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TRANSACTIONS OF THE SOCIETY.

XII.—*On some Microzoa from the London Clay exposed in the Drainage Works, Piccadilly, London,* 1885.

By Charles D. Sherborn and Frederick Chapman.

(*Read 13th October*, 1886.)

Plates XIV., XV., and XVI.

The excavation made in Piccadilly in 1885 gave us an opportunity of examining the London Clay there, and investigating its fossil microzoa. The specimens include both Foraminifera and Ostracoda, the latter being very rare. After a few preliminary words on the nature of the London Clay at this point, we will

EXPLANATION OF PLATES XIV., XV., XVI.

Plate XIV.

Fig. 1.—*Miliolina seminulum* (Linné), × 20. diams.
„ 2. „ *circularis* (Bornemann), × 20.
„ 3. „ *communis* (Deshayes), × 20.
„ 4. „ *secans* (d'Orbigny), × 20.
„ 5. „ *Ferussacii* (d'Orbigny), × 50.
„ 6*a*, *b*.—*Textularia agglutinans* d'Orbigny, × 50.
„ 7.—*Gaudryina pupoides* d'Orbigny, × 20.
„ 8.—*Bigenerina capreolus* (d'Orbigny), × 50.
„ 9.—*Verneuilina tricarinata* d'Orbigny, × 20.
Clavulina, see plate XV. fig. 1.
Bulimina, see plate XVI. fig. 1.
„ 10.—*Bolivina punctata* d'Orbigny × 50.
Cassidulina, see plate XVI. fig. 2*a*, *b*.
„ 11.—*Lagena globosa* (Montagu), × 50.
„ 12. „ „ „ var., × 20.
„ 13. „ *lævis* (Montagu), × 50.
„ 14. „ *apiculata* Reuss, × 20.
„ 15. „ *vulgaris* Williamson, v. *oxystoma* Reuss, × 50.
„ 16. „ *striata* (d'Orbigny), × 50.
„ 17. „ „ „ var., × 50.
„ 18. „ *sulcata* Walker and Jacob, × 50.
„ 19*a–d*. „ (*Obliquina*) *oviformis* n. sp. × 20.

proceed with a description of the Foraminifera, the Ostracoda having been handed over to Prof. Rupert Jones, who has expressed his wish to include them in his Supplement of the Tertiary Entomostraca to be published by the Palæontographical Society.

Commencing at Albert Gate, Knightsbridge, a series of shafts were sunk, which appear to have reached a depth of about 30 feet, passing through two "beds" of London Clay, an upper or brown,

Fig. 20*a*, *b*.—*Nodosaria* (*Glandulina*) *abbreviata* Neugeboren, × 20.
„ 21. „ „ *obtusissima* Reuss, × 50.
„ 22*a*, *b*. „ „ *semicostata* n. sp., × 50.
„ 23. „ *humilis* (Rœmer), × 20.
„ 24. „ *radicula* (Linné), × 20.
„ 25, 26. „ *soluta* (Reuss), × 20.
„ 27. „ *ovulata* n. sp., × 50.
„ 28, 29. „ *arundinea* Schwager, × 20.
„ 30. „ *subornata* Reuss, × 50.
„ 31. „ *clavata* Costa, × 50.
„ 32. „ *hispida* d'Orbigny, × 50.
„ 33. „ *affinis* d'Orbigny, × 20.
„ 34. „ *bacillum* Defrance, × 20.
„ 35. „ *badenensis* d'Orbigny, × 20.
„ 36. „ *raphanus* (Linné), × 20.
„ 37. „ „ „ var., × 20.
„ 38. „ *raphanistrum* (Linné) var., × 20.
„ 39*a*, *b*.—*Dentalina vertebralis* (Batsch), × 20.

Plate XV.

Fig. 1.—*Clavulina communis* d'Orbigny, × 20.
„ 2*a*, *b*; 3*a*, *b*; 4*a*, *b*.—*Nodosaria polygona*, Reuss, × 20.
„ 5. *Dentalina communis* d'Orbigny, × 20.
„ 6. „ „ „ var., × 20.
„ 7. „ *elegans* d'Orbigny, × 20.
„ 8. „ *inornata* d'Orbigny, × 20.
„ 9. „ *pauperata* d'Orbigny, × 50.
„ 10. „ *abnormis* Reuss, × 50.
„ 11*a*, *b*. } „ *adolphina* d'Orbigny, × 20.
„ 12. }
„ 13. „ *spinulosa* (Montagu), × 20.
„ *acicula* (Lam.) (woodcut), × 20.
„ 14. „ *multilineata* Bornemann, × 20.
„ 15. „ *obliquestriata* Reuss, × 20.
„ *vertebralis* (Batsch), see plate XIV. fig. 39*a*, *b*.
„ 16*a*, *b*.—*Rhabdogonium tricarinatum* (d'Orbigny) × 50.
„ 17.—*Marginulina bullata* Reuss, × 20.
„ 18. „ *Wetherellii* Jones, × 20.
„ 19*a*, *b*.—*Vaginulina legumen* (Linné), × 50.
„ 20*a*, *b*.—*Cristellaria obtorta* Terquem and Piette, × 50.
„ 21. „ *crepidula* (Fichtel and Moll), × 50.
„ 22*a*, *b*. „ *acutauricularis* (Fichtel and Moll), × 50.
„ 23*a*, *b*. „ *italica* (Defrance), see also plate XVI. fig. 4*a*, *b*), × 20.
„ 24*a*, *b*. } „ „ „ v. *spinulosa* nov., × 50.
„ 25*a*–*c*. }
„ *rotulata* (Lamarck) var., see plate XVI. fig. 3.
„ 26*a*, *b*. „ „ „ v. *flexuosa* nov., × 20.
„ 27*a*, *b*. „ *inornata* d'Orbigny, × 20.
„ 28*a*, *b*. „ *cultrata* (Montfort), × 20.
„ 29*a*, *b*. „ „ „ v. *splendens* nov., × 20.
„ 30. „ *megalopolitana* Reuss, × 20.

and a lower or black bed. We were unable to obtain any very definite information as to these strata, but from the foreman of the works we learned that, whilst at Albert Gate the "black bed" was almost at the surface, opposite Whitehorse Street, Piccadilly, where the last shaft was sunk, there was a considerable thickness of the "brown clay," with an occasional capping of gravel.

Respecting the "brown bed," Professor Prestwich has favoured us with the following note:—"It is probable that the brown clay belongs to a slightly higher bed, and it may be that the colour is due to the bed being slightly more porous, and to the percolation of the surface waters having oxidized the iron in it, producing the brown colour."* It may be well to mention that in washing we found both clays to be equally tenacious, and that there was some difference in the distribution of the fauna. Briefly here, and more particularly in the description of species, we note that in the brown or upper bed *Lagenæ* and *Planorbulinæ* were somewhat abundant and very delicate, whilst in the black clay these forms were very rare, the most abundant being *Pulvinulinæ* (*P. Boueana*, not found in the brown clay), *Nodosariæ*, *Dentalinæ*, and *Cristellariæ*; the *Lagenæ* being represented by thicker and more massive forms as *L. apiculata* and *L. oviformis*.

PLATE XVI.

Fig. 1.—*Bulimina affinis* d'Orbigny, × 50.
„ 2*a*, *b*.—*Cassidulina subglobosa* Brady, × 50.
„ 3.—*Cristellaria rotulata* (Lamarck) var., × 20.
„ 4*a*, *b*. „ *italica* Defrance, var., × 20.
„ 5.—*Polymorphina gibba* d'Orbigny, × 50.
„ 6. „ *gutta* d'Orbigny, × 50.
„ 7.—*Uvigerina asperula* Czjzek, × 50.
„ 8*a*, *b*.—*Globigerina bulloides* d'Orbigny, × 50.
„ 9.—*Orbulina universa* d'Orbigny, × 50.
„ 10*a*, *b*.—*Pullenia sphæroides* d'Orbigny, × 50.
„ 11*a*, *b*.—*Discorbina rosacea* d'Orbigny, × 20.
„ 12*a*–*c*.—*Truncatulina lobatula* Walker and Jacob, × 50.
„ 13*a*–*c*. „ *refulgens* (Montfort), × 50.
„ 14*a*–*c*.—*Planorbulina ammonoides* (Reuss), × 50.
„ 15*a*–*c*. „ *complanata* (Reuss) var., × 50.
„ „ *rotula* (d'Orbigny) (woodcut), 50.
„ 16*a*–*c*. „ *Ungeriana* (d'Orbigny), × 50.
„ 17*a*, *b*. „ *Haidingeri* (d'Orbigny) var., × 20.
Anomalina sp. (woodcut), × 20.
„ 18*a*–*c*.—*Pulvinulina repanda* (Fichtel and Moll), × 50.
„ 19*a*–*c*. „ „ „ „ v. *concamerata* Will., × 50.
„ 20*a*–*c*. „ *Boueana* (d'Orbigny), × 50.
„ 21*a*–*c*. „ *Karsteni* (Reuss), × 50.
„ 22*a*–*c*.
„ 23*a*–*c*. „ *punctatula* (d'Orbigny) var., × 50.
„ 24.—*Tinoporus baculatus* Montfort, × 50.

[The specimens will be deposited in the British Museum.]

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* See also Prestwich, Quart. Journ. Geol. Soc., x. (1854) pp. 401–19.

Of the nature of the two clays, it will be enough to note that the residuum, after washing, of the brown clay was mainly small crystals of selenite, a little coarse subangular sand, and microzoa, the whole residuum being 2½ per cent. by weight of the amount washed. The clay, almost orange-brown when wet, was a dull red-brown when dry. Of the black clay (bluish-black, drying grey and showing when broken numerous sparkling points, the surfaces of quartz-grains and scales of mica) the residuum, 1¼ per cent. by weight of the sample taken, consisted of fine sand, mica, a little carbonaceous matter, and microzoa. No selenite was found in this black clay.

Traces of other organic remains were very scanty; the brown clay yielded one fish-scale; and the black clay some woody fragments, a small vertebra of a fish, a *Natica*, a *Nucula* (broken), fragments of echinoderm spines, and a specimen (crushed in on one side) of *Nautilus regalis*, containing in the adherent clay impressions and casts of *Ditrupa*, and with a *Vermicularia* encrusting a portion of the shell.

In the body of the paper the reader will notice in the description of a few species a note to the effect that they were also found at Chelsea. The exact locality was at the eastern foot of Stanley Railway Bridge, King's Road; and they were obtained from a sample of clay collected by Prof. Rupert Jones, merely as a test. We have noted their occurrence, but shall make no special point of it until we have systematically worked out the clay from this spot.

In writing this paper we have derived much advantage from Professor Rupert Jones' advice, and from the use of his books relating to the subject.

The Entomostraca.

Through the kindness of Professor Rupert Jones, we are enabled to give the following preliminary list of the Entomostraca. This we may reasonably regard as very interesting, when we take into consideration that the total number of valves did not exceed nineteen.

Cythere scrobiculoplicata Jones.
Cythere scabra v. Münst., new to Britain.
Cythere triangularis Reuss.
Cytheridea perforata (Roemer).
Cythereis Bowerbankiana Jones.
Cythereis sp. nov.
Cytherella compressa v. Münst.
Bairdia barbata ? (Sow.).
Macrocypris ? sp.

The Foraminifera.

The series of Foraminifera here to be described does not pretend to be a complete collection of all the forms known to occur in the London Clay, but it has added largely to those varieties already noted. At the end of the paper we give a complete list of all forms reported by authors to have been found in the London Clay, and it is our intention to collect further material for a more comprehensive study of this group. We have been favoured with an inspection of some of the forms collected by Messrs. Jones and Parker, from Copenhagen Fields, and have been kindly offered the loan of the Sheppey forms by Mr. Shrubsole; but we have decided to postpone our further examination of this facies, so many localities remaining as yet untouched.

In dealing with these forms we have kept in view the biological nature of the animal constructing the tests; and guided by the researches of Williamson, Carpenter, Parker, Jones, Brady, and others, our studies confirm the generally adopted opinion, that in many cases the most intimate links can be traced between apparently widely different forms, and that external sculpture, although of classificatory value, has not the same biological importance. The passage may be completely followed from a smooth shell through every degree of ornamentation, as dots, tubercles, and spines, whether scattered or arranged in longitudinal lines, into the most perfectly ribbed forms, either broken up or continuous, especially in the *Nodosarinæ*. Hence we quite agree in the opinion that, except in rare cases, the word "species" should stand "variety," and that many genera even become of doubtful value. We retain these binomial appellations merely for convenience. It was our intention, when first preparing this paper, to endeavour to group together under type-forms the principal figured individuals which from their slight variations have received specific names; but this has been done carefully by A. Goës in his paper "On the Reticularian Rhizopoda of the Caribbean Sea," * and it is unnecessary for us to repeat the attempt, more especially since his paper is printed in English. As a careful and painstaking endeavour to unravel the multitude of varietal forms elevated to the doubtful rank of "species," we gratefully acknowledge the assistance we have derived from this book and, though we do not agree with the author at all points, we strongly advise students of this difficult group of animals to give his book careful attention.

As the most convenient method of dealing with descriptions of

* Kongl. Svenska Vet.-Akad. Handl., x. (1882).

Foraminifera, we have followed H. B. Brady's classification as given in the 'Challenger' Monograph.*

Sub-kingdom PROTOZOA.
Class RHIZOPODA.
Order FORAMINIFERA—(RETICULARIA).
FAMILY MILIOLIDÆ.
Sub-family MILIOLININÆ.

MILIOLINA Williamson [1858].

Miliolina seminulum (Linné), plate XIV. fig. 1. *Serpula seminulum* Linné, 1767, Syst. Nat., 12th ed., p. 1264, No. 791; 1788, 13th (Gmelin's) ed., p. 3739, No. 2.—A poor specimen, having a peculiarly shaped outer chamber very similar to the figures in Plancus, 1739, De Conch. min. not., pl. ii. fig. 1, B, C. One specimen; black clay.

Miliolina circularis (Bornemann), plate XIV. fig. 2*a*, *b*. *Triloculina circularis* Bornemann, 1855, Zeitschr. deutsch. geol. Ges., Bd. vii. plate xix. fig. 4.—A rounded, almost spherical, triloculine form. Two specimens; black clay.

Miliolina communis (Deshayes), plate XIV. fig. 3. *Triloculina communis* Deshayes, 1831, Descrip. Coq. caract., plate iii. figs. 5–7. —Two specimens; black clay.

Miliolina secans (d'Orbigny), plate XIV. fig. 4. *Quinqueloculina secans* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 303, No. 43.—Small and poor. One example; black clay.

Miliolina Ferussacii (d'Orbigny), plate XIV. fig. 5. *Quinqueloculina Ferussacii* d'Orbigny, 1826, modèle, No. 32.—A *Quinqueloculina* with flattened edges, and with the chambers hollowed out along the centre, and like a furrow. This variety is well figured by Parker and Jones in Phil. Trans., 1865, plate xv. fig. 36, from the Arctic Seas. One example; brown clay.

Family TEXTULARIDÆ.
Sub-family TEXTULARINÆ.

TEXTULARIA † Defrance [1824].

Textularia agglutinans d'Orbigny, plate XIV. fig. 6*a*, *b*. D'Orbigny, 1839, Foram. Cuba, p. 136, plate i. figs. 17, 18, 32, 34. —A well-developed, somewhat broad, but small example of this variety. One specimen; brown clay.

* Reports of the 'Challenger' Expedition, ix. (1884)—Report on the Foraminifera.

† See note on the Textulariæ of the London Clay by Jones and Parker, Ann. and Mag. Nat. Hist., xi. (1863) p. 96.

GAUDRYINA D'Orbigny [1840].

Gaudryina pupoides D'Orbigny, plate XIV. fig. 7. D'Orbigny, 1840, Mém. Soc. Géol. France, iv. p. 44, plate iv. figs. 22–4.—A small full-chambered variety of this typical form. Numerous; black clay.

BIGENERINA d'Orbigny [1826].

Bigenerina capreolus (d'Orbigny), plate XIV. fig. 8. *Vulvulina capreolus* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 264, No. 1, pl. xi. figs. 5, 6; modèles, No. 39.—This variety has been well figured by Brady in the 'Challenger' Monograph, plate xlv. figs. 1–4, and figs. 3 and 4 of these correspond very closely to our specimens. Unfortunately we have not met with a single individual with the continuous upper chamber, although this form is one of the most numerous in the collection. Very common, but small, in both clays (and at Chelsea).

VERNEUILINA d'Orbigny [1840].

Verneuilina tricarinata d'Orbigny, plate XIV. fig. 9. D'Orbigny, 1840, Mém. Soc. Géol. France, iv. p. 39, plate iv. figs. 3, 4.—A much worn example. Black clay.

CLAVULINA d'Orbigny [1826].

Clavulina communis d'Orbigny, plate XV. fig. 1. D'Orbigny, 1826, Ann. Sci. Nat., vii. p. 268, No. 4.—This sandy form is extremely common in our washings, but, with the single exception of the figure, only fragments occur.* One at least of our specimens has the triangular commencement mentioned by Brady as characteristic of *C. Parisiensis*. Abundant in both clays.

Sub-family BULIMININÆ.

BULIMINA d'Orbigny [1826].

Bulimina affinis d'Orbigny, plate XVI. fig. 1. D'Orbigny, 1839, Foram. Cuba, p. 109, plate ii. figs. 25, 26.—A very small but perfect example, corresponding with the one figured by Brady in the 'Challenger' Monograph, plate l. fig. 14. Brown clay.

BOLIVINA d'Orbigny [1839].

Bolivina punctata d'Orbigny, plate XIV. fig. 10*a*, *b*. D'Orbigny, 1843, Voy. Amér. Mérid., p. 63, plate viii. figs. 10–12.—A very small, rather flat and narrow form, minutely punctate all over; often bent or wavy in the line of growth. Abundant in both clays.

* See also op. cit., iv. (1859) p. 350, *Clavulina communis* (and "*Nodosaria rustica*" Jones).

Sub-family CASSIDULININÆ.

CASSIDULINA d'Orbigny [1826].

Cassidulina subglobosa Brady, plate XVI. fig. 2 *a*, *b*. Brady, 1881, Quart. Journ. Sci., n.s. xxi. p. 90. 'Challenger' Monograph, plate liv. fig. 17.—Our specimen, the first of this "genus" recorded from the London Clay, is very small, and we at first hesitated to place it under Brady's form, but remarking its pear-shaped bulimine-like orifice, and its subrotundate form, we consider it referable to this variety rather than to *C. crassa* d'Orbigny. One specimen; brown clay.

Family LAGENIDÆ.
Sub-family LAGENINÆ.

LAGENA Walker & Boys [1784].

Lagena globosa (Montagu), plate XIV. fig. 11. *Vermiculum globosum* Montagu, 1803, Test. Brit., p. 524.—A single spherical chamber, sometimes inclining to oval, smooth, and shining, with an aperture of radiating fissures, stellate in appearance. We figure a typical specimen, but have also found the more oval varieties. Four or five examples; brown clay.

Lagena globosa (Montagu), var., plate XIV. fig. 12.—A dwarfed variety of *L. globosa*, in which the upper portion of the test is attenuated, forming a neck, at the apex of which is a stellate aperture. From the black clay.

Lagena lævis (Montagu), plate XIV. fig. 13. *Vermiculum lævis* Montagu, 1803, Test. Brit., p. 524.—Smooth, oval, passing into the shape of an oil-flask; the aperture is a lipped circular hole at the end of a longer or shorter neck. Three or four specimens; brown clay.

Lagena apiculata Reuss, plate XIV. fig. 14. *Oolina apiculata* Reuss, 1850, Haidinger's Nat. Abh., iv. p. 22, plate i. fig. 1.—Smooth, egg-shaped; narrowing to a blunt stellate aperture above, and having a short point below. Three specimens; black clay.

Lagena vulgaris Williamson; var. *oxystoma* Reuss, plate XIV. fig. 15. *Lagena oxystoma* Reuss, 1858, Zeitschr. d. g. Ges., x. p. 433; 1862, Sitz. K. Ak. Wiss. Wien, xlvi. p. 335, plate v. fig. 66.—A spherical form, with a neck rising abruptly from the chamber and ending in a circular orifice. The surface of this variety is granular, thus presenting a slight difference from *L. hispida* and *L. hystrix* Reuss ('Lagenideen').* This form was first noted by Reuss as a new species in 'Ueber die Foraminiferen von Pietzpuhl,' Zeitsch. d. Geol. Ges., x. (1858) p. 433, being figured by him subsequently in his 'Lagenideen,' quoted above. One; brown clay.

* SB. K. Akad. Wiss. Wien, xlvi. (1862) pl. vi. figs. 77–80.

Lagena striata (d'Orbigny), plate XIV. fig. 16. *Oolina striata* d'Orbigny, 1839, Voy. Amér. Mérid., p. 21, plate v. fig. 12.—This beautiful form has a somewhat egg-shaped chamber, delicately ribbed, and a long neck ornamented with very thin rings of shelly matter, at regular intervals. Our specimen differs from that figured in the 'Challenger' Monograph, plate lii. fig. 22, in that the neck-rings are oblique in that specimen, whilst in ours they are horizontal. One specimen; brown clay.

Lagena striata (d'Orbigny), var., plate XIV. fig. 17.—Most likely a variety of the last. D'Orbigny's original figure is round, with a flattened base, like an onion, and therefore this is more like the type. It has evidently lost its neck; and at the base there is a small projection. One specimen; brown clay.

Lagena sulcata Walker and Jacob, plate XIV. fig. 18. *Serpula (Lagena) striata, sulcata, subrotundata,* Walker and Jacob, 1784, Test. Min., p. 2, plate 1, fig. 6.—A coarsely ribbed ovate test. Unfortunately, only half of this specimen remains. It has split longitudinally, but its characters are so well marked as to make it easy of identification. One specimen; brown clay.

Lagena (*Obliquina* Seguenza) *oviformis* n. sp., plate XIV. fig. 19*a–d*.—Test thick, symmetrically oval, perfectly smooth, and glossy; orifice lateral, large, at the top of a short truncated cone, in the second sixth of the side. The aperture is round or semicircular. When round it has a notch in its upper lip reaching to the base of the cone. This form appears to be entirely new, the nearest to it being Seguenza's *Obliquina acuticosta*, figured in Terr. terz. Messina, 4to, Messina, 1862, p. 75, plate ii. figs. 65–67. We do not consider the lateral aperture of "generic" value, and therefore keep to *Lagena*. Amongst other figured *Lagenidæ* as approximating to this variety may be mentioned a broken and repaired specimen of *L. vulgaris* Will., figured by O. Rymer Jones, Trans. Linn. Soc., xxx., plate xix. fig. 2, and *Lagena apiculata* Reuss, Brady's 'Challenger' Monograph, plate lvi. fig. 4. In both of these the aperture is lateral. Gümbel's *L. perovalis*, figured in 'N. Alp. Eocängebirge,' Abh. K. Bayer. Ak. Wiss., 1866, Bd. x., plate i. fig. 7, is closely similar in outline. The little notch in the upper lip might have been regarded as of more value, were there not one specimen at least without it. Five specimens; black clay.

Sub-family Nodosarinæ.

Nodosaria Lamarck [1816].
(Glandulina d'Orbigny [1826].)

Nodosaria (*Glandulina*) *abbreviata* Neugeboren, plate XIV. fig. 20*a, b*. *Glandulina abbreviata* Neugeboren, Denkschr. k. Ak. Wiss. Wien, 1856, p. 68, plate i. fig. 1.—A short, round form,

with a truncated neck and slit-like aperture. In this last feature it approaches *Lingulina*. One specimen (figured) from the black clay; not rare in the brown clay, but smaller and perhaps immature.

Nodosaria (*Glandulina*) *obtusissima* Reuss, plate XIV. fig. 21. Sitz. k. Ak. Wiss. Wien, 1863, xlviii. p. 66, plate 8 fig. 92.—Smooth and round, consisting of two (or three) chambers, the upper much larger than the lower, and ending in a slightly conical stellate aperture. Four specimens; brown clay.

Nodosaria (*Glandulina*) *semicostata* n. sp., plate XIV. fig. 22*a*,*b*. —An apparently two-chambered, acorn-shaped form; the upper chamber is somewhat compressed and bilobed (slightly deformed?) on one side; the lower chamber is round, bluntly acute, with delicate longitudinal costæ. Mouth, a circle of radiating fissures, slightly produced. This specimen was, unfortunately, lost; but, careful drawings having been made from it, we are enabled to include it in our figures. One specimen; black clay.

Nodosaria humilis (Roemer), plate XIV. fig. 23. Roemer, 1841, Verst. Norddeutsch. Kreide, p. 95, plate xv. fig. 6.—A short 3- to 4-chambered, glanduline-like form, common in the Chalk. A good figure of this form is to be seen in Brady's 'Challenger' Monograph, plate lxi. fig. 28, under the name of *N. radicula*, of which indeed *humilis* is zoologically a variety. One specimen; black clay.

Nodosaria radicula (Linné), plate XIV. fig. 24. *Nautilus radicula* Linné, 1767, Syst. Nat., 12th ed., p. 1164, 285; 1788, ibid., 13th (Gmelin's) ed., i. p. 3373, plate vi., No. 18.—A uniform or gradually increasing series of smooth chambers, spherical in section. Rare and poor; only found in the black clay.

Nodosaria soluta (Reuss), plate XIV. figs. 25, 26. *Dentalina soluta* Reuss, 1851, Zeitschr. d. geol. Ges., iii. p. 60, plate iii. fig. 4.—Of our two figured examples, one (26) approximates very closely to Reuss' original figure, and the other is comparable with the variety figured by Von Hantken in Mitth. k. ung. geol. Anst., 1875, iv., plate iii. fig. 2. In Reuss' figure we find the chambers to be apparently all of one size; in Von Hantken's figure, on the other hand, we are shown a series of four chambers, the last of which is three times larger than the first. Our specimen of this form has unfortunately only two chambers, and part of a third, but otherwise the resemblance to Von Hantken's figure is perfect. In 1865 Reuss figured in his 'Kreide Kanara-See' (Sitz. k. Ak. Wiss., lii. plate i. fig. 4), a form which he names *N. prægnans*; and as this is almost the same as that figured by Von Hantken as *N. soluta* Reuss, we presume Von Hantken did not see Reuss's figure. Biologically we draw no distinction between any of these forms, and are quite content to let the specimen under notice

remain as *N. soluta* Reuss, as figured by Von Hantken. In the British Museum (Natural History), tablet "49,531, London Clay, Haverstock Hill, London," are two large and single chambers, exactly like the last chamber of our figure. They are marked "*N. soluta*? Reuss," by Prof. Rupert Jones,* and we had no doubt on seeing them, that they were upper portions of the same form that we figure, having rapidly increasing chambers. Of Reuss' original type, one specimen only; black clay. Of Von Hantken's variety, the figured specimen, from the black clay and a few single chambers from the brown.

Nodosaria ovulata n. sp., plate XIV. fig. 27.—A series of sub-cylindrical, egg-shaped chambers, separated from each other by a short neck. This is the only specimen found in which there is a series of chambers; but as there are many single chambers in the brown clay, we consider it a permanent variety. Brown clay.

Nodosaria arundinea Schwager, plate XIV. figs. 28, 29. Schwager, 1866, 'Novara' Exped., Geol. Theil, Bd. ii. p. 211, plate v. figs. 43–5.—This long narrow *Nodosaria* has been considered by former authors to be the same as *N. longiscata* of d'Orbigny (Foram. Tert. Vienne, 1846, plate i. figs. 10–11); but on a careful examination of his figure, we find that the chambers end basally in an angular manner, the apices of the next below joining them in the centre, so that the shell presents, as it were, the appearance of a pile of narrow sugarloaves. In the table attached to Jones and Parker's 'Foram. London Clay' ('Geologist,' vii. 1864, p. 88), we note *longiscata* bracketed with *ovicula* d'Orbigny, as occurring at Copenhagen Fields. Having examined some of the original specimens in Prof. Rupert Jones' collection, we find that they are like the forms under notice, and we are more confirmed in the view that we are not dealing with d'Orbigny's *longiscata*. In Schwager's figures the precise form of our shells is given; those with the swollen centres being much rarer than those uniformly parallel-sided. All our examples are in a fragmentary state; we have not met with any specimens of more than two chambers. Mr. Shrubsole in his paper on 'The New Town-Well at Sheerness,' Proc. Geol. Assoc. v. (1876–8) p. 360, quotes *N. longisecta* as occurring; but we have treated this as a misprint for *longiscata*. Rare; in both clays; one fragment also from Chelsea.

Nodosaria subornata Reuss, plate XIV. fig. 30. Reuss, 1865, Sitz. k. Ak. Wiss. Wien, lii. p. 459, plate i. figs. 9–10.—A smooth *Nodosaria*, ornamented with short riblets crossing the septa. Under this name Reuss also figures one specimen ribbed continuously from end to end; but others, and ours, have fine ribs only at the junction of the chambers. In our specimen these are a little oblique; and from the fragment left to us we gather that the chambers were drop-shaped,

* Catal. Foss. Foram. Brit. Mus., 1882, p. 20.

longer, and not so uniform as in the specimen figured by Reuss. As striking examples of the close relationship of the many forms, slightly varying, as well in their Dentaline and Nodosarian shapes, as in their intermittent markings, we may refer to Reuss, Z. d. g. G., iii. (1851) plate iii., *D. Philippi* Rss., fig. 5, *D. Buchii* Rss., fig. 6, *D. obliquestriata* Rss., fig. 11; also to Reuss, Sitz. k. Ak. Wiss. Wien, xviii. (1855), plate i., *N. cylindrella* Rss., fig. 2, *D. capitata* Boll, fig. 4, *D. Sandbergeri* Rss., fig. 5, *D. Girardana* Rss., fig. 6, *D. intermittens* Bronn, fig. 7, and others. (See lists in Goës's excellent memoir, 1882, K. Sv. Vet.-Akad. Handl., Bd. xix.) From the brown clay.

Nodosaria clavata Costa, plate XIV. fig. 31. *Vaginulina clavata* Costa, 1855, Mem. Accad. Sci. Napoli, plate iii. fig. 18, A and B. This variety seems referable to Costa's figure A; our specimen and his figures are undoubtedly *Nodosariæ*, and, we are disposed to think, monstrosities. One only, black clay.

Nodosaria hispida d'Orbigny, plate XIV. fig. 32. D'Orbigny, 1846, Foram. Tert. Vienne, p. 35, plate i. fig. 24. A short, stout, and thickly spinous *Nodosaria*. Two specimens; black clay.

Nodosaria affinis d'Orbigny, plate XIV. fig. 33. D'Orbigny, 1846, Foram. Tert. Vienne, p. 39, plate i. fig. 36.—A very large and perfect individual, having all the characteristics of d'Orbigny's figure, with the exception of the basal spike. In its place our specimen has a circular orifice, probably due to fracture. Along the last few chambers the ribs have a tendency to take a spiral direction; and this in one individual (a passage-form to *N. badenesis* d'O.) persists to such an extent that a definite twist has occurred, and the last chamber is turned once round on the next below, the ribs being confusedly coiled together at the constriction. From the black clay; fragments numerous in both beds.

Nodosaria bacillum Defrance, plate XIV. fig. 34. Defrance, 1825, Dict. Sci. Nat., xxxv. p. 127, xxxvi. p. 487; Atlas Conch., plate xiii. fig. 4; Blainville, Malacologie, plate v. fig. 4.—Large and fine, differing very slightly from the last variety; it is bulbous at the lower end and not so distinctly constricted in the first three-quarters of the shell. Black clay; fragments numerous in both beds; found also at Chelsea.

Nodosaria badenensis d'Orbigny, plate XIV. fig. 35. D'Orbigny, 1846, Foram. Tert. Vienne, p. 38, plate i. fig. 34.—A short stunted variety of the last, differing from it chiefly in the chambers rapidly decreasing in size. Sowerby, in Wetherell's paper on the 'Hampstead Well,' Geol. Trans., ser. 2, v. plate ix. fig. 8, figures a typical London Clay example. Rare, but occurring in both clays. The figured specimen is from the brown clay.

Nodosaria raphanus (Linné), plate XIV. fig. 36. *Nautilus raphanus* Linné, 1767, Syst. Nat., 12th ed., p. 1164, No. 283; 1783, ibid., 13th (Gmelin's) ed., p. 3372, No. 16.—A very characteristic specimen of this type form. Sowerby figures a similar example from the Hampstead well in Wetherell's paper (op. cit.). One specimen; black clay.

Nodosaria raphanus (Linné) var., plate XIV. fig. 37.—An elongated variety of the last mentioned. One specimen; black clay.

Nodosaria raphanistrum (Linné), plate XIV. fig. 38. *Nautilus raphanistrum* Linné, 1767, Syst. Nat., 12th ed., p. 1163, No. 282.—Poor, thin and irregular, broken at lower end. H. B. Brady in 'Somerset Proceedings, &c.,' 1865–6, plate i. fig. 7, figures *N. raphanistrum* from the Lias, and this much resembles our specimen. One of Reuss' figures of *N. subornata* (Sitz. k. Ak. Wiss. Wien, lii. 1865, plate i. fig. 10) comes close to this form, and *Dentalina nodosa* d'O., as figured by Vanden Broeck in Ann. Soc. Belge Micr., ii. 1876, plate ii. fig. 10, represents the curved and tapering variety, *D. acicula* (Lam.). Parker and Jones (1859, A. M. N. H., ser. 3, iii. p. 478) state that "Mr. Hanley has satisfactorily determined the *Nodosaria* denominated *raphanistrum* by Linnæus, and has figured it in the Ipsa Linn. Conch., plate v. fig. 4. This proves to be the *Nodosaria bacillum* of Defrance (Dict. Sci. Nat.) and the *N. æqualis* of Sowerby ('Genera' and 'Manual'). It was published in the 10th edition of the Syst. Nat. without any reference to a figure; but in the 12th edition Linné referred to Ledermüller's plate iv. fig. *æ.* posterior, as the best published representation. This, though a dwarfish form, serves to link *N. raphanus* with *N. raphanistrum.*" These remarks are illustrated by our figures in plate XIV., where the gradations between the several varieties of this interesting *Nodosaria* can be readily recognized. Fig. 38 is equivalent to one of Ledermüller examples, though longer and more slender; and Ledermüller's other figure, quoted by Linné, is thicker and more like the common *N. raphanus.* One specimen; black clay.

Nodosaria polygona Reuss, plate XV. figs. 2*a*, *b*; 3*a*, *b*; 4*a*, *b*. Reuss, 1855, Z. d. geol. Ges., vii. p. 266, plate viii. fig. 7.—A many-chambered form, commencing with a swollen chamber and growing upwards regularly and increasingly for some distance, then assuming the characters of *N. bacillum* Defrance or *N. raphanus* (Linné). In transverse section in the lower part of the shell we see eight sharply angular ribs. Reuss' figure exhibits the peculiarities of the form perfectly, and in his description he has fully recognized its affinities to *N. bacillum* Defr. and *N. affinis* d'Orb. We figure a specimen of the early chambers (fig. 4), and one (fig. 3) showing the relation of the shell to *N. raphanus.* Five imperfect specimens, Stanley Railway Bridge, Chelsea.

Dentalina communis d'Orbigny, plate XV. fig. 5. D'Orbigny, 1826, Ann. Sci. Nat., vii. p. 254, No. 55; Jones, Parker, and Brady, Crag Foram. Pal. Soc., 1866, p. 58.—This rather fine individual, with straight septa, appears to have been still larger, as the last perfect chamber shows the broken base of another. It is smooth and translucent. One specimen and fragments; black clay.

Dentalina communis d'Orbigny, var., plate XV. fig. 6.—Much smaller than the last, but almost identical in other characters. Our figure is from the black clay, but it occurs, though rarely, in both clays; also at Chelsea.

Dentalina elegans d'Orbigny, plate XV. fig. 7. D'Orbigny, 1846, Foram. Tert. Vienne, p. 45, plate i. figs. 52–6.—An extremely delicate variety, and even neater than d'Orbigny's figure. One specimen; black clay.

Dentalina inornata d'Orbigny, plate XV. fig. 8. D'Orbigny, 1846, Foram. Tert. Vienne, p. 441, plate i. fig. 50.—The three last chambers of a *Dentalina* very near to d'Orbigny's figure. From the black clay.

Dentalina pauperata d'Orbigny, plate XV. fig. 9. D'Orbigny, 1846, Foram. Tert. Vienne, p. 46, plate i. figs. 57–8.—Characterized by its squat appearance, chambers square-shaped in side view, and regularly even in growth. Two specimens; from the brown clay.

Dentalina abnormis Reuss, plate XV. fig. 10.—Reuss, 1863, Sitz. k. Ak. Wiss. Wien, xlviii. p. 46, plate ii. fig. 24.—A three-chambered form, found by Reuss in the "Septarienthon" of Offenbach. Black clay.

Dentalina adolphina d'Orbigny, plate XV. fig. 11*a*, *b*; 12. D'Orbigny, 1846, Foram. Tert. Vienne, p. 51, plate ii. fig. 18.—This elegant and very common variety appears at first sight to be smooth; but under the Microscope it shows bases of delicate spines. These are uniformly distributed over the last chambers, but very regularly in two rows around the basal half of each of the other chambers. As these shells have been found by us straight instead of curved, and so becoming very much like the simpler forms, this arrangement of spines helps to fix the variety. A delicate spine, sometimes forked, usually commences the first chamber, and is generally placed on the concave side of the shell. Fig. 11*b* is a perfect mouth from another individual. Fig. 12 is a perfect, but feebly grown specimen. Very common in the black, rare in the brown clay.

Dentalina spinulosa (Montagu), plate XV. fig. 13. *Nautilus spinulosus* Montagu, 1808, Test. Brit. Suppl., p. 86, plate xix. fig. 5. Our specimens are like that figured by Sowerby in Wetherell's paper on the 'Hampstead Well' (op. cit.).—An extremely variable form in its markings, which pass from true

spines to triangular points (as in Sowerby's figure, which is a typical condition), from points to winged terminal riblets at the bases of the chambers, and further to riblets often continuous along the first-formed portions of the shell. The same gradations are shown, though less perfectly (on account of the paucity of individuals) on tablet 49,491, in the British Museum (Nat. Hist.). This series came from the London Clay of Haverstock Hill, London. Montagu's original figure appears to represent some of the middle chambers of a *D. adolphina* d'Orb. A reference to our figure of this variety (fig. 11*a*) will show that the uppermost chambers become elongate sometimes and fully spinose as in some chambers of *D. spinulosa*. Very common in both clays, generally fragmentary; also at Chelsea.

FIG. 154.

Dentalina acicula (Lamarck). Woodcut, fig. 154. *Orthocera acicula* Lamarck, 1822, Hist. Anim. sans Vert., vii. p. 594, No. 5.—Here are some lower chambers of an individual belonging to this variety. There is a similar fragment in the British Museum, tablet 49,490) from the London Clay, Islington, London), which shows the same continuous costæ. In both cases the upper part has disappeared. This form commences from a point and increases gradually in size.

Lamarck says it is straight (*Nodosaria*), but the difference between *Nodosaria* and *Dentalina* being merely one of curvature, we refer it to this latter form, taking as our type the specimen quoted above, from the British Museum, and included in Prof. Rupert Jones' Catalogue, p. 20. Black clay.

Dentalina multilineata Bornemann, plate XV. fig. 14. Bornemann, 1855, Zeitschr. d. geol. Ges., vii. p. 325, plate xiii. fig. 12.—A curved, horizontally chambered, and finely ribbed form, of which, unfortunately, the top is missing. Although Bornemann's figure only gives us three chambers, still, considering its fine ribbing and the position of chambers, we consider our form to be the same. In 1874 Reuss figured in Geinitz's 'Elbthalgebirge,' 4to, Cassel, 1872–4, plate xx. fig. 13, the upper end of a *Dentalina*, the same as that of Bornemann, calling it a new species and using the same name as Bornemann did twenty years before. Two fragments; black clay.

Dentalina obliquestriata Reuss, plate XV. fig. 15. Reuss, 1851, Zeitschr. d. geol. Ges., iii. p. 63, plate iii. figs. 12, 13.—Under this name Reuss figures in his 'Septarienthon,' two lower ends of a Dentaline form, with fine oblique striæ. Batsch, in 1791, figured a form very similar, but with fewer, coarser, and more continuous costæ; and this he called *Nautilus obliquatus*. Our specimen consists of five chambers, and both ends appear to have been broken away. One specimen; black clay.

Dentalina vertebralis Batsch, plate XIV. fig. 39*a*, *b*. *Nautilus (Orthoceras) vertebralis* Batsch, 1791, Conchyl. Seesandes, p. 3, No. 6, plate ii. figs. 6 *a* and *b*.—Six-sided, with horizontal chambers. Our figure is narrower and longer than that figured in 'Challenger' Report, plate lxiii. fig. 35. This and a fragment from the black clay.

RHABDOGONIUM Reuss [1860].

Rhabdogonium tricarinatum (d'Orbigny), plate XV. fig. 16*a*, *b*. *Vaginulina tricarinata* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 258, No. 4; modèle No. 4.—A many chambered Nodosarine; the chambers triangular. Balkwill and Wright in Trans. R. I. Acad., 1885, xxviii., plate xii. figs. 17, 18, figure a recent specimen of this variety. In their figure we are only shown a two-chambered form, whilst d'Orbigny's original has many chambers. Our example agrees with Balkwill and Wright's figure in having two chambers; but the lower chamber in our specimen is rotundate and not ribbed at the angles; moreover there is a marked swelling on two sides, and one of the ribs is double. The mouth also differs; in ours it is stellate,* in theirs it is triangular. These differences, however, we do not consider sufficient to allow us to form a new variety. One specimen; brown clay.

MARGINULINA d'Orbigny [1826].

Marginulina bullata Reuss, plate XV. fig. 17. Reuss, 1845–6, Verst. böhm. Kreide, part i. p. 29, plate xiii. figs. 34–8.—A dwarfed and much curved *Marginulina glabra* d'O. One specimen; black clay.

Marginulina Wetherellii Jones, plate XV. fig. 18. Jones, 1854, Morris' Cat. Brit. Foss., 2nd edition, p. 37.—This common and beautiful form shows great variety of sculpture—indeed, so much so, that amongst no more than one hundred individuals we are able to pick out nine or ten different ornamentations. Some of these are smooth, with a transverse rib or limbate thickening at the junction of each chamber; others are like the last, but with scattered tubercles on the chambers; others with tubercles closely packed on the coiled part of the shell, the upper part having plain limbate sutures or transverse ribs; a fourth variety, in which the transverse ribs alternate with bands of tubercles; a fifth has the ribs themselves broken up into tubercles and irregular bosses, the body of the chambers remaining smooth; a sixth is tuberculate but with no sutural ribs; a seventh has the sutural tubercles elongate, and so gradually forming longitudinal ribs; and lastly, there are specimens like our figure, which has its early chambers longitudinally

* See also Karrer, SB. K. Akad. Wiss. Wien, xliv. (1861) pl. i. fig. 5.

ribbed, and its upper chambers decorated with minute prickles and burs. In transverse section all specimens vary from nearly circular to a long oval; and many of them have a more or less serrated keel. Remarking all these differences, we cannot refrain from calling the student's attention to the undermentioned figures as a few of the forms shown under different names. All these we prefer to regard as belonging to this variety, for we can closely match them amongst the specimens collected by us from the Piccadilly clay.

Cristellaria decorata Reuss, Z. d. geol. Ges., 1855, vii. plate viii. fig. 10; plate ix. fig. 2. *Marginulina fragraria; M. (Crist.) asperula, C. cumulicostata* Gümbel, Abh. k. Ak. Wiss. Wien, 1868, x. plate i. figs. 58, 65, 67. *C. arcuata* Phil.; *C. gladius* Phil.; *C. fragraria* Gümb., Von Hantken, Mitth. k. ung. geol. Anst., 1875, iv. plate v. figs. 10 and 12; plate vi. figs. 1, 2, and 3.—Sowerby, in Wetherell's paper (op. cit., fig. 12), figures this variety; and an elongate specimen occurs in plate cxiv. fig. 14 of Brady's 'Challenger' Monograph. Although it was mentioned in Morris's Catalogue as above quoted, its relation to other forms was first described by Parker and Jones, 1859, Ann. and Mag. Nat. Hist., ser. 3, iv. p. 350. This is very common in both clays at Piccadilly, and also occurs at Chelsea.

Vaginulina d'Orbigny [1826].

Vaginulina legumen (Linné) var., plate XV. fig. 19*a*, *b*. *Nautilus legumen* Linné, Syst. Nat., 12th ed., p. 1164, fig. 288. Test smooth, much compressed, of six rapidly increasing chambers. One specimen; brown clay.

Cristellaria Lamarck [1816].

Cristellaria obtorta Terquem and Piette, plate XV. fig. 20*a*, *b*. Terquem, 1860–1, Mém. Acad. Imp. Metz, xlii. Ann. p. 459, plate vi. fig. 20.—A very rare form of *Cristellaria*, nearly straight, recorded by Terquem from the Lias of the Department Moselle. The figure referred to has more chambers than ours, and does not show any trace of the spiral; but we do not consider it necessary to divide them. One specimen; brown clay.

Cristellaria crepidula (Fichtel and Moll), plate XV. fig. 21. *Nautilus crepidula* Fichtel and Moll, 1803, Test. Microsc., p. 107, plate xix. figs. *g–i*. — An elongate, erect, and compressed form, eminently characteristic of Jurassic deposits, and subject to great variety. One specimen; brown clay.

Cristellaria acutauricularis (Fichtel and Moll), plate XV. fig. 22*a*, *b*. *Nautilus acutauricularis* Fichtel and Moll, 1803, Test. Microsc., p. 102, plate xviii. figs. *g–i*.—A small, smooth form, well figured in Brady's 'Challenger' Monograph, plate cxiv. fig. 17. One specimen; brown clay.

Cristellaria italica (Defrance), plate XV. fig. 23*a*, *b*, XVI. 4*a*, *b*.—*Saracenaria italica* Defrance, 1824, Dict. Sci. Nat., xxxii. p. 177; xlvii. p. 344; Atlas Conchyl., plate xiii. fig. 6.—Elongate, erect, and triangular, with chambers which rapidly widen. Fig. 4, plate XVI. is a variety of this form. Brown clay.

Cristellaria italica (Defrance) var. *spinulosa* nov., plate XV. fig. 24*a*, *b*; 25*a*–*c*.—In 1863, Reuss figured in his 'Foram. Septarien-Thones Offenbach,' Sitz. k. Ak. Wiss. Wien, xlviii. pp. 49–53, plate iv. figs. 44–9, 51–4, and plate v. figs. 60 and 61, several varieties of *Cristellariæ*, all referable to *C. italica*. Three of these (51, 52, 60) are very closely similar to our specimens, the difference being chiefly in the ornamentation; and on this account we propose to call them var. *spinulosa*. Similar unornamented figures occur in Von Schlicht, 'Foram. Septarienthones Pietzpuhl,' 4to, Berlin, 1870, plate XIII. figs. 19, 20, 23, 24, 25. One of our figures shows a two-chambered form, the other a 4- or 5-chambered, the first two being indistinct; both are more or less covered with short spines, and the larger of the two is limbate between its chambers. The two figured specimens are all that are known; from the brown clay.

Cristellaria rotulata (Lamarck) var., plate XVI. fig. 3. *Lenticulites rotulata* Lamarck, 1804, Ann. du Muséum, v. p. 188, No. 3; Tableau Encycl. et Méth., plate cccclxvi. fig. 5.—A poor and starved example. The true and well-developed form can be seen in many papers, especially in Vanden Broeck's memoir, Ann. Soc. Belge Microsc., ii. 1876, plate iii. fig. 1. Black clay, Piccadilly; also at Chelsea.

Cristellaria rotulata (Lamarck) var. *flexuosa* nov., plate XV. fig. 26*a*, *b*.—We have not previously met with this form. It appears to be a variety of *C. rotulata*, and may be described as follows:—A wax-like test, greenish-grey in colour, with the central boss much whiter than the rest of the shell. Keel obsolete or almost absent, merely defined by tint; no external trace of septation, the whole surface being uniformly smooth. Strongly waved or flexed in the line of growth, giving the shell a contorted appearance. One specimen; black clay.

Cristellaria inornata d'Orbigny, plate XV. fig. 27*a*, *b*. *Robulina inornata* d'Orbigny, 1846, For. Tert. Vienne, p. 102, plate iv. figs. 25, 26.—Smooth, the septal planes showing through the shell as darker lines. Rare; from the black clay.

Cristellaria cultrata (Montfort), plate XV. fig. 28*a*, *b*. *Robulus cultratus* Montfort, 1808, Conchyl. Syst., i. p. 214, 54^{e} genre.—A very common but distinct form, being keeled. The central boss passes from circular to polygonal, as shown in our figure. This is a rather fine example compared with the others from our washings, and there is apparently a chamber missing, which we have

indicated by a dotted line. *C. cultrata* has often been well figured, especially by Vanden Broeck, Ann. Soc. Belge Micros., 1876, ii. plate iii. fig. 3, and by Terrigi, Atti Accad. Pont. N. Lincei, 1880, anno xxxiii. pl i. fig. 12. Black clay; rare in the brown; also at Chelsea.

Cristellaria cultrata (Montfort), var. *splendens* nov., plate XV. fig. 29*a*, *b*.—More compressed than the type; no central boss; septa limbate, ten visible, neat and symmetrical; a large and showy specimen. One example; from the black clay.

Cristellaria megalopolitana Reuss, plate XV. fig. 30*a*, *b*. Reuss, 1855, Zeitschr d. geol. Ges, Bd. vii. p. 267, plate ix. fig. 5.—In 1860, Bornemann figured in Z. d. geol. Ges., Bd. xii. plate vi. fig. 2, *Robulina magdeburgica* (= *Nonionina magdeburgica* Philippi), a form with spreading septal ribs, similar in every respect to Reuss's *megalopolitana*. On reference to Philippi's original figure ('Palæontographica,' 1846–51, Bd. i. Tab. x^{a}. fig. 21), we find the septal ribs of his form to be regular and parallel-sided, and not tapering, hence we consider that Bornemann's figure cannot be accepted as the form intended by Philippi, but must be referred to Reuss's figure. The classificatory value of varying external ornament must be accepted as of some importance in these minor divisions. We therefore prefer to use Reuss's name, which has priority over Bornemann's. One specimen; black clay.

Sub-family Polymorphininæ.

Polymorphina d'Orbigny [1826].

Polymorphina gibba d'Orbigny, plate XVI. fig. 5. *Polymorphina* (*globulina*) *gibba* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 266. No. 20, modèle, No. 63.—Subrotundate, septal lines merely traced upon the surface. In our specimen the aperture is a little on one side. Only one specimen; black clay.

Polymorphina gutta d'Orbigny, plate XVI. fig. 6. *P.* (*Pyrula*) *gutta* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 267, No. 28, plate xii. fig. 5–6, modèle, No. 30.—Amongst the forms obtained occurs a shell which has been broken in half in its whole length, exposing the arrangement of the interior. We have no hesitation in recording it as above, but unfortunately can only figure it in outline. Brown clay.

Uvigerina d'Orbigny [1826].

Uvigerina asperula Czjzek, plate XVI. fig. 7. Czjzek, 1848, Haidinger's Nat. Abh., ii. p. 146, plate xiii. fig. 14.—The prickles on this form appear to be minute sharply pointed granules, very closely packed together. Very abundant in both clays.

Family Globigerinidæ.

Globigerina d'Orbigny [1826].

Globigerina bulloides d'Orbigny, plate XVI. fig. 8*a*, *b*. D'Orbigny, 1826, Ann. Sci. Nat., vii. p. 277, No. 1; modèles, Nos. 71 and 76.—Small but very perfect specimens. Abundant in the brown clay; not so common in the black.

Orbulina d'Orbigny [1839].

Orbulina universa d'Orbigny, plate XVI. fig. 9. D'Orbigny, 1839, Foram. Cuba, p. 3, plate i. fig. 1.—Of this interesting form we have only found one individual. It has been recorded from Sheppey by Mr. Shrubsole. It is not unlikely that, from its minute size, this is frequently overlooked. Brown clay.

Pullenia Parker and Jones [1862].

Pullenia sphæroides (d'Orbigny), plate XVI. fig. 10*a*, *b*. *Nonionina sphæroides* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 293, No. 1.; modèle, No. 43.—Only this single specimen met with; black clay.

Family Rotalidæ.
Sub-family Rotalinæ.

Discorbina Parker and Jones [1862].

Discorbina rosacea (d'Orbigny), plate XVI. fig. 11*a*, *b*. *Rotalia rosacea* d'Orbigny, 1826, Ann. Sci. Nat., vii. p. 273, No. 15; modèle, No. 39.—Not uncommon in our washings, and with the radiate limbation very distinct. Our specimens correspond closely with Williamson's figure in 'Recent Foram. Great Britain,' Ray Society, 1858, plate iv. figs. 109–111. In both clays, but rare.

Truncatulina d'Orbigny [1826].

Truncatulina lobatula (Walker and Jacob), plate XVI. fig. 12*a*–*c*. *Nautilus lobatulus* Walker and Jacob, 1798, Adams' Essays, Kannmacher's edit., p. 642, plate xiv. fig. 36.—Characteristic specimens of this variable form. Rare; black clay; also at Chelsea.

Truncatulina refulgens (Montfort), plate XVI. fig. 13*a*–*c*. *Cibicides refulgens* Montfort, 1808, Conchyl. Syst., i. p. 122, 31^{e} genre.—Our figure closely corresponds with d'Orbigny's modèle No. 77. Rare; brown clay; also at Chelsea.

Planorbulina d'Orbigny [1826].

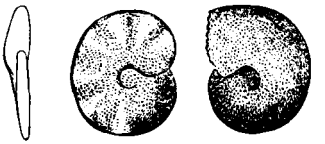
Planorbulina ammonoides (Reuss), plate XVI. fig. 14*a*–*c*. *Rotalina ammonoides* Reuss, 1845, Verst. Böhm. Kreideform., pt. 1, p. 36, plate viii. fig. 53; plate xiii. fig. 66.—The *Planorbulinæ* offer great difficulties in grouping, on account of their variation. *Pl. ammonoides* may be described as having rounded

chambers, and the whole shell generally symmetrical and depressed, sometimes concave at each umbilicus. Rare; in the brown clay. Also at Chelsea.

Planorbulina complanata (Reuss) var., plate XVI. fig. 15*a–c*. *Anomalina complanata* Reuss, 1851, Haidinger's Nat. Abh., Bd. iv. plate iv. fig. 3.—An example somewhat nearer our form was figured and described by Reuss in his paper on 'Hils und Gault,'* under the name of *Rosalina complanata*.

Planorbulina rotula (d'Orbigny). Woodcut, fig. 155. *Anomalina rotula* d'Orbigny, 1846, For. Tert. Vienne, p. 172, plate x. figs. 10, 11.—A much compressed, many-chambered variety; in our specimen the septation is indistinct. One specimen; brown clay.

FIG. 155.



Planorbulina Ungeriana (d'Orbigny) var., plate XVI. fig. 16*a–c*. *Rotalina Ungeriana* d'Orbigny, 1846, Foram. Tert. Vienne, p. 157, plate viii. fig. 16.—Our specimen, in spite of its ornamentation of riblets on the spire, agrees generally with d'Orbigny's figure. Bornemann figures in 'Septarien-thon Hermsdorf,' Z. d. geol. Ges., 1855, vii., plate xvi. fig. 5, a form in which the ornamentation appears to be a granulate boss. We have the normal type, but do not figure it. It is not rare in our washings. Brown clay; also at Chelsea.

Planorbulina Haidingeri (d'Orbigny) var., plate XVI. fig. 17*a, b*. *Rotalina Haidingeri* d'Orbigny, 1846, For. Tert. Vienne, p. 154, plate viii. figs. 9–11.—Sowerby, in Wetherell's paper (op. cit.), figures this small Rotaline, and describes it, with others, as *Rotalia*. We have examined our specimens carefully, and have come to the conclusion that it is a dwarfed and poor form, and may be safely described as a variety of *P. Haidingeri*.† It is of frequent occurrence in the London Clay, but in our washings we have found it only in the black bed.

FIG. 156.

Anomalina, sp. Woodcut, fig. 156. Unfortunately broken and lost after this drawing was made. It is near *Truncatulina grosserugosa* Gümbel. From the black clay.

PULVINULINA Parker and Jones [1862].

Pulvinulina repanda (Fichtel and Moll), plate XVI. fig. 18 *a–c*. *Nautilus repandus* Fichtel and Moll, 1803, Test. Micr., p. 35, plate iii. figs. *a–d*. Rare; brown clay; also at Chelsea.

* SB. K. Akad. Wiss. Wien, xlvi. (1863) p. 86, pl. xi. fig. 3.

† See also Geologist, vii. (1864) p. 87, and Catal. Foss. Foram. Brit. Mus., 1882, pp. 21 and 90.

Pulvinulina repanda (Fichtel and Moll) var. *concamerata* Williamson, plate XVI. fig. 19 *a–c*. *Serpula concamerata* Montagu, Test. Brit., Suppl., p. 160 (*fide* Williamson). *Rotalina concamerata* Williamson, 1858, Recent. For. Gt. Brit., p. 52, plate iv. figs. 102–3.—A limbate variety of *P. repanda*. Rare; brown clay.

Pulvinulina Boueana (d'Orbigny) plate XVI. fig. 20*a–c*. *Rotalia Boueana* d'Orbigny, 1846, Foram. Tert. Vienne, p. 152, plate vii. figs. 25–27.—A much ornamented form, having a delicate, thin keel. Extremely abundant, and varied in its ornamentation, in the black clay, and not met with in the brown.

Pulvinulina Karsteni (Reuss), plate XVI. fig. 21 *a–c*. *Rotalia Karsteni* Reuss, 1855, Z. d. geol. Ges., vii. p. 273, plate ix. fig. 6.—Rare; brown clay.

Pulvinulina punctatula (d'Orbigny) varr., plate XVI. figs. 22*a–c* and 23*a–c*. *Rotalia punctatula* d'Orbigny, 1826, Tabl. Méthod., p. 273, No. 25; modèles, No. 12. We have placed these two examples together, believing them to be varieties of the same form. From the brown clay.

Sub-family Tinoporinæ.

Tinoporus Montfort [1808].

Tinoporus baculatus Montfort (Carpenter), plate XVI. fig. 24. Montfort, 1808, Conchyl. Syst., i. p. 146, 37^{e} genre. Carpenter, 1860, Phil. Trans., p. 557, plates xviii. and xix.—A small example of this form, with a granular surface, occurred. Our specimen is comparable with Dr. Carpenter's figure in Introd. Foram., plate xv. fig. 8. One only found; black clay.

In the following table will be found a complete list of all the Foraminifera at present known to occur in the London clay. We have noted the localities and the authority for their occurrence, and have given our Piccadilly specimens in a separate column, noting their relative abundance.

The following books and memoirs include references to the Foraminifera of the London clay:—

1834, Wetherell, T. N., "Observations on a well dug on the south side of Hampstead Heath" [the Foraminifera figured and partly described by J. De C. Sowerby], Trans. Geol. Soc., 1834, ser. 2, v. p. 131, plate ix. figs. 3–10 and 12–20.

1864, Jones, T. Rupert, and Parker, W. Kitchen, "On the Foraminifera of the London Clay [of Middlesex and Surrey]," Geologist, 1864, vii. pp. 85–88. This paper deals with the nomenclature of Wetherell's figures, he having merely indicated the genera and gives a list of all known forms.

1854, Prestwich, Joseph, "On the Thickness of the London

Clay; on the Relative Position of Fossiliferous Beds of Sheppey, Highgate, Harwich, Newnham, Bognor, &c.; and on the Probable Occurrence of the Bagshot Sands in the Isle of Sheppey," Quart. Journ. Geol. Soc., 1854, x. pp. 401–19. Lists of the Foraminifera given on pp. 417 and 419.

1872, Whitaker, William, Memoirs of the Geological Survey of England and Wales, vol. iv. The Geology of the London Basin. 8vo, London, 1872. List of Foraminifera by Jones and Parker.

1878, Shrubsole, W. H., "On the New Town-Well at Sheerness" [with a] "List of Fossils found in the London Clay," Proc. Geol. Assoc., 1876–8, v. pp. 355–62. (No authors' names given to the species.)

1882, Jones, T. Rupert, Catalogue of the Fossil Foraminifera in the Collection of the British Museum. 8vo, London, 1882.

The following arrangement of initial letters will show the localities where the fossils were described from or noticed as occurring, and will also indicate the author responsible.

From Mr. Wetherell's collection (described in detail by Jones and Parker, 1864, *Geologist*, vii. pp. 85–89): H.W., Hampstead Well; H.H.F., Hampstead, Highgate, and Finchley.

From Messrs. Jones and Parker's collection (Geologist, op. cit.): C.F., Copenhagen Fields; C.T., Chelsea, bed of Thames; C., Clapham; W., Wimbledon Common.

Mr. Shrubsole's collection (Proc. Geol. Assoc., op. cit.): S., Sheppey.

Messrs. Sherborn and Chapman's collection: Ch., Chelsea, at the foot of Stanley Railway Bridge; the Piccadilly specimens appear in a separate column at the end of the table.

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Biloculina depressa d'Orb.	W.	
Spiroloculina excavata	S.	
„ planulata	S.	
Miliolina (Triloculina) oblonga Mont.	C.F., W.	
„ „ *trigonula*	S., Haverstock Hill (Cat. For. Brit. Mus., p. 19).	
„ „ communis Desh. ..	..	2, new to London Clay.
„ „ circularis Born.	..	1, new to London Clay.
„ (Quinqueloculina) seminulum Linné	S.	1.
„ „ secans d'Orb. ..	S.	1.
„ „ triangularis d'Orb.	H.W., H.H.F., C.F., W.	
„ „ bicornis	S.	

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Miliolina (Quinqueloculina) Ferussacii d'Orb.	S.	1.
„ „ agglutinans ..	S.	
„ „ sp. near *lyra* d'Orb.	Haverstock Hill (C.F.B.M., p. 19)	
Cornuspira involvens	S.	
Lituola nautiloidea Lamk.	C.F., C.T.	
Trochammina incerta d'Orb.	H.W., C.F., W., S.	
Textularia agglutinans d'Orb.	C.F., C.T., W., S.	1.
„ turris d'Orb.	C.F.	
„ abbreviata d'Orb.	W.	
„ carinata d'Orb.	H.H.F., C.F., C.T., W.	
„ sagittula	S.	
„ difformis	S.	
„ variabilis	S.	
Verneuilina tricarinata d'Orb.	..	1, new to London Clay.
„ Muensteri	S.	
Bigenerina (Vulvulina) capreolus d'Orb. ..	Ch.	Very abundant, new to L. C.
„ nodosaria	S.	
Gaudryina pupoides d'Orb.	..	Not rare.
Clavulina (Verneuilina) communis d'Orb. ..	H.W., H.H.F., C.F. C.T., W.	Abundant.
Bulimina ovata d'Orb.	C.F., C.T., W.	
„ pyrula	S.	
„ pupoides	S.	
„ variabilis	S.	
„ affinis d'Orb.	..	1, new to L. C.
Virgulina squamosa	S.	
Bolivina punctata d'Orb.	W.	Abundant.
Cassidulina subglobosa Brady	..	1, new to L. C.
Lagena globosa Mont.	S.	4.
„ lævis Mont.	S.	3.
„ apiculata Reuss	..	3, new to L. C.
„ vulgaris Will., v. oxystoma Reuss ..	..	1, new to L. C.
„ aspera	S.	
„ striata d'Orb.	S.	2.
„ sulcata W. and J.	S.	1.
„ melo	S.	
„ marginata	S.	
„ (Obliquina) oviformis S. and C. ..	..	5, new sp.
Nodosaria (Glandulina) glans	S.	
„ „ abbreviata Neug. ..	..	Not rare, new to L. C.
„ „ obtusissima Reuss ..	..	4, new to L. C.
„ „ semicostata S. and C.	..	1, new sp.
„ radicula Linné	C.F., C.T., W., S.	Rare.
„ humilis Roem.	C.F., C.T., W. ..	1.
„ pyrula d'Orb.	C.F., C.T., W., S.	
„ ovicula d'Orb.	C.F., C.T., W., S.	
„ arundinea Schw.	Ch...	Rare.
„ longiscata = ? arundinea	C.F., C.T., W.	
„ longisecta = ? longiscata	S.	
„ soluta Reuss	(?) Haverstock Hill (C.F.B.M., p. 20)	Very rare.

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Nodosaria ovulata S. and C.	..	Rare, new.
„ subornata Reuss	..	1, new to L. C.
„ clavata Costa	..	1, new to L. C.
„ hispida d'Orb.	S.	2.
„ hirsuta d'Orb.	W.	
„ spinosa d'Orb.	Islington (C.F.B.M., p. 20)	
„ scalaris	S.	
„ raphanus Linné	H.W., W., S. ..	2.
„ „ v. Zippei Reuss	Haverstock Hill (C.F.B.M., p. 20)	
„ raphanistrum Linné	H.W., C.F., C., W. (these specimens include N. bacillum, N. affinis, and N. badenensis)	1.
„ affinis d'Orb.	..	Not rare.
„ bacillum Defr.	Ch...	Not rare.
„ badenensis d'Orb.	H.W., C.F., C., W.	Rare.
„ polygona Reuss	Ch.	New to L. C.
Dentalina communis d'Orb.	H.W., C.F., C.T., W.	Rare.
„ „ v. guttifera d'Orb.	Haverstock Hill (C.F.B.M., p. 20)	
„ elegans d'Orb.	H.W., C.F., C.T., W., Ch.	1.
„ consobrina d'Orb.	C.F., C., W.	
„ pauperata d'Orb.	C.F., C., W., S.	2.
„ obliqua	S.	
„ brevis d'Orb.	W.	
„ inornata d'Orb.	..	Fragments, new to L. C.
„ Buchii = intermittens Roem.* ..	H.W.	
„ abnormis Reuss	..	1, new to L.C.
„ adolphina d'Orb.	S.	Very abundant.
„ spinulosa Mont.	H.W., C.F., C., W., Ch.	Abundant.
„ acuta d'Orb.	Quoted by Prestwich as occurring at Copenhagen Fields in Q.J.G.S., vol. x. p. 47.	
„ acicula Lamk.	C.F., C., W.	1.
„ acuticosta Reuss	W.	
„ multilineata Born.	..	2, new to L. C.
„ obliquestriata Reuss	..	1, new to L. C.
„ vertebralis Batsch	..	2, new to L. C.
Rhabdogonium tricarinatum d'Orb.	..	1, new to L. C.
Marginulina glabra	S.	
„ lituus d'Orb.	C.F., W.	
„ bullata Reuss	..	1, new to L. C.
„ similis d'Orb.	Haverstock Hill (C.F.B.M., p. 20)	

* Noted in Whitaker's 'London Basin,' p. 596. These are most probably the two single spherical chambers we refer to under our description of N. soluta Reuss.

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Marginulina Wetherellii Jones	H.W., H.H.F., C.F., C.T., C., W., Ch., S.	Very abundant.
Vaginulina legumen (Linné)	S.	
„ „ „ var.	..	1, new to L. C.
„ linearis Mont.	W.	
Cristellaria obtorta Terq.	..	1, new to L. C.
„ crepidula F. and M.	W., S.	1.
„ acutauricularis F. and M.	..	1, new to L. C.
„ italica Defr.	H.W., C.F., S. ..	2.
„ „ Defr. v. spinulosa S. and C.	..	2, new var.
„ rotulata Lamk.	H.W., H.H.F., C.F., C., W., S., Ch.	1.
„ „ v. flexuosa S. and C. ..	..	1, new var.
„ inornata d'Orb.	..	Rare, new to L. C.
„ cassis F and M.	W.	
„ cultrata Montf.	H.W., H.H.F., C.F., C., W., Ch.	Very abundant.
„ „ v. splendens S. and C. ..	..	1, new var.
„ megalopolitana Reuss	..	1, new to L. C.
Polymorphina gibba d'Orb.	..	1, new to L. C.
„ gutta d'Orb.	..	1, new to L. C.
„ (Globulina)	Quoted by Prof. Prestwich as occurring at Copenhagen Fields in Q.J.G.S., vol. x. p. 417.	
Uvigerina pygmæa	S.	
„ asperula Czjzek	..	Abundant, new to L. C.
Globigerina bulloides d'Orb.	W., S.	Abundant.
Orbulina universa d'Orb.	S.	1.
Pullenia sphæroides d'Orb.	W.	
Cymbalopora Poeyi	S.	
Discorbina rosacea d'Orb.	S.	Rare.
„ globularis	S.	
Truncatulina lobatula W. and J.	H.H.F., W., S., Ch.	Rare.
„ refulgens Mont.	Ch.	Rare, new to L. C.
Planorbulina ammonoides Reuss	C.T., W., S., Ch. ..	Rare.
„ complanata Reuss	..	Rare, new to L. C.
„ rotula d'Orb.	..	1, new to L. C.
„ Akneriana d'Orb. = Pulv. Boueana d'Orb., q. v.	H.W.	
„ Ungeriana d'Orb.	H.W., H.H.F., C.F.? C.T., C., W., S., Ch.	Not rare, also var.
„ Haidingeri d'Orb. var.	H.W., C.F.? C.T., W., S.	Not rare.
Anomalina, sp.	..	Very rare, new to L. C.
Pulvinulina repanda F. and M.	Ch.	Rare, new to L. C.
„ „ v. concamerata Will. ..	Ch.	Rare, new to L. C.
„ Boueana d'Orb.	(H.W.)	Very abundant.
„ elegans d'Orb	C.T., W.	
„ Micheliniana d'Orb.	W.	

Varieties.	Localities and Authors.	Forms found at Piccadilly.
Pulvinulina Karsteni Reuss	..	Very rare, new to L. C.
,, punctatula d'Orb.	..	Rare, new to L. C.
Rotalia Beccarii	S.	
,, Soldanii	S.	
,, orbicularis d'Orb.	C.T., W.	
Tinoporus baculatus Montf.	..	1, new to L. C.
Nonionina communis	S.	
,, umbilicatula	S.	
Polystomella striato-punctata	S.	

In addition to the above list we find in Professor Prestwich's paper on "The Thickness of the London Clay," Q.J.G.S., x. p. 417, mention made of *Robulina* from Copenhagen Fields and Haverstock Hill, and *Rosalina* from Highgate. It is most probable that these forms have been included in Messrs. Jones and Parker's lists, under the genera *Cristellaria, Planorbulina,* &c.