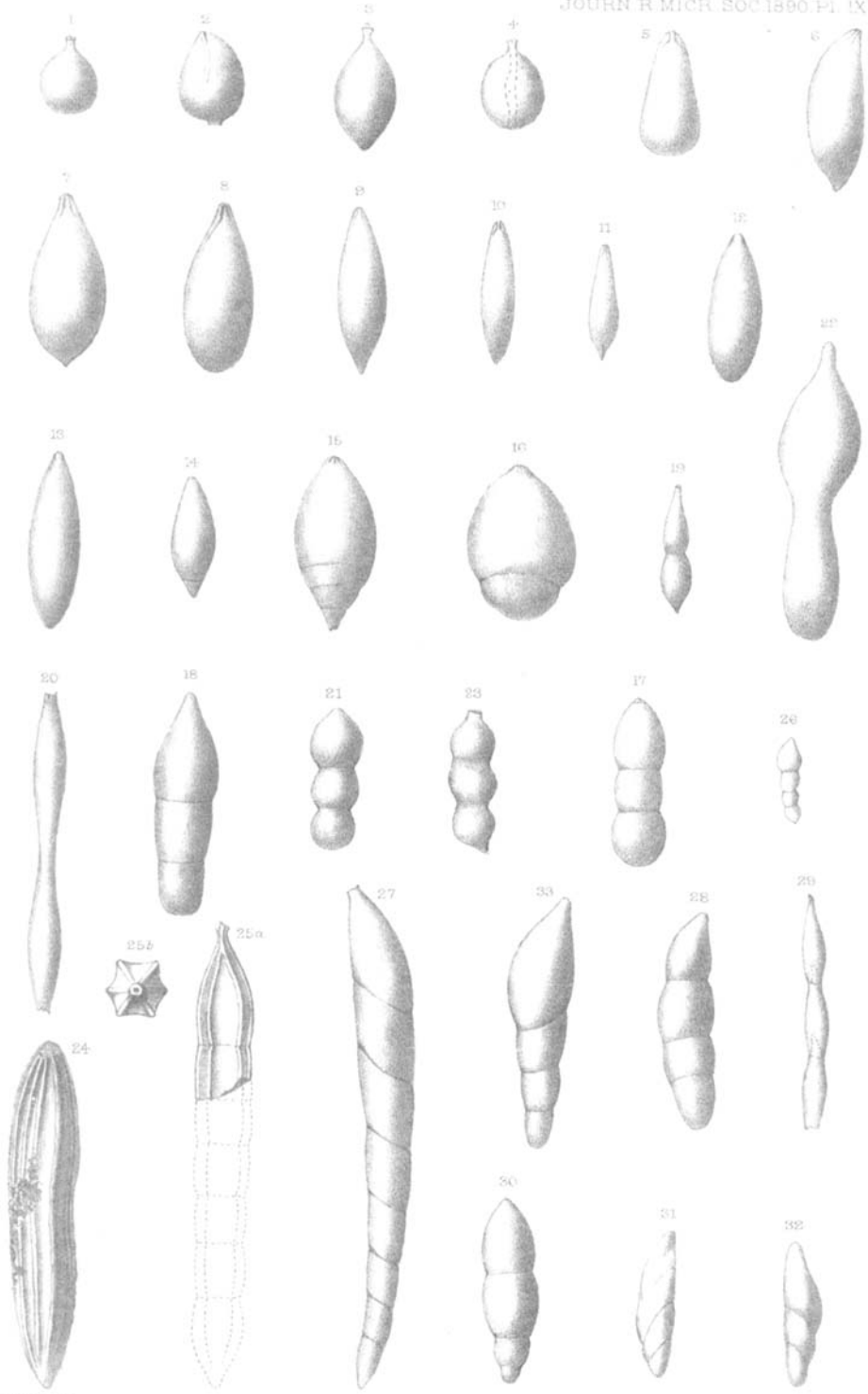


HWS del.
E.C. Knight lith.

Foraminifera of the Red Chalk.

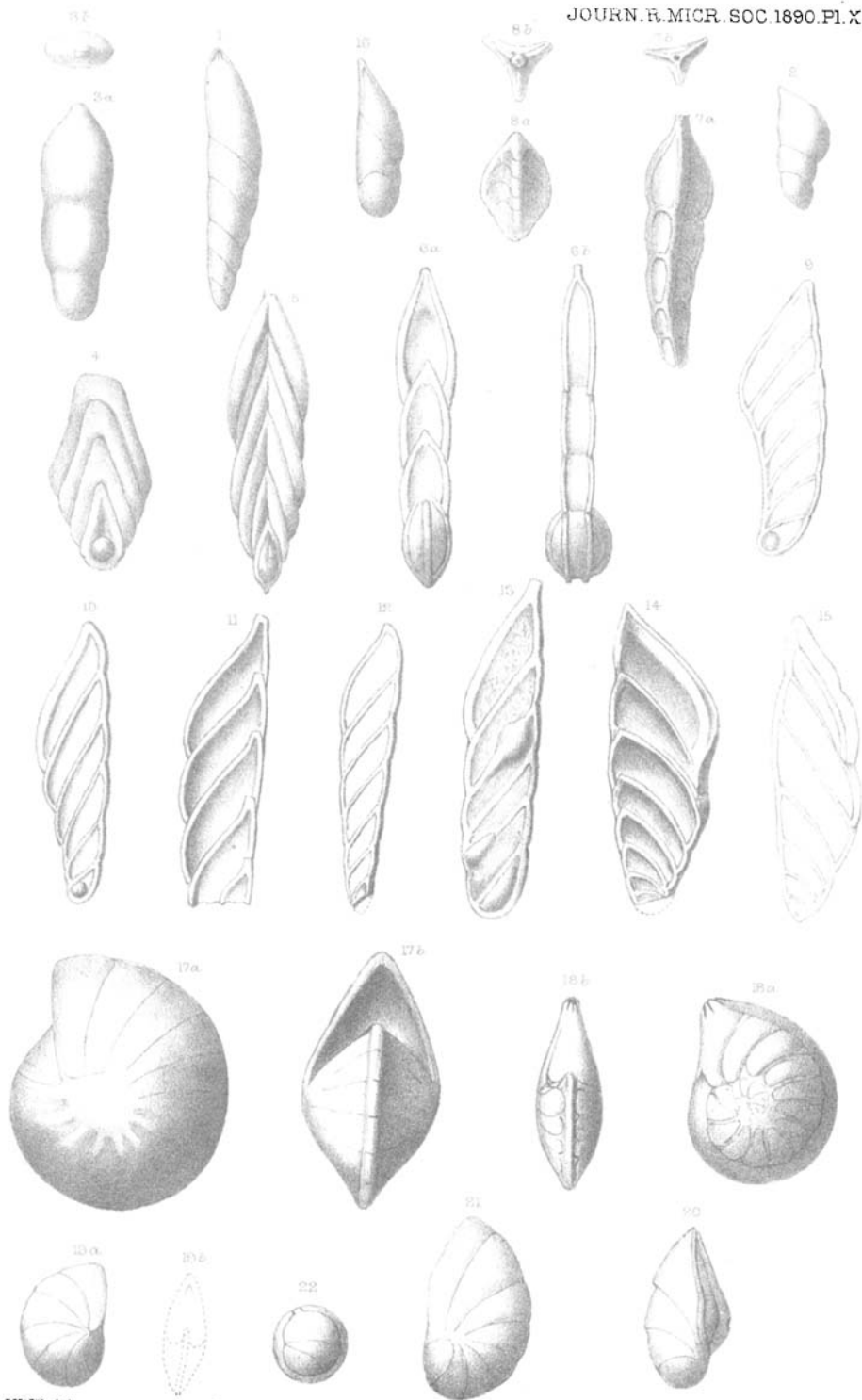
West, Newman imp.



Howell
W. C. Tangier, Ind.

Foraminifera of the Red Chalk

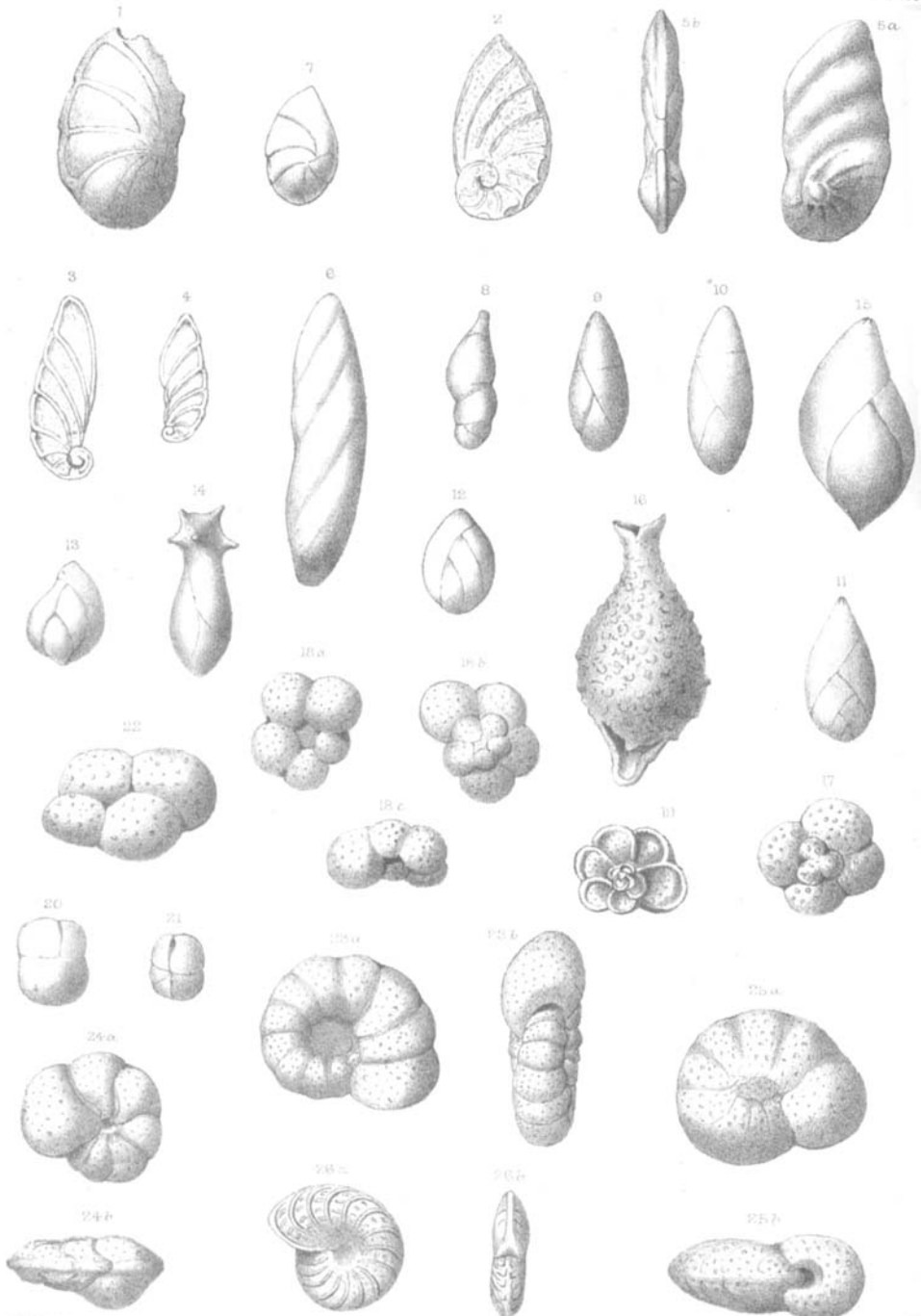
West, Newman imp.



HWB. del.
E. C. Knight lith

West, Newman imp.

Foraminifera of the Red Chalk.



H.W.S. del.
E.C. Knight lith.

West Newman imp.

Foraminifera of the Red Chalk.

JOURNAL
OF THE
ROYAL MICROSCOPICAL SOCIETY.

OCTOBER 1890.

TRANSACTIONS OF THE SOCIETY.

VIII.—*The Foraminifera of the Red Chalk of Yorkshire, Norfolk,
and Lincolnshire.*

By H. W. BURROWS, C. DAVIES SHERBORN, and
the Rev. GEO. BAILEY.

(Read 18th June, 1890.)

PLATES VIII. TO XI.

IN 1888 we communicated to this Journal (p. 383) a provisional list of Foraminifera from the Red Chalk, promising a memoir on the subject later. It is now our privilege to redeem this promise and further to

LIST OF FORMS RECORDED AND EXPLANATION OF PLATES.

PLATE VIII.

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| <p>Fig.
1.—<i>Spiroloculina papyracea</i> sp. n. × 50.
2. " <i>tenuis</i> (Czjz.) × 50.
3, 4.—<i>Miliolina</i> sp. × 50.
5, 6.—<i>Cornuspira cretacea</i> Reuss × 50.
7.—<i>Ammodiscus gordialis</i> (J. & P.)
 × 50.
8. " <i>incertus</i> (d'Orb.) × 50.
9. " <i>tenuis</i> Brady × 50.
10.—<i>Textularia attenuata</i> Reuss × 75.
11. " <i>pygmæa</i> Reuss × 50.
12. " <i>agglutinans</i> d'Orb. × 50.
13. " <i>gramen</i> d'Orb. × 50.
14. " <i>trochus</i> d'Orb. × 50.
15a, b. " <i>turris</i> d'Orb. × 50.
16. " <i>complanata</i> Reuss × 50.</p> | <p>Fig.
17a, b.—<i>Textularia</i> sp. (cf. fig. 10) × 50.
18a, b.—<i>Verneuilina propinqua</i> Brady
 × 50.
19, 20. " <i>triquetra</i> (v. M.) × 50.
21.—<i>Spiropecta bififormis</i> (P. & J.) × 50.
22.—<i>Gaudryina pupoides</i> d'Orb. × 50.
23.—<i>Bulimina affinis</i> d'Orb. × 75.
24. " <i>Presli</i> Reuss × 50.
25.—<i>Bolivina textularioides</i> Reuss × 50.
26. " <i>Beyrichi</i> Reuss v. <i>alatu</i>
 Seg. × 50.
 sp. (not figured).
27, 28, 29a, b.—<i>Pleurostomella subnodosa</i>
 Reuss × 50.
30. " <i>alternans</i> Schwager × 75.</p> |
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PLATE IX.

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| <p>Fig.
1, 2, 4.—<i>Lagena globosa</i> (Mont.) × 50.
3. " <i>lævis</i> (Mont.) × 50.
6, 7, 9, 10, 11. " <i>apiculata</i> Reuss
 × 50.
8, 12, 13. " " v. <i>emaciata</i>
 Reuss × 50.
5. " <i>cincta</i> Seguenza × 50.</p> | <p>Fig.
14, 15.—<i>Nodosaria (Glandulina) lævigata</i>
 d'Orb. × 50.
16. " " <i>obtusissima</i> Reuss × 50.
17. " " <i>cylindrica</i> Reuss × 50.
18. " " <i>candela</i> Egger × 50.
19.—<i>Nodosaria simplex</i> Silvestri × 75.
20. " " <i>longiscata</i> d'Orb. × 50.</p> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

1890.

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illustrate our remarks by a series of plates generously granted to us by the Royal Microscopical Society.

The material contributing to this paper has been derived from six sources.

(1) A small collection made by C. D. Sherborn from material carefully selected from the softer band of the Red Chalk at Hunstanton by Mrs. R. E. May. These specimens are of minute size.

(2) A large collection made by H. W. Burrows, from material obtained from the upper portion of the Red Chalk at Speeton, kindly

PLATE IX.—continued.

Fig.	Fig.
21.— <i>Nodosaria culamorpha</i> Reuss × 50.	28.— <i>Nodosaria (Dentalina) brevis</i> d'Orb. × 50.
22. " sp. × 50.	29. " " <i>filiformis</i> d'Orb. × 50.
23. " <i>limbata</i> d'Orb. × 50.	30. " " <i>marginulinoides</i> Reuss × 50.
24. " <i>obscura</i> Reuss × 40.	31. " " <i>mucronata</i> Neugeboron × 50.
25a, b. " <i>prismatica</i> Reuss × 50.	32. " " <i>abnormis</i> Reuss × 75.
26. " (<i>Dentalina</i>) <i>soluta</i> Reuss × 100.	33.— <i>Marginulina inaequalis</i> Reuss × 50.
27. " " <i>communis</i> d'Orb. × 50.	

PLATE X.

Fig.	Fig.
1.— <i>Marginulina glabra</i> d'Orb. × 50.	10, 11, 12, 13.— <i>Vaginulina recta</i> Reuss × 50.
2. " <i>variabilis</i> Neugeboren × 50.	14, 15. " <i>arguta</i> Reuss × 50.
3a, b.— <i>Lingulina carinata</i> d'Orb. × 50.	16. " <i>legumen</i> (Linn.) × 75.
4.— <i>Fronicularia biformis</i> Marsson × 50.	" sp. (not figured).
5. " <i>gaultina</i> Reuss × 25.	17a, b (and) <i>Cristellaria rotulata</i> (Lam.) XI. 7) } × 50.
6a, b. " <i>Archiaciana</i> d'Orb. × 50.	18a, b. " <i>cultrata</i> (Montf.) × 50.
7a, b.— <i>Rhabdogonium tricarinatum</i> (d'Orb.) × 50.	19a, b, 21. " <i>gibba</i> d'Orb. × 50.
8a, b. " <i>minutum</i> Reuss × 75.	20. " <i>italica</i> (DeFr.) × 50.
9.— <i>Vaginulina eurynota</i> Reuss × 25.	22 (and) XI. 8) } " <i>variabilis</i> Reuss × 50.

PLATE XI.

Fig.	Fig.
1.— <i>Cristellaria lata</i> Reuss × 50.	17.— <i>Globigerina bulloides</i> (d'Orb.) × 50.
2. " <i>multiseptata</i> (F. & M.) × 50.	18a, b, c. " <i>cretacea</i> (d'Orb.) × 50.
3, 4. " <i>crepidula</i> (F. & M.) × 50.	19. " <i>Linnæana</i> (d'Orb.) × 75.
5a, b. " <i>Marckii</i> Reuss × 50.	<i>Orbulina universa</i> d'Orb. (not figured).
6. " <i>cymboides</i> d'Orb. × 50.	20, 21.— <i>Sphæroidina bulloides</i> d'Orb. × 75.
9, 10.— <i>Polymorphina lactea</i> (W. & J.) × 50.	22.— <i>Truncatulina variabilis</i> d'Orb. × 50.
11. " <i>communis</i> d'Orb. × 50.	23a, b.— <i>Planorbulina ammonoides</i> (Reuss) × 50.
12, 13. " <i>amygdaloides</i> Reuss vel <i>P. gibba</i> d'Orb. × 50.	<i>Pulvinulina Menardii</i> (d'Orb.) (not figured).
14, h. " <i>horrida</i> Reuss × 75.	24a, b.— <i>Discorbina</i> vel <i>Truncatulina</i> × 50.
15. " sp. × 50.	25a, b.— <i>Anomalina grosseruqosa</i> (Gümb.) × 50.
<i>Uvigerina</i> sp. (not figured) × 50.	26a, b.— <i>Polystomella macella</i> (F. & M.) × 50.
16.— <i>Ramulina aculeata</i> (d'Orb.) × 50.	

(Some of these specimens have been deposited in the Natural History Museum.)

supplied by Mr. J. T. Day, F.G.S., who also suggested the method of disintegrating the hard material which is described in the footnote.*

Many of the specimens obtained are gigantic in comparison with those from the same and other localities.

(3) A still larger collection of balsam-mounted slides of material from Speeton, disintegrated and prepared by the Rev. G. Bailey. The greater part of this material was obtained from a deep-red band about two miles east of Speeton Gap, and near the boundary line of Buckton and Bempton parishes. It was collected at extreme low water during spring tides, at which time the bed is most conveniently exposed.

(4) A large collection of sliced Red Gaults and Red Chalks from various localities in Norfolk, Yorkshire, and Lincolnshire, kindly placed at our disposal by Mr. W. Hill, jun., F.G.S.

(5) Three slides of balsam-mounted dust from the Red Chalk of Flamborough Head † lent to us by Dr. H. B. Brady, F.R.S.

(6) A slide of dust, also balsam-mounted, by the favour of Dr. Clifton Sorby, F.R.S.

We have also availed ourselves of the published records of the Rev. T. Wiltshire, Messrs. Parker, Jones, Blake, and Whitaker, details of which will be found in our previous note.

SPIROLOCULINA d'Orbigny, 1826.

Spiroloculina papyracea sp. n., plate VIII. fig. 1.—The lower half of a thin and much compressed form from the red chalk of Flamborough Head. The nearest figures to this which have come under our notice are *Spiroloculina* sp. (Hantken, Mitth. Jahrb. k. ung. Geol. Anst., iv. 1875, plate xiii. fig. 1) and *S. Freyeri* (Reuss, Denkschr. k. Ak. Wiss. Wien, xxiii. 1864, plate i. fig. 9), of which the former shows rounded chambers, and the latter is referable to *S. planulata* d'Orb. We have therefore ventured to record it under a new specific name. Dr. Brady's Coll.

S. tenuis (Uzjz.) plate VIII. fig. 2. *Quinqueloculina tenuis* Czjzek, Haidinger's Nat. Abh., ii. 1848, p. 149, plate xiii. fig. 31-34; *S. tenuis*, Brady, Rep. Challenger, ix. 1884, p. 152, plate x. fig. 9. One specimen (Canada balsam, Bailey Coll.) is referable to this form: the outer chamber has been crushed and displaced.

* Owing to its great hardness, the separation of the Foraminifera from the Red Chalk is always difficult. The following method, however, greatly simplifies the process:—Break up the chalk into small pea-sized fragments, and boil in strong solution of sulphate of soda till reduced to powder; wash till all muddiness is removed.

† Speeton or Buckton. This applies also to the "Flamborough Head" of Emmett, these being the nearest places to Flamborough Head at which the red chalk crops out. (See Parker and Jones, 'Geologist,' 1860, p. 419.)

MILIOLINA Williamson, 1858.

Miliolina sp., plate VIII. figs. 3, 4.—Two characteristic examples of a trilocoline form occurring at rare intervals in Mr. Bailey's preparations. We are not at all sure that these do not represent younger stages of *Spiroloculina tenuis* (*supra*), but as only one specimen, by reason of the number of its chambers, can be truly referred to that genus, we hesitate either to place these with it, or to impose upon them a new specific name.

CORNUSPIRA Schultze, 1854.

Cornuspira cretacea Reuss, plate VIII. figs. 5, 6. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 177, plate i. figs. 1a, b.—Occurs frequently at Speeton. The individuals vary in shape from circular to oval, as shown in the figures, but all possess the true characters of the "species." Several have either grown irregularly or have been injured since being deposited, for they show a depressed line from margin to margin, and appear at first sight to belong to *Spiroloculina*.

AMMODISCUS Reuss, 1861.

Ammodiscus gordialis (Jones & Parker), plate VIII. fig. 7. *Trochammina gordialis* Jones & Parker, Quart. Journ. Geol. Soc., xvi. 1860, p. 304. *A. gordialis*, Brady, Rep. Challenger, ix. 1884, p. 333, plate xxxviii. figs. 7-9.—Two specimens of this interesting foraminifer occur in Mr. Burrows' washings. In one example the tube is thickened by subsequent deposition into an apparently solid boss in the centre.

A. incertus (d'Orbigny), plate VIII. fig. 8. *Operculina incerta*, d'Orb. in De la Sagra's Hist. Ile Cuba, 1839, Foram., p. 49, plate vi. figs. 16, 17; *A. incertus*, Brady, Rep. Challenger, ix. 1884, p. 330, plate xxxviii. figs. 1-3.—Several specimens of this variable form occur in Mr. Bailey's preparations.

A. tenuis Brady, plate VIII. fig. 9. Brady, Rep. Challenger, ix. 1884, p. 332, plate xxxviii. figs. 4-6.—This foraminifer, of which only one example was found, agrees so closely with Brady's figure that we do not hesitate to record it as such; at the same time we endorse Dr. Brady's remark, "that it is probably nothing more than a local variety of *A. incertus*." Bailey Coll.

TEXTULARIA DeFrance, 1824.

Textularia attenuata Reuss, plate VIII. fig. 10. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (i.) 1863, p. 59, plate vii. fig. 87.—Reuss figures and describes this species from the Septarienthon, and states that it is very variable in shape. Our specimen agrees with his figure, except that it has fewer chambers. One specimen, Bailey Coll.

T. pygmæa Reuss, plate VIII. fig. 11. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (i.) 1862, p. 80, plate ix. fig. 11.—Described by Reuss from

the *Minimus*-Thon of the North German gault. The specimen figured comes from Hunstanton (Sherborn Coll.), and is the only one met with. Jones and Parker record this species as "common" in the Emmett collection, from Flamborough Head.

T. agglutinans d'Orb., plate VIII. fig. 12. D'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, p. 144, plate i. figs. 17, 18, 32-34.—Occurs rarely in our collections; the specimen figured is from Mr. Burrows' washings.

T. gramen d'Orb., plate VIII. figs. 13*a*, *b*. D'Orbigny, Foram. Foss. Vienne, 1846, p. 248, plate xv. figs. 4-6.—One specimen, Burrows Coll.

T. trochus d'Orb., plate VIII. fig. 14. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 45, plate iv. figs. 25, 26.—Common in Mr. Bailey's preparations. The chambering in all the specimens is obscure, and can only be made out by careful study.

T. turris d'Orb., plate VIII. figs. 15*a*, *b*. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 46, plate iv. figs. 27, 28.—This form seems rare in the red chalk; Hunstanton (Sherborn Coll.); Speeton (Bailey Coll.).

T. complanata (Reuss), plate VIII. fig. 16. *Proroporus complanatus*, Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 231, plate xii. figs. 5 *a*, *b*.—This interesting textularian occurs abundantly in Mr. Burrows', but more sparingly in Mr. Bailey's preparations. The specimens vary from Reuss' type, in that they are shorter and broader and have fewer chambers.

Textularia sp., plate VIII. figs. 17*a*, *b*.—One specimen only of a textularian with a bladder-like final chamber, the orifice being produced into a snout; Burrows Coll. Dr. Brady informs us that this anomalous condition is occasionally met with, and therefore the character is not specific. It is probably a well-developed specimen of Reuss's *T. attenuata* (*supra*).

VERNEUILINA d'Orbigny, 1840.

Verneuilina propinqua Brady, plate VIII. figs. 18*a*, *b*. Brady, Rep. Challenger, ix. 1884, p. 387, plate xlvi. figs. 9, 10.—Specimens of *Verneuilina* in Mr. Burrows' collection show so strong a resemblance to Dr. Brady's species that we do not hesitate to refer them to that form. In the figure the mouth is perhaps a little accentuated, the tenacious adherence of the matrix making it difficult to ensure the absolute freedom of the specimens.

V. triquetra (Münster), plate VIII. figs. 19, 20. *Textularia triquetra* v. Münster in Roemer, Neues Jahrb., 1838, p. 384, plate iii. fig. 19: *V. triquetra*, Brady, Rep. Challenger, ix. 1884, p. 383, plate xlvii. figs. 18-20.—Extremely common in Mr. Bailey's preparations, but often obscure and difficult to determine. We have, however, no doubt as to its identity. In many cases, possibly from its extra-

transparency, this form has the appearance of a textularian, and occasionally (see fig. 20) resembles closely Reuss's *Polymorphina sub-rhombica* (SB. k. Ak. Wiss. Wien, xlv. 1861, p. 339, plate vii. fig. 3), from the Senonian of New Jersey, in general shape and appearance. It is likely, too, that Marsson's *Bolivina tenuis* (Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 126, plate iii. fig. 23*b*) is this form, as also *B. tenuis* Marss. as figured by Tutkovskii (Zap. Kievsk. Obsch. Estest., vii. 1887, p. 350, plate viii. fig. Γ), for both these figures were drawn from balsam-mounted specimens, in which medium false appearances are very apt to occur.

SPIROPLECTA Ehrenberg, 1844.

Spiroplecta biformis (Parker & Jones), plate VIII. fig. 21. *Textularia agglutinans* v. *biformis*, Parker & Jones, Phil. Trans., 1865, p. 370, plate xv. figs. 23, 24; *S. biformis*, Brady, Rep. Challenger, ix. 1884, p. 377, plate xlv. figs. 25-27.—A few examples have been met with in Mr. Bailey's preparations. Parker and Jones record it from the Gault and Chalk in their paper quoted above; the species occurs also in a section of Red Chalk from Speeton, and in another of Gault from Roydon, both in Mr. W. Hill's collection.

GAUDRYINA d'Orbigny, 1840.

Gaudryina pupoides d'Orb., plate VIII. fig. 22. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 44, plate iv. figs. 22-24; Brady, Rep. Challenger, ix. 1884, p. 378, plate xlvi. fig. 2.—One large individual, Burrows Coll.

BULIMINA d'Orbigny, 1826.

Bulimina affinis d'Orb., plate VIII. fig. 23. D'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, p. 105, plate ii. figs. 25, 26; Brady, Rep. Challenger, ix. 1884, p. 400, plate l. figs. 14 *a*, *b*.—Common in Mr. Bailey's preparations. From its minute size, it has probably escaped observation when searching dry material from the same and other localities.

B. Presli Reuss, plate VIII. fig. 24. Reuss, Verst. böhm. Kreide, part i. 1845, p. 38, plate xiii. fig. 72, and Haidinger's Nat. Abh., iv. (i.) 1851, p. 39, plate iii. fig. 10.—One of the most common forms in the red chalk as in other cretaceous deposits, occurring often of a considerable size.

BOLIVINA d'Orbigny, 1839.

Bolivina textularioides Reuss, plate VIII. fig. 25. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (i.), 1862 (1863), p. 81, plate x. figs. 1 *a*, *b*.—Abundant but small in Mr. Bailey's slides. Described by Reuss from the middle Hils-Thon of north-west Germany.

B. Beyrichi Reuss, plate VIII. fig. 26. Reuss, Zeitschr. deutsch.

geol. Ges., iii. 1851, p. 83, plate vi. fig. 51.—Fragments of Seguenza's variety *alata** are frequently met with in Mr. Bailey's preparations.

Bolivina sp. A third species of this genus is common in Mr. Bailey's slides. Apparently near to *B. punctata* d'Orb., but the difficulty of determining balsam-mounted specimens prevents us from doing more than recording its presence.

PLEUROS TOMELLA Reuss, 1859.

Pleurostomella subnodosa Reuss, plate VIII. figs. 27, 28, 29 *a, b*.
Dentalina subnodosa Reuss, Verst. böhm. Kreide, part i. 1845, p. 28, plate xiii. fig. 22. *P. subnodosa* Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 204, plate viii. figs. 2 *a, b*.—Nine examples, the characteristic variation of which is well shown in the specimens selected for illustration. The rapidly increasing form (fig. 29) is the more common, that shown in fig. 27 approaches *P. alternans*. Burrows Coll.

P. alternans Schwager, plate VIII. fig. 30. Schwager, Novara Reise, 1866, p. 238, plate vi. fig. 80.—A small specimen, the last chamber of which is possibly imperfect. Bailey Coll.

LAGENA Walker & Boys, 1784.

Lagena globosa (Mont.), plate IX. figs. 1, 2, 4. *Vermiculum globosum* Montagu, Test. Brit., 1803, p. 523; *L. globosa* Brady, Rep. Challenger, ix. 1884, p. 452, plate lvi. figs. 1-3.—Rare in our washings. Some of the specimens show the entosolenian neck. Bailey preparations.

L. lævis (Mont.), plate IX. fig. 3. *Vermiculum læve* Montagu, Test. Brit., 1803, p. 524; *L. lævis* Brady, Rep. Challenger, ix. 1884, p. 455, plate lvi. figs. 7-14, 30.—One specimen; the closing of the aperture is probably due to matrix. Burrows Coll.

L. apiculata Reuss, plate IX. figs. 6, 7, 9, 10, 11. *Oolina apiculata* Reuss, Haidinger's Nat. Abh., iv. (i.) 1851, p. 22, plate i. fig. 1; *L. apiculata* Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 319, plate i. figs. 4-8, 10, 11; Brady, Rep. Challenger, ix. 1884, p. 452, plate lvi. figs. 4, 15-18.—Most abundant and very variable in shape, a condition characteristic also of its living representatives.

L. apiculata var. *emaciata* Reuss, plate IX. figs. 8, 12, 13. *L. emaciata* Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 319, plate i. fig. 9.—Numerous specimens occur in Mr. Burrows' collection. It can scarcely be separated from the foregoing, and Reuss says of it, "der wesentliche Unterschied liegt in dem völligen Mangel des Centralstachels an der Basis des Gehäuses."

L. cincta Seguenza, plate IX. fig. 5. *Fissurina cincta* Seguenza, Foram. Monotal. Messina, 1862, p. 62, plate ii. fig. 31.—One specimen

* *Vulvulina alata* Seg., Atti Acc. Gioenia, [2] xviii. 1862, p. 115, pl. ii. f. 5; *B. Beyrichi* v. *alata* Seg., Brady, Rep. Challenger, ix. 1884, p. 422, pl. liii. figs. 2-4.

only (Bailey Coll.) of this curious compressed *Lagena*, previously described by Seguenza, with a fissurine aperture, from the Miocene of Messina.

NODOSARIA Lamarck, 1816.

(GLANDULINA d'Orbigny, 1826.)

Nodosaria (Glandulina) lævigata d'Orb., plate IX. figs. 14, 15. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 252, No. 1, plate x. figs. 1-3; Brady, Rep. Challenger, ix. 1884, p. 490, plate lxi. figs. 17-22.—Rare at Speeton, the specimen figured is in the Burrows Coll.

N. (G.) obtusissima Reuss, plate IX. fig. 16. Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1863, p. 66, plate viii. fig. 92; Sherborn & Chapman, Journ. R. Micr. Soc., 1886, p. 746, plate xiv. fig. 21.—One specimen, Burrows Coll.

N. (G.) cylindræa Reuss, plate IX. fig. 17. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 190, plate iv. fig. 1: also figured as *N. glandulinoides* = *Geinitziana*, by Neugeboren, Verh. Mitth. Siebenbürg. Ver. Nat., iii. 1852, p. 37, plate i. fig. 2, and *ibid.*, xi. 1860, p. 55, etc.; and as *N. parvula* by Dunikowski, from the Lemberg Chalk, Kosmos (Lwow), iv. 1879, p. 107, plate, fig. 6.—One specimen, Burrows Coll.

N. (G.) candela Egger, plate IX. fig. 18. Egger, Neues Jahrb., 1857, p. 304, plate xv. fig. 28.—Described by Egger from the Miocene of Ortenburg, Lower Bavaria. In his figure the second chamber is slightly smaller than the first, otherwise our specimen corresponds with it exactly. Burrows Coll.

(NODOSARIA.)

N. simplex Silvestri, plate IX. fig. 19. Silvestri, Atti Acc. Gioenia, vii. 1872, p. 95, plate xi. figs. 268-272; Brady, Rep. Challenger, ix. 1884, p. 496, plate lxii. figs. 4-6.—Of rare occurrence in our washings. This = *N. oligostegia* Reuss, referred to in our earlier list (this Journal, 1888, p. 384).

N. longiscata d'Orb., plate IX. fig. 20. D'Orbigny, Foram. Foss. Vienne, 1846, p. 32, plate i. figs. 10-12; Brady, Quart. Journ. Geol. Soc., xlv. 1888, p. 6.—One fragment, Burrows' collection. Dr. Brady has cleared up the doubt as to the exact shape of d'Orbigny's original specimens in the paper referred to above.

N. calamorpha Reuss, plate IX. fig. 21. Reuss, Denkschr. k. Ak. Wiss. Wien, xxv. 1865, p. 129, plate i. fig. 18. See also *Glandulina crassa* Dunikowski, Kosmos (Lwow), iv. 1879, p. 122, plate, p. 14, from the chalk of Lemberg.—This and similar forms figured on plate IX. are all closely allied to *N. radícula* Linn., which has been met with by us, only in a varietal form at Hunstanton (Sherborn), but as trivial names have been given to them, we repeat them here for convenience of classification and reference.

Nodosaria sp., plate IX. fig. 22.—Apparently a very coarsely grown variety of *N. calamorpha*. A similar form was figured by Soldani as "*Orth. perfecte globularia*," Saggio Oritt., 1780, p. 108, plate vi. fig. G, g.

N. limbata d'Orb., plate IX. fig. 23. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 12, plate i. fig. 1. Hunstanton, Sherborn Coll. Gümbel's *N. granito-calcareo*, Abh. k. bay. Ak. Wiss. (cl. ii.) x. (2) p. 613, plate i. fig. 19, apparently belongs to this form.

N. obscura Reuss, plate IX. fig. 24. Reuss, Verst. böhm. Kreide, part i. 1845, p. 26, plate xiii. fig. 8.—This figure is a much restored drawing of a damaged specimen in Mr. Burrows' collection. The sutures are not shown as they are quite indistinguishable in the original. Since the figure was drawn two or three more perfect specimens have been found by Mr. Bailey at the same locality (Speeton).

N. prismatica Reuss, plate IX. fig. 25 a, b. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 180, plate ii. fig. 2.—Two upper chambers of a specimen so exactly corresponding to Reuss's type that we have ventured to restore the missing portion by a dotted outline traced from Reuss's figure. Burrows Coll.

DENTALINA d'Orbigny, 1826.

N. (Dentalina) soluta Reuss, plate IX. fig. 26. Reuss, Zeitschr. deutsch. geol. Ges., iii. 1851, p. 60, plate iii. fig. 4.—A small but perfect individual, from Mr. Bailey's preparations.

N. (D.) communis d'Orb., plate IX. fig. 27. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 254, No. 35; Brady, Rep. Challenger, ix. 1884, p. 504, plate lxii. figs. 19–22.—Common. Recorded by Jones and Parker from Flamborough Head (Emmett Coll.).

N. (D.) brevis d'Orb., plate IX. fig. 28. D'Orbigny, Foram. Foss. Vienne, 1846, p. 48, plate ii. figs. 9, 10.—One specimen, Burrows Coll.

N. (D.) filiformis d'Orb., plate IX. fig. 29. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 253, No. 14; Brady, Rep. Challenger, ix. 1884, p. 500, plate lxiii. fig. 4.—Three chambers of a specimen occurring in one of Mr. Bailey's slides is here figured.

N. (D.) marginuloides Reuss., plate IX. fig. 30. Reuss, Haidinger's Nat. Abh., iv. (i.) 1850, p. 25, plate ii. (i.) fig. 12.—Closely allied to *D. brevis*; figured by Reuss from the chalk of Lemberg. One specimen, Bailey Coll.

N. (D.) mucronata Neugeboren, plate IX. fig. 31. Neugeboren, Denkschr. k. Ak. Wiss. Wien, xii. (2) 1856, p. 83, plate iii. figs. 8–11; Brady, Rep. Challenger, ix. 1884, p. 505, plate lxii. figs. 27–29.—A few specimens of this variety occur in Mr. Bailey's preparations.

N. (D.) abnormis Reuss, plate IX. fig. 32. Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1863, p. 46, plate ii. fig. 24.—Bailey Coll.

MARGINULINA d'Orbigny, 1826.

Marginulina glabra d'Orb., plate X. fig. 1. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 259, No. 6; Brady, Rep. Challenger, ix. 1884, p. 527, plate lxxv. figs. 5, 6.—One specimen, Bailey Coll.

M. inequalis Reuss, plate IX. fig. 33. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 207, plate vii. fig. 3.—Reuss figures this from the chalk of Westphalia. One example, Burrows Coll.

M. variabilis Neugeb., plate X. fig. 2. Neugeboren, Verh. Mitth. Siebenbürg. Ver. Nat., ii. 1851, p. 133, plate v. figs. 10–14 (including *M. Ackneriana*, *M. erecta*, and *M. intermedia* Neugeboren, *ibid.*, xi. 1860, p. 55, etc.).—Abundant in the rich tertiary deposits of Felső-Lapugy, Hungary. Occurring rarely in Mr. Bailey's preparations.

LINGULINA d'Orbigny, 1826.

Lingulina carinata d'Orb., plate X. figs. 3 *a, b*. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 257, No. 1; Brady, Rep. Challenger, ix. 1884, p. 517, pl. lxxv. figs. 16, 17.—One specimen from Hunstanton (Sherborn), now in the Geological Collection, Science Schools, South Kensington. Reuss figured this foraminifer from the chalk of Bohemia under the name of *L. bohémica* (Verst. böhm. Kreide, part 2, 1846, p. 108, plate viii. (xliii.) fig. 10) and also as *L. nodosaria* from the Speeton clay of Speetsbrink (SB. k. Ak. Wiss. Wien, xlvi. 1862, p. 59, plate v. fig. 12). We have also seen it in a slice of red gault from Hershingham lent to us by Mr. W. Hill, F.G.S.

FRONDICULARIA Defrance, 1824.

Frondicularia biformis Marsson, plate X. fig. 4. Marsson, Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 137, plate ii. fig. 17.—One specimen, Burrows Coll.

F. gaultina Reuss, plate X. fig. 5. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 190, plate v. fig. 5.—One example, Burrows Coll.

F. Archiaciana d'Orb., plate X. figs. 6 *a, b*. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 20, plate i. figs. 31–36.—We regard this as referable to d'Orbigny's form. Reuss figured it from the chalk of Bohemia under the name of *F. bicuspidata* (Verst. böhm. Kreide, part 1, 1845, p. 32, plate xiii. fig. 46), a varietal form, with which our specimens closely agree. Dunikowski's *F. polonica* (Kosmos [Lwow], iv. 1879, p. 124, plate, fig. 16), from the chalk of Lemberg, belongs also to d'Orbigny's species.

RHABDOGONIUM Reuss, 1860.

Rhabdognium tricarinatum (d'Orbigny), plate X. figs. 7 *a, b*. *Vaginulina tricarinata* d'Orbigny, Ann. Sci. Nat., vii. 1826, p. 258, No. 4, and Modèles, No. 4; *R. tricarinatum* Brady, Rep. Challenger, ix. 1884, p. 525, plate lxxvii. figs. 1–3.—A fine and perfect specimen,

Burrows Coll. This species appears only to have been recorded previously from Tertiary and Recent deposits.

Rhabdognium, plate X. figs. 8 *a, b*.—A small example in Mr. Burrows' collection. The specimen is free from matrix, but the chambering is very obscure. We believe it to be referable to Reuss's *R. minutum*, SB. k. Ak. Wiss. Wien, lv. (1) 1867, p. 84, plate v. figs. 4, 5; Brady, Rep. Challenger, ix. 1884, p. 526, plate lxvii. figs. 4–6, but cannot definitely say.

VAGINULINA d'Orbigny, 1826.

Vaginulina eurynota Reuss, plate X. fig. 9. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (1) 1863, p. 90, plate xii. figs. 9 *a, b*.—Rare at Speeton.

V. recta Reuss (*non* Karrer, 1864), plate X. figs. 10–13. Reuss, SB. k. Ak. Wiss. Wien, xlvi. (1) 1863, p. 48, plate iii. figs. 14, 15. Frequent, Burrows Coll. A variety of this form is given at fig. 11, and differs from it in the ornamentation produced by the mouths of each succeeding chamber.

V. arguta Reuss, plate X. figs. 14, 15. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 202, plate viii. fig. 4. Rare, at Speeton.

V. legumen (Linn.), plate X. fig. 16. *Nautilus legumen* Linnæus, Syst. Nat. ed. 12, 1767, p. 1164; Brady, Rep. Challenger, ix. 1884, p. 530, plate lxvi. fig. 14.*—Several specimens, Bailey Coll.

Vaginulina (immature).—Numerous similar examples of elongate nodosarian forms occur in Mr. Bailey's preparations.

CRISTELLARIA Lamarck, 1816.

Cristellaria rotulata (Lam.), plate X. figs. 17 *a, b*, and plate XI. fig. 7. *Lenticulites rotulata*, Lamarck, Ann. du Mus., v. 1804, p. 188, and viii. 1806, plate lxii. fig. 11; *C. rotulata* Brady, Rep. Challenger, ix. 1884, p. 547, plate lxix. fig. 13.—Common, but the figured specimen in Mr. Burrows' collection is gigantic as compared with the others. Jones and Parker record it from Flamborough Head (Emmett Coll.), and Wiltshire figures it from Hunstanton.

C. cultrata (Montf.), plate X. figs. 18 *a, b*. *Rotulus cultratus* Montfort, Conch. Syst., i. 1808, p. 215, genre 54; *C. cultratus* Brady, Rep. Challenger, ix. 1884, p. 550, pl. lxx. figs. 4–8.—One fine specimen only, Burrows Coll. Doubtless many of the small specimens in Mr. Bailey's preparations belong to this species, but they are too immature for determination.

C. gibba d'Orb., plate X. figs. 19 *a, b*, 21. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 292; and in De la Sagra's Hist. Ile Cuba, 1839, p. 40, plate vii. figs. 21, 22.—One example, Bailey Coll.

* See also Fornasini, Boll. Soc. Geol. Ital., v. 1886, p. 25, pl. i., where the life-history of the typical form is traced and figured.

C. italica (Defrance), plate X. fig. 20. *Saracenaria italica* Defrance, Dict. Sci. Nat., xxxii. 1824, p. 177, Atlas Conch., plate xiii. fig. 6; *C. italica* Brady, Rep. Challenger, ix. 1884, p. 544, plate lxviii. fig. 17, etc.—Rare in Mr. Bailey's slides.

C. lata Reuss, plate XI. fig. 1. *Rotulina lata* Reuss, SB. k. Ak. Wiss. Wien, xlvi. 1868, p. 52, plate v. fig. 57.—Recorded by Reuss from the Septarienthon of Offenbach. One specimen (Bailey Coll.) is damaged, but preserves enough character to admit of identification.

C. variabilis Reuss, plate X. fig. 22, and plate XI. fig. 8. Reuss, Denkschr. k. Ak. Wiss. Wien, i. 1850, p. 369, plate xlvi. figs. 15, 16; Brady, Rep. Challenger, ix. 1884, p. 541, plate lxviii. figs. 11–16. Reuss's figures give the student little idea of the variability of this species. Brady, more fortunate in working over the 'Challenger' material, was able to trace and figure the life-history, finding individuals of all ages. It is interesting to find in the red chalk an example (fig. 22) of the youngest form figured by Brady. Bailey Coll.

C. multiseptata Reuss, plate XI. fig. 2. Reuss, Haidinger's Nat. Abh., iv. 1850, p. 33, plate ii. fig. 9.—This robust variety of *C. crepidula* was found by Reuss in the chalk of Lemberg. Our drawing is taken from a specimen from Flamborough Head, from a balsam-mounted slide lent to us by Dr. Brady. It is drawn as viewed by transmitted light. *C. multiseptata* differs but little from *C. gibba* d'Orb., and was figured several times by Reuss under different specific names. Of these we may mention *C. recurrens* (Denkschr. k. Ak. Wiss. Wien, xxv. 1865, p. 140, plate ii. fig. 36) and *C. galeata* (ibid., p. 141, plate iii. fig. 8) from the German Septarienthon. Marsson's *C. foliacea* (Mitth. Nat. Ver. Neu-Vorpommern u. Rügen, x. 1878, p. 143, plate ii. fig. 18) also belongs to this form.

C. crepidula (F. & M.), plate XI. figs. 3, 4. *Nautilus crepidula* Fichtel & Moll, Test. micros., 1798, p. 107, plate xix. figs. *g-i*; Brady Rep. Challenger, ix. 1884, p. 542, plate lxviii. fig. 1.—Abundant. The two figured are drawn as viewed by transmitted light.

C. Marckii Reuss, plate XI. figs. 5*a, b*. Reuss, SB. k. Ak. Wiss. Wien, xl. 1860, p. 212, plate ix. fig. 4.—Found by Reuss, but rarely, in the Senonian clays of the Hilgenberges. One specimen, Burrows Coll.

C. cymboides d'Orb., plate XI. fig. 6. D'Orbigny, Foram. Foss. Vienne, 1846, p. 85, plate iii. figs. 30, 31; v. Hantken, Mitth. Jahrb. k. ung. Geol. Anst., iv. 1875, p. 49, plate v. fig. 3.—Although regarded as synonymous with *C. crepidula* this foraminifer has amongst fossil forms some representatives far removed from the neat and elegant type of that species shown by us in fig. 3. One of these representatives, coarsely grown, and with but four chambers, we have figured. It agrees almost precisely with the specimen given by v. Hantken from the *Clavulina Szaboi* Tertiary beds of Hungary.

POLYMORPHINA d'Orbigny, 1826.

Polymorphina lactea (Walker & Jacob), plate XI. figs. 9, 10. *Serpula lactea*, Walker & Jacob in Kannmacher's edition of Adams, Essays Micros., 1798, p. 634; *P. lactea*, Brady, Rep. Challenger, ix. 1884, p. 559, plate lxxi. fig. 11.—Common in the red chalk. The two figured specimens of *P. lactea* v. *elongata* Brady, Rep. Challenger, ix. 1884, p. 559, plate lxxi. fig. 14, are in Mr. Burrows' collection.

P. communis d'Orb., plate XI. fig. 11. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 266, No. 15, plate xii. figs. 1-4.—Not rare. Mr. Bailey's preparations.

P. amygdaloides Reuss, and *P. gibba* d'Orb., plate XI. figs. 12, 13.—Abundant specimens of small *Polymorphinæ* occur in Mr. Bailey's preparations, and can, we believe, be referred to these two forms. As shown in the figures given by Brady, Parker, and Jones (Trans. Linn. Soc., xxvii. plate xxxix., woodcuts p. 215) these forms differ principally in degree of compression; it is therefore difficult to separate them when mounted in Canada balsam.

P. horrida Reuss, plate XI. fig. 14. *Globulina horrida* Reuss, Verst. böhm. Kreide, part 2, 1846, p. 110, plate xliii. fig. 14. *P. horrida* J. Wright, Proc. Belfast Nat. Field Club, App. iii. 1875, p. 85 (87), plate iii. figs. 14, 15.—This characteristic cretaceous foraminifer occurs sparingly in our washings.

Polymorphina sp., plate XI. fig. 15.—One large, irregularly grown form in Mr. Burrows' collection.

UVIGERINA d'Orbigny, 1826.

A fine and perfect specimen of *Uvigerina* was found by Mr. Bailey in Speeton washings, but was unfortunately lost before a drawing had been taken.

RAMULINA Rupert Jones, 1875.

Ramulina aculeata (d'Orb.), plate XI. fig. 16. *Dentalina aculeata* d'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 13, plate i. figs. 2, 3; *R. aculeata*, Wright, Proc. Belfast Nat. Field Club, App. ix. 1886, p. 331, plate xxvii. fig. 11.—Several large isolated chambers of this foraminifer occur in Mr. Burrows' collection. Fragments have also been met with in Mr. Bailey's preparations.

GLOBIGERINA d'Orbigny, 1826.

Globigerina bulloides d'Orb., plate XI. fig. 17. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 277, No. 1.—Frequent in our washings. Jones & Parker record it from Flamborough Head (Emmett Coll.).

G. cretacea d'Orb., plate XI. figs. 18 a, b, c. D'Orbigny, Mém. Soc. Géol. France, iv. 1840, p. 34, plate iii. figs. 12-14.—Very common.

G. Linnæana (d'Orb.), plate XI. fig. 19. *Rosalina Linnæana*

d'Orbigny in De la Sagra's Hist. Ile Cuba, 1839, Foram., p. 101, plate v. figs. 10-12. *G. Linnæana* Brady, Rep. Challenger, ix. 1884, p. 598, plate cxiv. figs. 21a, b, c.—Also common as the last.

ORBULINA d'Orbigny, 1839.

Orbulina universa d'Orb. D'Orbigny, Hist. Nat. Canaries, 1839, Foram., p. 123, plate i. fig. 1.—We have not met with this foraminifer in our washings. It occurs, however, in Mr. Hill's section of red chalk from Bed 1 at Speeton, and also at Great Girendale. It is a rare red chalk form, and is liable to be confounded with the larger of the curious spherical bodies (*incertæ sedis*) which crowd this deposit, the white chalk of Yorkshire, and some of the Norfolk gaults.*

SPHÆROIDINA d'Orbigny, 1826.

Sphæroidina bulloides d'Orb., plate XI. figs. 20, 21. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 267, No. 1. Brady, Rep. Challenger, ix. 1884, p. 620, plate lxxxiv. figs. 1-7.—Occurs twice in Mr. Bailey's slides.

TRUNCATULINA d'Orbigny, 1826.

Truncatulina variabilis d'Orb., plate XI. fig. 22. D'Orbigny, Ann. Sci. Nat., vii. 1826, p. 279, No. 8. Brady, Rep. Challenger, ix. 1884, p. 661, plate xciii. fig. 6.—Four chambers of a foraminifer in Mr. Burrows' collection, which we refer with some doubt to this variable Truncatuline.

PLANORBULINA d'Orbigny, 1826.

Planorbulina ammonoides (Reuss), plate XI. figs. 23a, b. *Rosalina ammonoides* Reuss, Verst. böhm. Kreide, pt. i. 1845, p. 36, plate viii. fig. 53, plate xiii. fig. 66; T. R. Jones, 'Geologist,' vi. 1863, p. 294, plate xv. figs. 7, 8.—Very common in all chalk deposits. Recorded by Jones & Parker from Flamborough Head (Emmett Coll.). The fine specimen figured is from Mr. Burrows' collection.

PULVINULINA Parker & Jones, 1862.

Pulvinulina Menardii (d'Orb.). *Rotalia Menardii* d'Orbigny, Ann. Sci. Nat., vii. 1826, p. 273, No. 26. Brady, Rep. Challenger, ix. 1884, p. 690, plate ciii. figs. 1, 2.—A typical and well-marked specimen of this form was found by Burrows in his Speeton washings, but unfortunately was subsequently lost.

(DISCORBINA Parker & Jones, 1862; vel TRUNCATULINA.)

Discorbina vel *Truncatulina*, plate XI. figs. 24a, b.—A small rotaline showing affinities to both of these genera. As, however, the

* See this Journal, 1888, p. 383: "I do not think they can be placed with Radiolaria, and they are not to be included with Sponges."—G. J. Hinde, *in litt.* August 25, 1890.

test is much altered by infiltration it would be unwise to attempt to fix its position.

ANOMALINA d'Orbigny, 1826.

Anomalina grosse-rugosa Gumb., plate XI. figs. 25a, b. *Truncatulinina grosserugosa* Gumbel, Abh. k. bay. Ak. Wiss. (cl. ii.) x. (2) 1868, p. 660, plate ii. fig. 104. *A. grosserugosa* Brady, Rep. Challenger, ix. 1884, p. 673, plate xciv. figs. 4, 5. From a fine specimen in the Burrows Collection. We have also noted its occurrence at Hunstanton (Sherborn).

POLYSTOMELLA Lamarck, 1822.

Polystomella macella (F. & M.), plate XI. figs. 26a, b. *Nautilus macellus* Fichtel & Moll, Test. microsc., 1798, p. 66, plate x. figs. e-g, h-k. *P. macella* Brady, Rep. Challenger, ix. 1884, p. 737, plate cx. fig. 8.—One small, but perfect individual, Burrows Coll.

In our preliminary list (Journal, 1888, p. 383) we quoted *Lagena aspera* and *L. marginata*, *Nodosaria oligostegia*, *Nonionina* sp., and *Polystomella subnodosa* as occurring in the red chalk. The first of these has turned out to be a piece of matrix, the second was due to false appearance, possibly from an abnormally thick cell-wall; *Nodosaria oligostegia* is absorbed by *N. simplex* Silvestri; *Nonionina* does not occur, nor does *Polystomella subnodosa*.

The whole of the Foraminifera described above, with the exception of *Spiroloculina papyracea*, *Textularia pygmæa*, and *Lingulina carinata*, occur in the red chalk of Speeton. The following lists of occurrences in the red chalk at other localities will be useful to the worker:—

HUNSTANTON, NORFOLK.—*Text. pygmæa*, *T. trochus*, *T. turris*, *Bulim. Presli*, *Lagena brevis*, *L. apiculata*, *Nodos. radiata* var. (*N. limbata*), *Dent. communis*, *Lingul. carinata*, *Crist. rotulata* *C. italica*, *C. crepidula*, *Polymorphina*, *Globig. cretacea*, *G. bulloides*, *G. Linnæana*, *Anom. grosserugosa*, *Planorb. ammonoides*.

CANDLESBY, LINCOLNSHIRE.—Hunstanton limestone, varying from yellowish-pink to true red chalk:—*O. universa*, *G. cretacea*, *G. bulloides*, *L. apiculata*, *Dentalina*, *Verneuilina*, *Miliolina*, *N. radícula* var., *C. rotulata*, *C. crepidula*, *Polymorphina*, *Textularia*, *Glandulina*.

SOUTH CAVE, YORKSHIRE.—Pink limestone:—*O. universa*, *G. cretacea*, *L. apiculata*, *C. crepidula*, *C. variabilis*, *Verneuilina*, *Glandulina*, *Miliolina*. Red chalk (streaky, white and red):—*O. universa*, *G. cretacea*, *G. bulloides*, *Dentalina*, and *Planorbulina*.

FLAMBOROUGH HEAD, YORKSHIRE.—*Spiroloc. papyracea*, *Text. pygmæa*, *Dent. communis*, *C. cultrata*, *C. rotulata*, *C. multiseptata*, *G. bulloides*, *G. Linnæana*, *P. ammonoides*, *Bolivina*, *Polymorphina*, *Lagena*.

GREAT GIRENDALE, YORKSHIRE.—*C. crepidula*, *Polymorphina*, *G. cretacea*, *G. bulloides*, *G. Linnaeana*, *O. universa*, *Miliolina*.

WHANAM GRANGE, YORKSHIRE.—*Textularia*, *Lag. laevis*, *Pleurostomella* (?), *C. rotulata*, *C. crepidula*, *Polymorphina*, *G. bulloides*, *G. cretacea*.

The report* appended on Mr. Hill's microscopical sections of red chalks and red gaults shows in an interesting way the connection between the red chalk, red gault clays, and gaults. On the whole, we cannot at present say that the Foraminifera help us in deciding the age of the red chalk, for our knowledge of the fauna of other English cretaceous deposits is very limited. This lack of knowledge will, however, soon be supplied for the gault, at least, as we understand that our friend, Mr. Fred. Chapman, has decided to publish shortly the result of many years' labour on these deposits.

Report on a Collection of Microscopical Sections of Red Chalk and Gault belonging to Mr. W. HILL, F.G.S.

While writing his paper on the Upper Cretaceous Series in Suffolk and Norfolk, in conjunction with Mr. Jukes Brown, Mr. W. Hill prepared a large series of microscopical sections of red chalk, red clays, and gaults. The results of his investigations will be found in the Quart. Journ. Geol. Soc., xliii. 1887, pp. 544 *et seq.*, while below are given some few observations on a selected series of the slides, which he has kindly placed at our disposal. The distribution of the "spheres" is of especial interest.

(1) Hunstanton limestone (yellowish-pink). Top of Rutters Pit, Candlesby, Lincolnshire. A thin section showing little matrix and containing *Orbulina universa*, *Globigerina cretacea*, *G. bulloides*, *Lagena apiculata*, *Dentalinæ*, *Verneuilinæ* and *Miliolinæ*, *Ostracoda*, spheres and sponge-spicules.

(2) Hunstanton limestone (pink). Middle of Rutters Pit. Little matrix and containing *O. universa*, *G. cretacea*, *L. apiculata*, *Nodosaria radicularis*, *Cristellaria crepidula*, *C. rotulata*, *Dentalinæ*, *Polymorphinæ*, *Textulariæ*, *Miliolinæ*, *Ostracoda*, spheres, and spicules.

(3) Hunstanton limestone (red chalk). Base of Rutters Pit. A thick section, almost entirely composed of Foraminifera and spheres. Contains *G. cretacea*, *Glandulina*, *Textulariæ*, *Miliolinæ*, and others obscured on account of the thickness of the section, *Ostracoda*, spheres, and spicules.

(4) Streaky red chalk (red and white). From a railway cutting, east of South Cave Station; the organisms occurring in lines and more abundantly in the red than in the lighter coloured streaks.

* C. D. Sherborn is alone responsible for this Report.

Containing *O. universa*, *G. cretacea*, *G. bulloides*, Dentalinæ and Planorbulinæ, Ostracoda, spheres, and sponge-spicules in position.

(5) Hunstanton limestone (pink) from South Cave cutting. Almost entirely composed of organisms. Containing *O. universa*, *G. cretacea*, *L. apiculata*, *C. crepidula*, *C. variabilis*, Verneuiliinæ, Glandulinæ, Miliolinæ, Ostracoda, spheres, and sponge-spicules.

(6) Gault from floor of pit at Muzzle, near West Dereham. Full of organisms. *G. cretacea*, Nodosariæ, and others mostly unrecognizable; entire absence of spheres.

(7) Gault, West Dereham, from the base of the gault. Full of organic fragments, but almost entirely devoid of recognizable Foraminifera.

(8) Gault from a well-boring at Stoke Ferry (54-55 feet). Containing *O. universa*, *G. cretacea*, *G. bulloides*, *C. rotulata*, Textularia, and Ostracodal valves.

(9) Red chalk, Whanam Grange, Yorkshire (2 slides), streaky, with abundant Foraminifera, chiefly fragmentary. *G. cretacea*, *G. bulloides*, *C. crepidula*, *C. rotulata*, *Lagena lævis*, and another, *Pleurostomella* (?), Textulariæ, Polymorphinæ, Glauconitic and brown grains, spheres, sponge-spicules, black specks, with some dendritic markings.

(10) Red chalk, Great Girendale, Yorkshire. Streaky, and although almost entirely composed of spheres and Foraminifera, the latter are not generally recognizable. *O. universa*, *G. cretacea*, *G. bulloides*, *G. Linneana*, *C. crepidula*, Polymorphina, Miliolinæ, Glauconitic and brown grains, Ostracoda, and spheres.

(11) Red chalk, Speeton, bed 1 (upper part). A thick section showing abundant unrecognizable Foraminifera. *O. universa*, *G. cretacea*, *G. bulloides*, *Cristellaria*, *Spiroloculina*, and spheres.

(12) Red chalk, Speeton, basal band of bed 1. A thick section almost entirely made up of spheres to the exclusion of other organisms. Containing *G. cretacea*, *Dentalina*, *Spiroplecta biformis*, Miliolinæ, spheres, and Ostracoda.

(13) Red chalk, Hunstanton, upper third. Containing *G. cretacea*, *G. bulloides*, *N. radricula*, *C. rotulata*, *C. crepidula*, Planorbulinæ, Textulariæ, spheres, Ostracoda, and abundant sponge-spicules, some of which are in position.

(14) Red chalk, Hunstanton. Containing *G. cretacea*, *G. bulloides*, *L. lævis*, *N. radricula*, *C. rotulata*, Planorbulinæ, Polymorphinæ, and other forms of doubtful affinity, spheres, and Ostracoda; few spicules.

(15) Red chalk, Hunstanton (middle). *G. cretacea*, *G. bulloides*, *L. apiculata*, *T. trochus*, *C. rotulata*, *C. crepidula*, Planorbulina, spheres, and Ostracoda; few spicules.

(16) Red gault from boring at Hersingham. *G. cretacea*, *G. bulloides*, *C. rotulata*, *Lingulina carinata*. Ostracoda and spicules

are absent, Foraminifera rare, and the spheres characteristic of the red chalk entirely absent.

(17) Gault, Hersingham boring; the brown bed above the red gault. The same as the last, but without *L. carinata*.

(18) Gault, the brook, Grimstone. Densely packed with spheres and Foraminifera; few spicules. *G. cretacea*, *L. apiculata*, *Textularia* (very large compared with the other forms), *Miliolina*.

(19) Pink gault, the brook, Grimstone. Similar to the last.

(20) Red gault, Roydon Cutting (Norfolk). Densely packed with spheres and Foraminifera, the latter very small. *G. cretacea*, *Cristellaria*.

(21) Gault, Roydon cutting. Foraminifera abundant in some layers but absent in others. Spheres entirely wanting. *G. cretacea*, *Polymorphina* (long var.), *Planorbulina*, *Textularia*, *Spiroplecta biformis* (one with ten chambers above the spiral, another with six).

(22) Gault, Roydon cutting (15 feet). A thick section. Foraminifera almost absent. *G. cretacea* only noticed.

(22) Hard nodules from just above the red gault, Roydon cutting. Crowded with spheres. Foraminifera rare (*G. cretacea*).

(23) Gault, lower hard bed, Grimstone Cutting. Containing *G. cretacea*, large *Textularia*, *Nodosaria*, *C. rotulata*, spheres and spicules.

(24) "Red chalk, Speeton, No. 3." A thin section, kindly lent to us by Mr. H. Clifton Sorby, F.R.S., showing plenty of matrix. Foraminifera abundant, amongst which can be recognized *G. cretacea*, *G. Linnæana*, *Dentalina*, *Nodosaria*, *C. crepidula*, *Planorbulinæ*, *Textulariæ*, and spheres.
