastward of Yeni Keni (or Yeni Sel), Lake Raselm.

- a. A red conglomerate. The fragments which it contains are of schists and shales, but there are none of limestone; neither are they rounded, as if water-worn.
- b. Compact limestone, grey and reddish, much veined, and semi-crystalline; 20 feet thick.
- c. Compact calcareous strata, associated with schists and shales, thinly stratified, and fully 50 or 60 feet thick; but, being overlaid by the superficial marls (*d*), they are not fully seen. The beds *c* correspond with the thinly stratified grey and yellow calcareous shales forming the next cape or promontory to the south, called Dolashina, where they contain *Inocerami*. Here also they lie nearly horizontal, and are again capped by the superficial drift, which extends thence to Cape Media, where the dark vertical shales appear, and then the cream-coloured *Inoceramus*-limestones; followed by the Chalk at Kanara, described in my former papers*.

Thus supplying some links in the line of research, it is hoped that these notes and remarks will, by the aid of the fossils already presented to the Society, throw some light on the geology of the Dobrutcha.

3. *On the RHIZOPODAL FAUNA of the MEDITERRANEAN, compared with that of the ITALIAN and some other TERTIARY DEPOSITS.*

By T. RUPERT JONES, Esq., F.G.S. and W. K. PARKER, Esq., Mem.M.S.

Introduction.—The Mediterranean has been the source whence a large number of the known species of *Foraminifera* have been derived. Beccarius (1731), Plancus (Bianchi, 1739), Gualtieri (1742), Ginanni (1755), Soldani (1780 & 1789), and Fichtel and Moll derived most of the material for their notices of these microscopic shells from the Mediterranean. D'Orbigny also and later naturalists have drawn largely from this rich source.

Of late years, we have been favoured with the results of many dredgings taken in different parts of the Mediterranean by Prof.

* Quart. Journ. Geol. Soc. vol. xiv. p. 207, &c.

E. Forbes and Capt. E. Spratt, also with shell-sands from Leghorn and Venice by Mr. W. J. Hamilton, and with other shell-sands from both sides of Italy by Prof. Meneghini and the Marchese Carlo Strozzi (through the zealous kindness of Dr. H. Falconer), with sponge-sands from Crete and elsewhere (communicated by friends), and we have obtained other like material from various sources. We have thus been able to work out a very large series of the Mediterranean *Foraminifera*.

The authors already mentioned, as well as Defrance and others, have also described a large number of fossil *Foraminifera*, obtained from the Tertiary deposits of Tuscany, Piedmont, and other countries bordering the Mediterranean. These bear a close relation to the recent forms of the same area; and towards the elucidation of their affinities, we can now bring forward the results of a careful examination of an extensive series of the fossil *Foraminifera* of the Mediterranean region, either supplied to us by some of the friendly hands above referred to, or obtained from the Museum of this Society and other sources, especially (in the case of the Malaga clays) through Professor Ansted. We have also been favoured by Dr. Wilhelm Haidinger with a large quantity of the Nussdorf Marl (*Amphistegina*-bed) from the Vienna Basin; and from Baljik (on the Black Sea) we have received, through the hands of Capt. Spratt, a most interesting sample of a Tertiary deposit which affords marked *Rhizopodous* alliances with the so-called Miocene fauna of the Vienna basin and the Pliocene fauna of Mediterranean Tertiaries.

We propose to arrange in a Synoptical Table the species and varieties of *Foraminifera* which we have found in the gatherings, dredgings, and soundings brought from several (26) localities of which we have definite information; and in many cases the shells obtained at different depths, or in distinct sea-zones, in one locality will be discriminated, on account of the importance arising from the variability of a given species under different conditions of depth and sea-bottom. We follow the same plan with the fossil forms; in some instances the different beds of the deposits being treated separately. In every case where we offer tabulated results we feel satisfied of having had at our command a sufficient quantity of material to afford trustworthy evidence.

We prefer to tabulate the fossil *Foraminifera* of the Vienna basin from D'Orbigny's beautiful Monograph, and from the elaborate Memoirs of Czjcek and Reuss, not yet having had time to do justice to the valuable Viennese material supplied us by Dr. Haidinger.

With respect to the nomenclature adopted in our Table, we have, in the first place, been careful to eliminate all unnecessary binomial terms, such as duplicate names, or names given to but slightly varied individuals; and at the same time we have enumerated many well-marked varieties in each species, because of their value as indications of peculiar conditions of habitat; and because, many of them presenting at first sight striking differences of form, size, and ornamentation, and being easily mistaken for types of distinct specific groups, they have acquired an importance in the eyes of zoologist

and geologist which makes it convenient to give them a sort of subspecific value and a binomial term.

It has been doubted by some whether in this, the most variable, because simplest, family of the animal kingdom, every variety should not be distinguished by its own binomial appellation,—a plan that has been followed almost to the full by many naturalists. In this, however, we cannot agree, for the unlimited multiplication of quasi-specific names, linked together by pseudo-generic titles, can only weary the catalogue-maker, and throw obstacles in the way of the systematist; for it keeps up a false notion of the value of external characters which are rarely essential, whilst no clue is thereby obtained to the morphological law of each real specific type. Evidences of such law, however, are not wanting when we carefully examine varietal forms as they diverge, and, as it were, radiate, from a given central type.

Though Linnæus was somewhat parsimonious in giving names to the microscopic shells which he knew, and though Fichtel and Moll partially indicated their great variability, and were cautious in naming them, yet it was not until Dujardin demonstrated the nature of the Rhizopodous sarcode and its simple, non-differentiated character, and until Williamson and Carpenter, taking up the study of certain species, showed what extreme forms might be connected together by innumerable gentle intermediate gradations, that anything like a really scientific appreciation of these Microzoa may be said to have existed. Our own experience of the wide limits within which any specific group of the *Foraminifera* multiply their varietal forms, related by some peculiar conditions of growth and ornamentation, has led us to concur fully with those who regard nearly every species of *Foraminifera* as capable of adapting itself, with endless modifications of form and structure, to very different habitats in brackish and in salt water,—in the several zones of shallow, deep, and abyssal seas,—and under every climate, from the poles to the Equator. Our principles of nomenclature, and the application of them, may be seen in our papers on *Foraminifera* in the ‘Annals and Mag. Nat. Hist.’

Remarks on the Materials of the Tabular Synopsis.—In arranging our synoptical tables of the Mediterranean *Rhizopoda*, recent and fossil, and in comparing their numerous specific and varietal forms one with another, we have not confined ourselves to our collections from this region, but have necessarily made comparisons of forms from almost every part of the globe, from the Arctic and the Tropic Seas, from the temperate zones of both hemispheres, and from shallow, as well as deep sea-beds. Geologically, also, we have reviewed the *Foraminifera* in their manifold aspects as presented by the ancient faunas of the Tertiary, Cretaceous, Oolitic, Liassic, Triassic, Permian, and Carboniferous times; finding, to our astonishment, that scarcely any of the species of the *Foraminifera* met with in the Secondary Rocks have become extinct; all, indeed, that we have as yet seen have their counterparts in the recent Mediterranean deposits. This is still more clearly found to be the case with regard to the Chalk of Maestricht and the Tertiaries.

Taking the recent Mediterranean *Foraminifera* systematically, we commence with the littoral fauna, comprising those met with in the seaweed-zone, and those washed up by the waves and found between the tidal lines, or occasionally in sand-banks blown up by the wind. Amongst those obtained under these circumstances are the numerous specimens found in sponges, when the latter have been thrown on the shore and trampled or washed about in the sand. Samples of such littoral shell-sand we have from the Golfo di Spezzia*, Leghorn†, and Crete‡, from shores having a western aspect; from the sand-bank of Lido§ (Venice), and from Rimini||, in the Adriatic. The equivalent deposits of the Levant, including those off the Nile, we retain for future description.

Our selected examples from the next stages of sea-depths are from 40 fathoms at Suda Bay, north side of Crete¶, from 90 fathoms off Syra in the Archipelago**, from 170 fathoms off Serpho in the Archipelago††, from 250 fathoms to the north-west of Crete‡‡, from 360 fathoms near Crete§§, from 500 fathoms near Ipsara in the Archipelago|||, from 1100 fathoms between Crete and Santorin¶¶, from 1620 and 1650 fathoms between Malta and Crete***, and from 1700 fathoms between Malta and the Archipelago†††.

The fossil *Foraminifera* of the Mediterranean area will be illustrated in our columns by lists of species from the Tejares clay of Malaga, the shelly beds of Turin, several deposits from Sienna, the shell-beds of Palermo, the fossiliferous Tertiaries of Malta, those of the Vienna basin, and lastly, from a shell-bed at Baljik, near Varna, on the Black Sea. The last three of these deposits are regarded as being of Miocene age,—the others, with one or two exceptions, as Pliocene.

The richest of these are the Siennese Subapennine beds, samples of which have been freely communicated to us by Prof. Meneghini and the Marchese Carlo Strozzi (through the hands of our friend Dr. Falconer). The following is the list of these beds from which we have specimens (Nos. 1–8 are from Prof. Meneghini; Nos. 9–12 from March. C. Strozzi).—1. Blue clay, from Cerajolo and Santo Donnino (see Soldani's 'Testaceographia,' vol. ii. p. 26). 2. Blue clay, from S. Lazzaro, near Sienna (see Soldani, 'Testaceographia,' vol. ii. p. 42). 3 and 4. Blue clay, from Coroncina, near Sienna (see Soldani, 'Testaceographia,' vol. ii. p. 79). 5. Blue clay, from S. Quirico, not far from Sienna. 6. Clay, from Pescaja, near Sienna (rich in *Entomostraca*, but poor in *Foraminifera*). 7. Sand, from Pienza, in the Siennese. 8. Clay, from Monte Ariosio, near Sienna. 9. "Sabbie Gialle di Montopoli," Tuscany (upper Pliocene). 10. Castell' Arquato nel Piacentino (Pliocene). 11. "Delle Crete Senesi" (Lower

* From Prof. Meneghini.

† From Mr. W. J. Hamilton and the Marchese Carlo Strozzi.

‡ From Mr. Dines.

§ From Mr. W. J. Hamilton.

|| From Prof. Meneghini and the Marchese C. Strozzi.

¶ From Mr. Huxley.

** From Capt. Spratt.

†† From Capt. Spratt.

‡‡ From Capt. Spratt.

§§ From Mr. Hilton.

||| From Capt. Spratt.

¶¶ From Capt. Spratt.

*** From Capt. Spratt.

††† From Capt. Spratt.

Pliocene). 12. St. Frediano, Colline Pisane (Miocene); this last and No. 7 resemble the *Amphistegina*-bed of the Vienna Basin.

Nos. 1-4 will be grouped together in one column, as they contain but one series of forms, with a great uniformity of mineral matter.

Excepting the *Amphistegina*-beds, the Italian Tertiaries under notice yield *Foraminifera* similar to those of the Mediterranean, both of shallow and deep habitats.

The next columnized group will be that from Malaga. In the Quart. Journ. Geol. Soc. vol. xv. p. 597 and p. 600, Prof. Ansted has described the geological relations of the Tejares clay of the neighbourhood of Malaga, and has briefly alluded to its very rich Rhizopodal fauna. This is the richest, next to that of the Siennese tertiaries, that we know of, and well agrees with that of the present Mediterranean, especially the Adriatic.

Fossils in the collection of the Society, from the neighbourhood of Turin, have afforded the shelly sands from which the next column of species has been arranged. In many respects these are equivalent to some of those from the Siennese district; especially the more shallow-water forms.

Palermo gives us the next column; these materials being also from the Society's collection. This fauna is more like that of the recent shallow-water Mediterranean deposits than most of the Siennese or the Malaga clays.

Our Maltese *Foraminifera* belong to another fauna, characterized by the abundance of *Heterostegina* (the reddish fragile limestone being almost wholly composed of this shell). The recent analogue of this fauna has to be sought for in the Eastern seas (Philippines).

The Vienna Basin has afforded, as palæontologists well know, a large series of *Foraminifera* to the patient researches of D'Orbigny, Czjck, and Reuss. Like the *Amphistegina*-beds of Italy and the *Heterostegina*-rock of Malta, these Viennese Tertiaries are of older date than the Pliocene beds of the Subapennine series, and are regarded as of Miocene age, or Oligocene of the German geologists. The Viennese species have been so carefully figured and described by the above-named palæontologists that we gladly use their materials in our columns of the Mediterranean species and of the fossil fauna that preceded them in that area and the conterminous regions.

A very important relic of an old fauna closely allied to the Miocene forms of some of the Vienna deposits, and not without some relationship to the Eocene beds of Grignon, is indicated by a whitish shelly marl from Baljik, containing also remains of aquatic mammals. This is referred to in the Quart. Journ. Geol. Soc. vol. xiii. p. 77, by Capt. Spratt, who has also kindly supplied us with a quantity of this valuable material for examination. This affords a curious and instructive fauna, allied to that of the Mediterranean, but having remarkable peculiarities. In mineral character it much resembles the deep-sea deposits of the Mediterranean, having a large proportion of greyish-white aluminous matter, and a considerable quantity of fragments of Molluscan shells, with but a few that are perfect, and those small. It does not, however, contain the delicate

small Pteropodous shells so common in deep soundings in the Mediterranean.

In this instance we have taken in hand the Mediterranean *Foraminifera* and their older relatives found in the neighbouring Tertiary deposits. We propose, if circumstances permit, to present at another time comparative views of other faunas, such as those of the Atlantic with the fossil *Foraminifera* of Bordeaux and the Faluns—and those of Australia compared with the well-known Grignon forms, &c.

Notes on the several Columns in the Table.—Columns Nos. 1 to 11, illustrating the recent Rhizopodal fauna of the Mediterranean, will require a detailed history of their interesting contents too long for the present occasion. The value of these columns, as terms of comparison, will be shown in treating of the fossil forms tabulated in Columns Nos. 12 to 28.

Column No. 12. Blue Clays from Cerajolo and S. Donnino, from S. Lazaro, and from Coroncina.

These Siennese clays (for which we are indebted to Professor Meneghini) are exceedingly rich in the Nodosarian and Cristellarian species. They also abound with the Bulimine, Textularian, Rotalian, and Nonionine groups; but are poor in *Lagenæ*, *Polymorphinæ*, and *Polystomellæ*. The *Miliolæ* are moderately represented, but not proportionately abundant.

This deposit is amongst the richest of those containing the “Stichostegian” *Foraminifera* that we know of; the only comparable instances being the Malaga and Vienna clays. Several of the Cretaceous and Jurassic deposits (chiefly clays) are also extremely rich in this group. In the recent state we find the *Stichostegia* generally rare in littoral deposits. At Rimini they are exceptionally abundant; the shore-sand there being almost as markedly characterized with them (though of smaller size) as the Subapennine clays are. In column No. 4 we have, from ninety fathoms, a fine series of Stichostegues, nearly equal to those from Rimini; but the minor varieties have more delicate shape, with thicker shell-walls; conditions obtaining in every group of *Foraminifera* in deep water. In abyssal depths of the Mediterranean, as well as of the open ocean, the Nodosarian group becomes rare, and the specimens are very small.

As to the Bulimine group, column No. 12 agrees well with No. 4, and is not very dissimilar from Nos. 5, 6, & 7; but in the two latter (250 and 360 fathoms) most of these forms are of much diminished size. The same may be said of the Textularians. The favourite range of *Buliminæ* and *Textulariæ* appears to be (from what we have seen in the Mediterranean and elsewhere) from 20 to 200 fathoms.

The *Cassidulinæ* are represented by varieties that are usually found, in sands and clays, at from about 50 to 150 fathoms.

Orbulina and *Globigerina* (with their two allies the so-called *Nonionina sphaeroides* and the *Sphaeroidina bulloides*) are faithful indicators of abyssal depths, though occasionally found in shallow

water. In column No. 12 these forms are well represented by full-sized individuals, though not in a large proportional number.

Of the leading Rotalian forms, we have here some of the varieties of *Rotalia* (*Planorbulina*) *farcta* that are usual in moderately deep water; so also of *R. repanda*; the varieties of *R. Beccarii* are those of deep water; the varieties of *R. Turbo*, which usually affects shallow waters and sandy bottoms, are feebly represented here.

The *Nonioninae*, and their more highly developed relatives the *Polystomellæ*, seem, by the varieties here present, to indicate a moderate depth.

Of the opaque-shelled *Foraminifera* we have here a few good varieties of *Miliola*, inhabiting deepish water; the truly littoral forms being almost wanting. Of the rest of the opaque group, there are some large helicine specimens of *Lituola nautiloidea*, and a few smallish *Cornuspiræ*, none of which inhabit shallow water.

From the evidence thus gathered by a comparison of the contents of column No. 12 with the Foraminifers of the existing seas and oceans, we may conclude that these particular Siennese clays were deposited at a depth of not less than about 40 fathoms, and not more than about 100 fathoms. We must remember here that an area of a clay-bed or any other sea-deposit may have a considerable extension under a gently varying depth of water, within certain limits; and that samples of the same clay-bed taken from within a few miles, or even yards, of each other, may yield somewhat dissimilar portions of one great well-characterized fauna. Thus we may take our specimens from the spot where the littoral overlaps the deep zone, or where the latter is sliding into the abyssal. The wide limit of from 40 to 100 fathoms, indicated for the Siennese clays, illustrated by column No. 12, may be thus accounted for.

No. 13. Blue Clay from S. Quirico (Professor Meneghini).

From the smallness of the specimens, and the proportional abundance of *Globigerina*, this was very probably formed in a depth of from 150 to 250 fathoms.

No. 14. Blue Clay from Pescaja (Meneghini).

This yields numerous small specimens of *Rotalia Beccarii* intermixed with innumerable *Entomostraca* (*Cythere Muelleri*, var.). From the small size of the *Rotalia* and the presence of this *Cythere*, we may confidently interpret this clay as a deposit of shallow and probably brackish water. Both *R. Beccarii* and *C. Muelleri* are found to range upwards into estuaries and salt-marshes.

No. 15. Sand from Pienza (Meneghini).

This is an *Amphistegina*-bed. It has a few shallow-water forms besides the *Amphistegina*, especially *Rotalia Beccarii* and *Polystomella crispa*, which are large and abundant. We best know *Amphistegina*, in the Canaries, West Indies, and Eastern Seas, in shell-beds at from 20 to 40 fathoms. In the white mud from the Australian reefs (10 to 20 fathoms), dredged by Mr. Jukes, and rich in Foraminifers, *Amphistegina* is large and common. We have not met with a recent *Amphistegina* in the Mediterranean.

We may suppose the *Amphistegina*-bed of Pienza to have been formed at no great depth; perhaps at not more than 10 fathoms, if we are swayed by the presence of the *R. Beccarii* and *P. crispa*, as indeed we ought to be.

Amphisteginae form a large proportion of the 'material of some other fossil deposits in the neighbourhood of the Mediterranean (as shown in columns Nos. 17, 18, 20, 21, & 23). It abounds in the white Nussdorf marl of the Vienna Basin; and is not absent from the Malaga clay. It may yet be found in some part of the Mediterranean; but, as it seems to have disappeared from this area, geologists may be right in setting a value on its abundance in some of the Tertiary beds, and in regarding it as indicative of the Miocene period. It abounds in the Miocene Tertiaries of San Domingo.

No. 16. Clay from Monti Arioso (Meneghini).

The fauna here is made up of *Rotalia Beccarii* with a few other shallow-water forms.

No. 17. "Sabbie gialle," Montopoli (Strozzi).

This yellow sand much resembles in its fauna No. 15; but the *Amphistegina* is here accompanied with a larger suite of *Rotalia*, *Polystomella*, *Textularia*, &c., with some *Miliola*. The varieties here present indicate rather deeper water than that peculiar to the fauna of No. 15.

No. 18. Castel' Arquato (Strozzi).

This also has *Amphistegina*. It contains also *Operculina complanata*, which is, however, feebly developed in the Mediterranean; but this is very rare at Castel' Arquato, and may have been a "derived" fossil, being very much worn. This deposit was formed in shallow water, and has much agreement with the fauna of column No. 1, in its many well-developed littoral forms.

No. 19. "Delle Crete Senesi" (Strozzi).

This, like No. 14, is extremely rich in *Rotalia Beccarii*. It has also many good-sized specimens of *Polystomella crispa*, a few *Miliola*, and a unique specimen of *Dactylopora*, which looks worn, like a "derived" fossil. *Dactylopora* is a characteristic Eocene Foraminifer; it is not found in the Mediterranean; but the subtropical seas yield some small specimens, exhibiting, as it were, an arrest of growth*. It occurs also in the Miocene clays of San Domingo.

No. 20. San Frediano (Strozzi).

Another *Amphistegina*-bed with a few littoral forms besides its abundant *Amphisteginae*. *Polystomella* is again large and common, as in most of the *Amphistegina*-deposits.

No. 21. Tejares Clay, Malaga (Ansted).

What we have said respecting column No. 12 holds good for the Rhizopodal fauna afforded by this Malaga clay. At from 170 to 500 fathoms in the Mediterranean very many of the same group of forms occur, but the individuals are smaller. At from 1100 to 1700 fathoms there are fewer, and many of them very small; but *Orbulina* and

* See Annals of Nat. Hist. 3rd ser. vol. v. p. 473.

Globigerina are largest here and most common. In the middle depth also these two genera present the best developed forms both in number and size.

One of the Rhizopods in the Tejares Clay particularly deserves notice, namely the *Fronicularia*, which we here find very large. Soldani figures similar large specimens from the Siennese deposits; but we have met with small ones only. In the recent sand from Rimini we find large, worn, and probably "derived" *Froniculariæ*, having their chambers occupied with ferruginous clay, as is the case with the large fossil *Cristellaria* of Sienna. D'Orbigny had large *Froniculariæ* from the Viennese Tertiaries; and we find some in the Tertiary beds of San Domingo*.

No. 22. Turin (Geol. Soc.).

Characterized by very large *Nodosariæ* and *Cristellariæ*, the Turin deposits which we have examined have the general features of the Pliocene Tertiary. A considerable number of forms, just as may be found on the western shores of Italy at this day, combined with gigantic *Cristellariæ* and the largest of known *Nodosariæ*, compose the fauna in this column No. 22.

No. 23. Palermo (Geol. Soc.).

Our specimens from the tertiary deposits of Palermo yield a very rich fauna of rather shallow-water forms, commingled with some from deeper zones. *Amphistegina* is present here also, and is common, though not preponderating. The Textularian, Rotalian, and Miliolite groups are in force; there are a few traces, however, of the *Nodosariæ* and *Cristellariæ*. This fauna has much resemblance to the large assemblage of forms which Mr. S. V. Wood, F.G.S., has collected from the Crag at Sutton in Suffolk. With the latter, however, the existing sea-bed, at 21 fathoms†, off the north-west of Sicily, has such close relations, as to the varieties and conditions of the *Foraminifera*, that we may regard them as almost identical.

No. 24. Malta (Geol. Soc.).

The *Heterostegina*-bed at Malta is not without smaller *Foraminifers* (some of which we can identify,—as the *Globigerina bulboides*, *Truncatulina lobatula*, &c.), but the matrix is too stubborn to yield all its treasures. The *Heterostegina*‡ (which is found also in the Vienna Basin) appears to be extinct in the Mediterranean.

Nos. 25, 26, 27. Vienna Basin. (D'Orbigny, Czjeck, and Reuss.)

The remarkably rich fauna obtained from different deposits in the

* We have lately met with a long narrow *Fronicularia* (like *F. striatula*, Reuss) in Commander Dayman's dredgings, made in July 1859, off Lisbon, at 700 fathoms.—May 26, 1860.

† Shown by the dredgings made by the Commander of H.M.S. 'Queen,' August 1851.

‡ Spratt, Forbes, and Wright, in their notices of the Maltese strata and fossils (Proc. Geol. Soc. iv. pp. 226 & 230; and Annals Nat. Hist. 2 ser. xv. p. 101, &c.), have misnamed this *Foraminifer*, referring it erroneously to *Lenticulites* (*Operculina*) *complanatus*, Basterot. *Operculina complanata* occurs in a hard white limestone at Malta; and for a very fine specimen we are indebted to Lord Ducie, F.G.S.

Vienna Basin have been elaborately studied by D'Orbigny, Czjcek, and Reuss. We find in their works figures and descriptions of nearly every form mentioned in our columns Nos. 12-24, and a large majority also of the species and varieties that are found living in the Mediterranean.

One of these deposits (marl at Nussdorf) is abundantly rich with *Amphisteginae*. Here also *Alveolina* occurs, as well as at Baden. These forms are extinct as to the present Mediterranean. *Orbiculina*, as a small variety, has been found fossil at Buitur in Transylvania*; this also we have not met with living in the Mediterranean, though others have mentioned it.

The forms figured by Czjcek may be for the most part regarded as *intermedia* between the bolder forms figured in D'Orbigny's great work; at the same time they comprise some very important varieties, and a few are new varietal types.

Reuss also has figured, besides a few new forms, numerous *intermedia*, most of them being delicate varieties of the subspecies so well shown in the large work by D'Orbigny, and of considerable value to the zoologist.

No. 28. Baljik. (Capt. Spratt.)

A whitish marl characterized by a few peculiar forms, some of them extremely rich in individuals. The *Polystomellæ* and *Nonionineæ* afford multitudes of minute specimens, and also the beautiful and rare spinose form termed *P. Regina* by D'Orbigny; it is the *P. unguiculata*, Gmel. sp. D'Orbigny had it from the Vienna Basin; Gmelin's specimen came from the Red Sea. *Vertebralina inæqualis*, Gmel., obtained by Spengler, and also by ourselves, from the sand of the Red Sea, and which is common in the Calcaire Grossier of Grignon, occurs in the Baljik marl, common and large. A few *Miliolæ* and *Lageneæ*, and an occasional *Rotalia Beccarii* and *Nubecularia* complete the list of *Foraminifera* obtained by the careful examination of some pounds of this marl.

We have here evidently an old sea-bed of the seaweed-zone (probably at a depth of from 10 to 20 fathoms), having relations, it would seem, rather with the fauna of the Red Sea than with that of the Mediterranean.

Notes on the Species and Varieties.—Many of the species and varieties mentioned in the foregoing Table have been named (as species) by D'Orbigny in the 'Annales des Sc. Nat.,' after figures published in Soldani's 'Testaceographia' and 'Saggio Orittografico†'; and, as we have had the opportunity‡ of referring at our leisure to Soldani's great work, we have verified and adopted these names, often to the exclusion of synonyms that have been needlessly multiplied in works subsequent to those of the authors mentioned.

* D'Orbigny, For. Foss. Vien. p. 142.

† This appears also in the form of an Appendix to the 'Testaceographia,' vol. ii.

‡ Through the kindness and liberality of Dr. Falconer, F.G.S., who for our sake purchased in Italy a perfect copy of this expensive work, the loan of which we at present enjoy.

Some other varieties and species are but little known, and call for a few remarks as to their structure and alliances. Others are determined here for the first time, and require a few words of notice.

1-43. The varieties here enumerated comprise nearly all the best marked and most distinct forms known of the genus *Nodosarina*, including *Nodosaria* and *Cristellaria* and all their varieties. The Flabelline subgroup, however, is not well represented, though some of the *Cristellarice* here put on to some extent the essential features of *Flabellina*. We have elsewhere stated* our views of the close relationship of *Dentalina*, *Lingulina*, *Fronicularia*, *Dimorphina*, *Rimulina*, *Vaginulina*, *Planularia*, and *Marginulina* to *Nodosaria* on one hand and *Cristellaria* on the other.

3. *Nodosaria ovicula*, D'Orb. Ann. Sc. Nat. vii. p. 252, No. 6; Soldani, Testaceog. ii. pl. 10. figs. H-M; *N. longicauda*, D'Orb. For. Foss. Vien. p. 32, pl. 1. figs. 10-12.
4. *N. Pyrula*, D'Orb. Ann. Sc. Nat. vii. p. 253, No. 13; Soldani, Testaceog. ii. pl. 10. fig. B-C; *N. stipitata*, Reuss, Denkschr. Ak. Wien, i. pl. 46. fig. 4.
5. *N. longicauda*, D'Orb. Ann. Sc. Nat. p. 254, No. 28; Soldani, Testaceog. i. pt. 2, pl. 95. fig. B-M; *N. striaticollis*, D'Orb. Hist. Nat. Canar. pl. 1. fig. 2-4.
6. *N. hirsuta*, D'Orb. Ann. Sc. Nat. vii. p. 252, No. 7; Soldani, Testaceog. ii. pl. 2. fig. P; *N. hispida*, D'Orb. For. Foss. Vien. pl. 1. f. 24, 25.
21. *Vaginulina striata*, D'Orb. Ann. Sc. Nat. vii. p. 257, No. 3; Soldani, Saggio Orittog. pl. 6. f. N.
24. *V. marginata*, D'Orb. Ann. Sc. Nat. vii. p. 285, No. 7; Soldani, Testaceog. i. pt. 2, pl. 103. f. M.
28. *Marginulina Falx*. New variety. [Type, *Nodosarina Raphanus*, Linn.] An elegant dimorphous, striated, little *Nodosarina*, with the first six or seven cells arranged in the form of a partially uncoiled trihedral (or *Cristellaria Saracenaria* of DeFrance), and with the last two, three, or four chambers rectilinear and not distinguishable from those of *Nodosaria longicauda*, with which this variety is always associated in nature. *N. longicauda* may be regarded as the normal form to which this variety belongs, and is the more prevalent of the two. Soldani has given two or three figures (Testaceog. i. pt. 2, pl. 95. fig. L; pl. 96. fig. P; and pl. 102. fig. 6), which, though wanting in definiteness, may have reference to this variety.
30. *Marginulina hirsuta*, D'Orb. For. Foss. Vien. p. 69, pl. 3. f. 17, 18. This is not the *Marginulina hirsuta* of the Ann. Sc. Nat. vii. p. 259, No. 5, which is *Bigenaria Nodosaria*, as shown by Soldani's figures referred to by D'Orbigny.

* In the 'Annals of Nat. Hist.' 3 ser. vol. iii. p. 477.

31. *Marginulina Lituus*, D'Orb. Ann. Sc. Nat. vii. p. 259, No. 11; Soldani, Testaceog. i. pt. 2, pl. 106. fig. *aa*, *bb*.
43. *Cristellaria aculeata*, D'Orb. Ann. Sc. Nat. vii. p. 292, No. 14; Soldani, Testaceog. i. pt. 1, pl. 57. fig. *tt*; *C. echinata*, D'Orb. For. Fos. Vien. pl. 4. f. 21, 22.

51–60. The genus *Bulimina* comprehends all the forms here indicated. *Virgulina* is a delicate, compressed, biserial *Bulimina*, the chambers not increasing with exact regularity. *Bolivina* is a similar form, but more regularly plaited in its growth, being a Textularian isomorph. All these lie within the limits of an essential species.

53. *Bulimina aculeata* D'Orb. Ann. Sc. Nat. vii. p. 269, No. 7; Soldani, Testaceog. i. pt. 2, pl. 127. fig. I, pl. 130. f. VV.
64. *Uvigerina nodosa*, D'Orb. Ann. Sc. Nat. vii. p. 269, No. 3; Soldani, Testaceog. i. pt. 2, pl. 126. fig. *xx*, *yy*, *zz*, A, B.

65–82. *Textularia*. Varieties of one manifold species, belonging to one generic type. The shell of *Gaudryina* commences with three cells in a coil, before it takes on its biserial Textularian character. Such as take on a uniserial growth have been termed *Clavulina*, and confounded with similar varieties of *Valvulina*. The arrested triserial growth is *Verneulina*. *Bigenerina* is a *Textularia* becoming uniserial. *Grammostomum* is a compressed form of *Textularia*, with a terminal slit-like aperture. This kind of aperture passes gradually, on the one hand, into the common arched passage of *Textularia*, and on the other into the round terminal aperture of *Bigenerina*. *Grammostomum* also may be dimorphous,—passing from the complex to the simple arrangement of cells.

82. *Verneulina communis*, D'Orb. This is the *Clavulina communis*, D'Orb. For. Foss. Vien. p. 196, pl. 12. f. 1, 2. For some remarks on the several forms referred to *Clavulina* by authors, see Annals Nat. Hist. 3 ser. vol. v. p. 469.
83, 84. The characters and relationship of *Orbitolina* and *Patellina*, with their numerous varieties, are explained in the Annals Nat. Hist. 3 ser. vol. vi. pp. 29–38.
85. *Polytrema miniacea*, Esper, sp.* *Millepora miniacea*, Esper, Zooph. i. pl. 17; Gmel. Syst. Nat. 3784; *M. rubra*, Lamarck, Hist. An. s. Vert. ii. p. 202, No. 8; *Polytrema corallina*, Risso, Europe Méridion. v. p. 340, No. 91; *Polytrema miniacea*, Blainville, Actinolog. p. 410, pl. 69. f. 4. This is a fixed, reddish, often branching Rhizopod, related to *Orbitolina*.
86. *Spirillina vivipara*, Ehrenb. See Annals Nat. Hist. 2 ser. xix. p. 284. This has been often confounded with other *Foraminifera*, similarly shaped, but with sandy and opaque shells, and of distinct relationship. *Sp. vivipara* is related to *Rotalia* through the simple vermiculate varieties of *R. repanda*, especially *R. vermiculata*.

* We have to thank Dr. J. E. Gray for pointing out the synonymy of this species.

88-91. *Trochammina*. We have elsewhere* expressed an opinion that the *Rotalia inflata* of Montagu belongs to a subgenus distinct from the common *Rotalia*. The study of more varieties than we were then acquainted with leads us to regard it as generically distinct. The sandy structure, great variability of shape, and the more or less imperfect formation of the chambers, are important characters of this genus, which we have termed *Trochammina*.

The shell consists of a dense ferruginous cement filled with small sand-grains which do not project above the surface. It resembles a worked plaster-surface. It differs from the shell of *Nubecularia*, in which the sand, when present, roughens the surface, but is often absent; and from that of *Lituola* where the sand is in greater proportion than the cement, and is very coarse.

The simplest forms of *Trochammina* belong to a species (*T. irregularis*, D'Orb. sp.) of which we know three varieties. First, *T. irregularis* proper (*Webbina*† *irregularis*, D'Orb., Prodrôme, ii. p. 111; Bronn, Leth. Geog. 3rd edit. ii. pt. 5. p. 91, pl. 291. f. 27; "Œufs des Mollusques," Cornuel, Mém. Soc. Géol. France, 2 sér. iii. p. 259, pl. 4. f. 37‡), which is adherent, moniliform, with more or less oval chambers, and varying in the relative length of the stoloniferous connecting tubes, in the number of the chambers, and in the straightness or curvature of their line of growth.

Secondly, *T. irregularis alternans*, which is adherent and has the stolons springing from the chambers alternately and towards their front, giving the shell a loose Textularian character. The chambers are usually somewhat pyriform.

Thirdly, *T. irregularis clavata*, which is another fixed form, and consists frequently of a single pyriform chamber, tubular at one end, and bearing a slightly margined and semioval aperture at the other. The tubular portion frequently gives off another tube and chamber. This bifurcation is also occasionally seen in *T. irregularis* (from the Oxford clay); nor is it wanting in low forms of *Nodosaria* (*Dentalina aculeata*, D'Orb.).

The second species, *Trochammina squamata*, comprises five varieties, which are spiral, and more or less Rotalian, in their growth.

The simpler of these forms, such as *T. squamata incerta* (*Operculina incerta*, D'Orb. For. Cuba, pl. 6. f. 16, 17; *Spirillina arenacea*, Williamson, Monograph, p. 93, pl. 7. f. 203), consist of a long spiral undivided chamber, having the shape of the clear, perforated, discoidal *Spirillina vivipara*, Ehrenb., and of the white, opaque, Milioline *Cornuspira foliacea*, Philippi.

T. squamata charoides is a similar undivided tubular chamber vertically spiral (instead of being complanate), and presents a curious resemblance to the fruit of the *Chara*.

The third variety, *T. squamata gordialis* (from the Indian and

* Annals Nat. Hist. 3 ser. iv. p. 347.

† The name *Webbina* was first applied by D'Orbigny to a few-chambered, uniserial, curved form of *Nubecularia* (*Webbina*) *rugosa*, For. Canaries, pl. 1. f. 16-18, and For. Foss. Vien. p. 74, pl. 21. f. 11-12.

‡ Fig. 36 is *Lituola* (*Placopsilina*) *cenomana*.

Arctic Seas), has more than one chamber, the shell in its early stage being formed of a few spirally arranged but variable chambers; and at a later period being moulded on an undivided, vermiform sarcode, either discoidal or irregularly elevated; sometimes passing at nearly right angles over the disc, or forming sudden loops and twistings*.

T. squamata proper has the shell divided throughout into lunate and flattened chambers, several in a whorl, and regularly increasing with the progress of growth. It much resembles those flatter varieties of *Rotalia Turbo* which are intermediate between *R. globularis* and *R. rosacea*. *T. squamata* may easily be confounded with little, conical, scale-like varieties of *Valvulina triangularis*; but the latter (more nearly allied to the Verneuline *Textulariæ*) have never more than three chambers in a whorl, and are more coarsely sandy.

T. squamata inflata (*Rotalia inflata*, Montagu) has been already described (Ann. Nat. Hist. loc. cit.).

92. *Valvulina angularis*, D'Orb. *Clavulina angularis*, D'Orb. Ann. Sc. Nat. vii. p. 102, pl. 12. f. 7. The chief distinctive feature of this Clavuline form is the lingual process, or valve, partially occluding the aperture,—a characteristic of *Valvulina*.

94. *Globigerina helicina*, D'Orb. Ann. Sc. Nat. vii. p. 277, No. 4; Soldani, Testaceog. i. pt. 2. pl. 130. fig. qq, rr, pp, p.

97–108. These are varieties of *Rotalia (Planorbulina) farcta*, F. & M.

109–118. Varieties of *Rotalia repanda*, F. & M.

114. *Rotalia elegans*, D'Orb. Ann. Sc. Nat. vii. p. 276, No. 54; Soldani, Saggio Orit. pl. ii. f. Q, R; *Rotalia Partschiana*, D'Orb. For. Foss. Vien. pl. 8. f. 1–3. This is a variety of *R. repanda*.

116. *Rotalia vermiculata*, D'Orb. *Planorbulina vermiculata*, D'Orb. Ann. Sc. Nat. vii. p. 280, No. 3; Soldani, Testaceog. i. pt. 3, pl. 161. fig. A B C D. This flat few-celled Spirilline *Rotalia*, resembling the Planorbuline forms of *R. farcta* merely in outline and flatness, passes gradually into the *R. repanda* by regular gradations, especially through *R. pulchella*; and differs in structure and habit very markedly from every variety of *Rotalia (Planorbulina) farcta*.

118. *Rotalia excavata*, D'Orb. *Valvulina excavata*, D'Orb. For. Canaries, pl. 1. f. 43–45. The lobular process of the chamber (common in varieties of *R. repanda*), which has nothing in common with the lingual plate of sandy *Valvulina*, has caused this form to be mistaken for a *Valvulina*. The shell is essentially Rotalian in its structure.

119–123. These are varieties of *Rotalia Beccarii*, Linn.

120. *Rotalia ammoniformis*, D'Orb. Ann. Sc. Nat. vii. p. 276, No. 33; Soldani, Testaceog. i. pt. 1, pl. 34. fig. K.

* The *Serpula pusilla* of Schlotheim (*Spirillina pusilla*, Jones), from the Permian limestones of Durham and Germany, is probably closely related to this form.

124-126. These are varieties of *Rotalia (Calcarina) Spengleri*, Gmelin.

126. *Calcarina excentrica*. This is a peculiar, and not previously described variety of *C. Spengleri*, attaining a relatively large size (that of half a mustard-seed). It commences its growth as a little *Rotalia*, scarcely distinguishable from *R. armata*, which is a small variety of *C. Spengleri*. Each cell grows out into a projecting angle, giving a dentate margin to the shell. At first spirally discoid, this *Calcarina* soon begins to grow all on one side, producing a subtriangular or fan-shaped mass; the apex consisting of the first few spiral chambers; the base being notched in outline, and broadening with a cyclical tendency. Beyond this stage a further growth of cells would produce a complanate cyclical shell. *Planorbulina fureta* presents at one stage of its growth a plan of growth like that of *C. excentrica*, and at a later period such a cyclical arrangement as that above referred to.

127-132. Varieties of *Rotalia Turbo*, D'Orb.

128. *Rotalia Turbo*, D'Orb. Here represented by *R. Patella*, Reuss, Denkschr. Akad. Wien, i. pl. 46. f. 22, which is evidently a small form of *R. Turbo*.

132. *Rotalia elegans*, D'Orb. *Anomalina elegans*, D'Orb. Ann. Sc. Nat. vii. p. 282, No. 4; Modèles, No. 42; *Rosalina complanata*, D'Orb. For. Foss. Vien. pl. 10. f. 13-15. This is a variety of *R. Turbo*.

134. *Nonionina sphaeroides*, D'Orb. This differs from the other *Nonioninæ* (which are varieties of *Polystomella*), and indeed it appears to be more nearly related to *Globigerina* than to *Polystomella*. It has fewer chambers than any common *Nonionina*, and its low arched aperture is very much wider; its substance is dense, clear, finely porous, and highly polished (except at the margins of the aperture, which are granular). By these features, and by the setting on of the chambers, it is markedly distinguished from *Nonionina*, and probably deserves another appellation; but until its relationship to the deep-sea varieties of *Polystomella* and to the abyssal species *Globigerina* and *Sphaeroidina* shall have been worked out more fully, we prefer leaving it with its present name. Large varieties of *N. sphaeroides* occur at great depths (2200 fathoms, Indian Ocean, &c.), and often present a want of symmetry in the spiral form.

135-146. We have shown elsewhere* that the *Nonioninæ* are feebly developed *Polystomellæ*. The varieties here enumerated present a fair example of the increase of complexity in form and structure from *N. Scapha* to *P. crispa*. Carried still further, the peculiarities of structure are exaggerated in the typical *P. craticulata*.

* Annals Nat. Hist. 3 ser. vol. v. pp. 101-103.

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- 154–173. These are *Miliolæ* not separable specifically from the type, *Miliola Seminulum*, Linn.
155. *Spiroloculina limbata*, D'Orb. Ann. Sc. Nat. vii. p. 299, No. 12; Soldani, Testaceog. ii. pl. 19. fig. *m*.
160. *Quinqueloculina vulgaris*, D'Orb. Ann. Sc. Nat. vii. p. 302, No. 33; Soldani, Testaceog. i. pt. 3, pl. 152. fig. *E*; *Q. secans*, D'Orb. Ann. Sc. Nat. p. 303, No. 43; Modèles, No. 96; Soldani, Testaceog. i. pt. 3, pl. 152. fig. *C*.
161. *Q. pulchella*, D'Orb. Ann. Sc. Nat. vii. p. 303, No. 42; Soldani, Testaceog. ii. pl. 18. fig. *F*; *Q. Schreibersii*, D'Orb. For. Foss. Vien. p. 296, pl. 19. f. 22–24.
168. *Triloculina reticulata*, D'Orb. Ann. Sc. Nat. vii. p. 299, No. 9; Soldani, Testaceog. i. pt. 3, pl. 159. fig. *bb*, *cc* (by error quoted *ee*, *ff* by D'Orbigny).
170. *Biloculina elongata*, D'Orb. Ann. Sc. Nat. vii. p. 298, No. 4; Soldani, Testaceog. i. pt. 3, pl. 153, fig. *M*, *Q*, *p*.
184. *Lituola Soldanii*. New variety. [Type: *Lituola nautiloidea*, Lamarck.] This is a relatively large and straight *Lituola*, having the shape of a *Nodosaria*. It has a variable number of chambers, from about four to eight, each much subdivided and labyrinthic, as is the case also in the large crozier-shaped variety that occurs in the Chalk. Soldani has figured this straight subcylindrical *Lituola* (Testaceog. ii. pl. 3. fig. *cc*; and Saggio Orittog. pl. 19. fig. 92 *Z*), from San Quirico. Our finest specimens of this variety are from the Miocene sandy clays of San Domingo. It occurs recent at a depth of 40 and 47 fathoms off the Abrolhos Bank (Lat. 23°07'S.; Long. 41°17'W.). The deposits on this bank have peculiar faunal analogies with the Italian Tertiaries.

JANUARY 18, 1860.

James Poyntz M'Donald, Esq., Kingsdown Parade, Bristol; William Purdon, Esq., C.E., Punjab; and James Winter, M.D., Hampstead, were elected Fellows.

The following communications were read:—

1. *Notice of some SECTIONS of the STRATA near OXFORD.*

By JOHN PHILLIPS, M.A., F.R.S., Pres.G.S., Reader in Geology in the University of Oxford.

No. II. *Sections South of Oxford.*

IN England, unconformity between the Cretaceous and the Oolitic strata is discoverable at almost every part of the range of the junction