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XLIV.—*On Rhætic Foraminifera from Wedmore, in Somerset.*

By FREDERICK CHAPMAN, F.R.M.S.

[Plates XI. & XII.]

Introductory.

THE following paper is the result of a microscopical examination of various samples of clays, argillaceous sands, and shelly limestones of Rhætic age, which were obtained by Mr. W. A. Sanford, F.G.S., from a quarry to the south-east of the village of Wedmore. For the opportunity of examining these interesting and important deposits I am indebted to Dr. Henry Woodward, F.R.S., Pres.G.S., &c., who very kindly placed the material in my hands for description.

There were six distinct samples of rocks, taken from different horizons, and all of these have been subjected to a careful microscopical examination. With one exception, namely that from bed no. 9, these samples were of such a nature that they could be reduced by washing without much difficulty. In order to examine the hard limestones of bed no. 9 it was necessary to prepare thin slices; and these yielded distinct evidence of the presence of hyaline Foraminifera in this group of rocks, although their remains are by no means common.

There appears no reason to doubt the Rhætic age of the Wedmore beds, since Mr. Sanford has found characteristic Rhætic fossils in the various strata. The measurements of the various beds seen in the quarry yielding Megalosaurian remains at Wedmore have already been published by Mr. Sanford *, and they are here repeated for convenience:—

	inches.
"1. Top soil.....	12–15
"2. Dark sticky clay. Maximum	29
"3. Thin shaly or concretionary bed, locally gravelly.	1–3
"4. Somewhat similar; some clay and shale mixed, irregular in composition; large *Septaria*	About 8
"5. Light-coloured sandy clay, with some few fossil teeth and shells	9
"6. Darker clay, with small *Septaria* numerous, some teeth, and bits of bone	9
"7. Saurian bed; the bones generally found next	

* Proc. Somerset Arch. and Nat. Hist. Soc. vol. xl. (1894) p. 231.

inches.

the rock; many teeth of reptiles, fish, and batrachians (?), vegetable remains..... 9–10 or 12

"8. A bed found in places, and next the rock, generally near the larger bones, whitish or even quite white, like mortar..... $\frac{1}{2}$–1

"9. The Wedmore stone, described above, in three beds generally, from a few inches to 2 feet 6 inches."

Details (chiefly microscopical) of the Beds examined.

The descriptions of the rocks and the microscopical appearance of the washings of each of the samples selected and numbered by Mr. Sanford are as follows, the beds being described in descending order.

Bed no. 2.—A note made by Mr. Sanford and attached to the specimen reads thus :—" Upper dark sticky clay, almost absolutely black, and tending to split up when only slightly dried. It varies much in thickness, and the measurement in this quarry is about 29 inches. In another quarry, about $\frac{1}{4}$ mile S. or S.E. of this, the bed is covered by a succession of strata, more or less irregular, and which closely resembles that between this clay and the ' Wedmore Stone ' (bed no. 9). There are hardly any fossils to be seen excepting one or two fragments of bone. This clay thins out in a very short distance to nothing."

The residuum of bed no. 2, after washing away the fine argillaceous material, consists of fine angular and subangular quartz-grains, and some of the latter exhibit secondary outgrowths and envelopes. From the sand-grains a fine example of a doubly terminated quartz-crystal was picked out, measuring $\frac{1}{48}$ inch (·52 millim.) in length, and with perfectly sharp edges. A large portion of the washed material consists of the sandy tests of arenaceous Foraminifera, chiefly of the genera *Ammodiscus* and *Haplophragmium*, and there were also a few examples of *Stacheia*. Many of the tests of the Foraminifera in these washings are almost chalky white, but some are slightly stained with ferruginous material, or, more rarely, composed of ferruginous particles mingled with quartz-sand. The remainder of the washed material consists of ferruginous particles and some bone-fragments. This sample was the only one which showed the presence of carbonate of lime on treatment with acid.

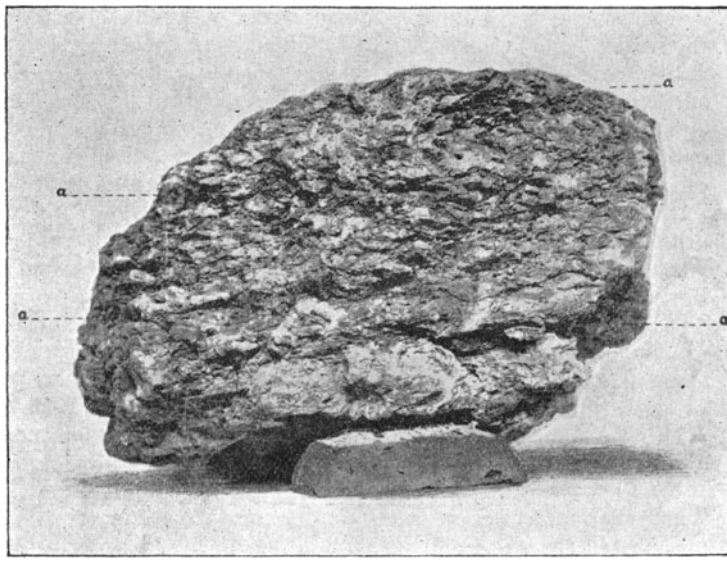
Bed no. 3.—This is a bluish-grey sandy clay, with thin limonitic partings. The residuum after washing is seen to consist of fine angular quartz-grains, ferruginous particles, and a few glauconite grains of no definite shape. Examples of *Haplophragmium* and *Stacheia* also occur in these washings,

but the latter are not so clearly defined in outline as those of bed no. 5, and they are more fragmentary.

(This sample appears to agree in part with no. 5 of Mr. Sanford's section.)

Bed no. 4.—A pale brown friable sandstone, coarsely laminated. It contains some clay, which is apparent on crushing the rock under water. The residuum, after washing, consists of brown and white sand-grains. The coarser brown particles, when mounted in balsam and viewed under a tolerably high power, are seen to be in many cases more or less perfect examples of obscure arenaceous Foraminifera belonging to the genus *Haplophragmium*. A single specimen of *Stacheia* was also met with. The white sand is much finer and consists of sharp angular quartz-grains.

Bed no. 5.—A blue sandy clay, with ochreous and ferruginous layers, which consist almost entirely of the remains of



A small block of clay showing *Stacheæ* in regular layers at *a a*; from bed no. 5 of the Rhætic series, Wedmore. Reduced to ¾ nat. size.

Stacheia. These organisms form layers about 4 millim. thick, which conspicuously mark the planes of sedimentation. This is shown in the woodcut, which is from a photograph kindly taken by my brother, Mr. R. S. Chapman.

The residuum, after washing, is 12 per cent. of the whole,

and consists of a coarse brownish sand, the larger grains of which are more or less perfect examples of various forms of *Stacheia* and *Nodosinella*, the organisms constituting about 8 per cent. of the natural rock.

This coarse material, consisting of the fragments of *Stacheia* and *Nodosinella*, was tested for chitin, since the microscopic structure of the test has all the appearance of such. The chemical analysis, however, gave no evidence of the presence of chitin; and therefore it seems conclusive that the delicate areolate tissue observed in these fossils, though originally chitinous, has been chemically replaced by another substance. For this analysis I am indebted to Mr. W. Tate, F.C.S., of the Royal College of Science. Also, with a view of obtaining information regarding the nature of the intricate tissue of the test of *Stacheia*, staining was resorted to, for which purpose a specimen of *S. dispansa* was treated with a solution of methylene blue, and, after being washed and dried, cut for a microscopic section. Examined under a $\frac{1}{4}$-inch objective the section evidenced staining throughout the cementing tissue, whilst sand-grains and sponge-spicules with other mineral substances worked into the test were left clear.

The finer material from the washings consists almost entirely of the tests of minute and obscurely septate specimens of *Haplophragmium*, the tests of which are constructed of ferruginous and quartzose particles. In the washings there are also occasional quartz-grains with well-rounded outlines.

Bed no. 6.—Blue sandy clay, with ferruginous partings, but with the latter character not so marked as in bed no. 5.

The washings consist of a somewhat fine sand, with ferruginous or limonitic particles, a few angular quartz-grains, some glauconite-grains, and a few bone-fragments. There are also some examples present of arenaceous Foraminifera, such as *Haplophragmium* and *Ammodiscus*, but they are not abundant.

Bed no. 9.—This bed is known as the "Wedmore Stone." Three distinct varieties were examined in thin sections. The specimens are compact limestones. One of these is of a yellowish-brown colour, and is composed chiefly of remains of molluscan shells; it is, however, much altered and partly recrystallized. A microscopical section of this specimen showed a globose-chambered foraminifer which has the outline of *Nodosaria radicula* (L.), and there were also many fragments of similar organisms, but with no specially recognizable characters.

The second specimen is of a bluish-grey colour, and, seen under the microscope, it appears to consist of finely crystal-

lized calcite; and included in the matrix are unaltered remains of lamellibranch shells, echinoderm plates, &c. No Foraminifera were noticed in this rock.

The third specimen is a hard shelly limestone, somewhat porous in texture, and composed almost entirely of the remains of molluscan shells. There are also some traces of Foraminifera, amongst which an elongate form of *Ammodiscus*, *Nodosaria radicula*, and *Marginulina glabra* (?) were noticed.

In the above descriptions of the contents of the various washings mention has been made of the occurrence of examples of the genus *Stacheia*, hitherto known only from the Carboniferous formation, but which is here present in large numbers, especially in bed no. 5. On the surface of the test of this arenaceous foraminifer sharply defined and geometrically shaped cavities may be seen, evidently formerly occupied by adventitious crystals. Also, when the cylindrical tests of *Nodosinella* are broken across, radially grouped cavities of prismatic form are not uncommonly seen, apparently having their origin in radial clusters of crystals. There can, therefore, scarcely be any question that this organism constructed its test in part of these small crystals. This is the more apparent when thin slices of the tests of *Nodosinella* and *Stacheia* are examined; the crystals which have left cavities are then seen to have been built into the minute structure of the test, quite unlike what one would expect to find if these crystals had been developed subsequently to fossilization. Professor Judd, who kindly examined these curious cavities in *Stacheia*, has suggested that there is great probability of the lost crystals having once been of the nature of small zeolites, such as phillipsite or christianite, a mineral which has lately been discovered in some abundance in the red clays and radiolarian oozes of the Central Pacific and Indian Oceans during the voyage of the 'Challenger,' and described by Drs. Murray and Renard*.

It has been pointed out by the above authors† that the principal reason to be adduced for the occurrence of these zeolitic crystals solely in deep-water deposits is that in the red clay the formation and deposition of the crystals are carried on free from the disturbing action of waves, tides, and currents, the stability of the waters containing the material in solution having thereby the opportunity to deposit the substance.

* Chall. Rep., "Deep-sea Deposits" (1891), pp. 400–411, pl. xxii. figs. 1–4; woodcut (p. 402), fig. 36.

† *Op. cit.* pp. 409, 410.

In reference to the supposed zeolitic crystals in the tests of the Rhætic Foraminifera, it may be presumed that they may have been formed in tranquil water and subsequently washed by tidal or other action within reach of the numerous Foraminifera, which utilized them in the construction of their tests.

Remarks on the Rhætic Foraminifera as compared with those from other Geological Horizons.

So far as I am aware no records have been published of Foraminifera having been found in strata of undoubted Rhætic age. They are not unknown in the older (Triassic) beds, notably from the Muschelkalk of Thuringia *; and the younger strata of Liassic age contain Foraminifera in abundance.

In his paper on "The Range in Time of Foraminifera" † Professor T. Rupert Jones gives a table of genera, in which fifteen spaces are filled up in the Rhætic column. These genera are again recorded in the 'Catalogue of the Fossil Foraminifera of the British Museum' ‡. In the earlier of these works, however, Professor Rupert Jones has remarked §: "*Nubeculoria* [the remark applying also to the other genera mentioned] is Rhætic in origin (taking the blue clay of Chellaston as of that age)." The Foraminifera of the clay supposed to have come from Chellaston were originally described as of Triassic age ‖; they have, however, since been determined by Professor Rupert Jones to be neither of Triassic nor even Rhætic age, as was formerly supposed, but to have a true Liassic facies, and probably from Leicestershire. A comparative study of the Rhætic Microzoa shows that they bear some close resemblances to the fauna obtained from Upper Palæozoic strata. Several of the species of *Ammodiscus* found at Wedmore were already known from Permian and Carboniferous rocks, whilst many forms belonging to the genus *Stacheia* were previously known only from Carboniferous and Silurian ¶ strata.

* L. G. Bornemann, "Beiträge zur Kenntniss des Muschelkalks, insbesondere der Schichtenfolge und der Gesteine des Unteren Muschelkalks in Thüringen," Jahrb. k. preuss. geol. Landesanst. Berlin, 1885.

† Proc. Geol. Assoc. vol. ii. (1872) p. 175.

‡ 1882, pp. xiv & xv.

§ *Op. suprà cit.* p. 178.

‖ Jones and Parker, "On some Fossil Foraminifera from Chellaston, near Derby," Quart. Journ. Geol. Soc. vol. xvi. (1860) p. 452.

¶ The Silurian specimens under the name of *Psammosiphon*, Vine.

The affinity which these Rhætic Foraminifera bear towards the younger (Jurassic) strata is also marked, since many characteristic arenaceous forms present in the Rhætic clays have their analogues in the faunæ of the Swiss Jurassic (Argovian) beds of the zones of *Ammonites transversarius* and *A. bimammatus* (=Corallian) described by Dr. Rudolf Hæusler *.

As regards the foraminiferal facies of the Lias, a *complete* comparison cannot be made with the Rhætic fauna, for the former group of beds have yielded a large preponderance of the perforate Foraminifera, whilst the arenaceous types, which are so well represented in the Rhætic beds of Wedmore, are poorly represented in the Lias. In a sample of the Upper Lias (*Leda-ovum* beds) of Northampton, kindly given me by Mr. J. Harrison, of the Royal College of Science, I have, however, found examples of *Ammodiscus*, such as *A. anceps*, *A. centrifugus*, and *A. Robertsoni*, which brings the range of these forms from the Carboniferous up to the Lias strata.

The examination of the Rhætic clays of Wedmore has resulted in the discovery of certain species of *Stacheia* which are comparable with the hitherto obscure and imperfectly known fossils described by Mr. G. R. Vine in 1882 †, and for which he proposed the generic name of *Psammosiphon*, placing it in the class Vermes, and regarding the fossils as being related to the tubicolate Polychæta. Two species of *Psammosiphon* were described by Vine—*P. amplexus* and *P. elongatus*. The original specimens were obtained from Silurian strata of Wenlock age—the Coalbrookdale beds and the Tickwood beds. During the examination of similar fossils from the Rhætic such evidence was obtained as to fully establish them as true Rhizopods, and belonging to the well-known Carboniferous genus *Stacheia*. I have since found similar fossils in some numbers in the Silurian strata (Wenlockian) of the island of Gothland; for a sample of the clay I am indebted to Mr. F. A. Bather, M.A., F.G.S. For the opportunity of examining in thin sections some of the original specimens of *Psammosiphon amplexus* in the Vine collection at the Royal College of Science I wish to express my sincere thanks to Professor Judd, C.B., F.R.S.

In the elucidation of these somewhat problematic fossils much assistance has been afforded me by the loan of some rare

* "Monographie der Foraminiferen-Fauna der Schweizerischen *Transversarius*-Zone," Abhandl. der Schweiz. palæontogr. Gesellsch. vol. xvii. (1890).

† Quart. Journ. Geol. Soc. vol. xxxviii. (1882) pp. 390-392, pl. xv. fig. 8.

arenaceous types of recent Foraminifera from Mr. F. G. Pearcey, and I am indebted to Mr. John Smith, of Kilwinning, for allowing me a sight of his specimens of *Psammosiphon*, selected from the Silurian shale-washings, amongst which are individuals apparently referable to *P. elongatus* of Vine; but otherwise no figure has been given and only a short description *.

In Terquem and Berthelin's "Microscopical Study of the Clays of the Middle Lias of Essey-les-Nancy" † some fossils are figured and described which are precisely analogous in their external forms to certain Rhætic examples of *Stacheia*.

Concerning the bathymetrical aspect of the Rhætic Microzoa there is not very direct evidence, although what there is points in the main towards the shallow-water nature of the deposits. The genera which are most commonly represented in these beds are *Ammodiscus* and *Haplophragmium*, both of which are quite unrestricted as to depth, occurring in shallow water and down to depths of 3000 fathoms or more. Their small size and stunted appearance would lead one to suppose that these organisms had lived at great depths, although that feature might also be (and, in this case, probably is) occasioned by their having lived under unfavourable conditions, such as would result from a change to brackish water. The modern representatives of *Stacheia* are most probably the Polytremata and similar adherent forms with acervuline aggregates of chamberlets; although the latter are hyaline types, yet one series is possibly only a modification of the other. This relationship would indicate shallow-water conditions, since *Polytrema* is characteristic of such deposits.

The occurrence of bone- and teeth-fragments in nearly all of the various beds examined also points to the shallow-water origin of these deposits.

The presence of crystal-impressions in the tests of these fossils (presuming they were once occupied by a zeolite) is somewhat opposed to the idea of its being a shallow-water fauna, since crystals of phillipsite occur in the deeper deposits of the ocean.

I take this opportunity of expressing my best thanks for invaluable aid in many particulars to Professor T. Rupert Jones, F.R.S., to Professor J. W. Judd, C.B., F.R.S., to Mr. Fortescue W. Millett, F.R.M.S., and to Mr. C. Davies Sherborn, F.Z.S.

* Quart. Journ. Geol. Soc. vol. xxxviii. (1882) p. 390.

† Mém. Soc. Géol. France, sér. 2, vol. x. (1875), Mém. iii. p. 103, pl. ix. figs. 1 *a–c*, p. 105, figs. 3 *a–f*.

Description of the Foraminifera from Wedmore.

Family **Lituolidæ.**

Subfamily *Litvolinæ.*

Reophax, Montfort, 1808.

1. *Reophax difflugiformis*, Brady. (Pl. XI. fig. 1.)

Reophax difflugiformis, Brady, 1879, Quart. Journ. Micr. Sci. vol. xix. n. s. p. 51, pl. iv. figs. 3 *a*, *b*; id. 1884, Chall. Rep. vol. ix. p. 289, pl. xxx. figs. 1–5; Hæusler, 1885, Neues Jahrb. f. Min., Beil. Bd. iv. p. 9, pl. i. fig. 1; id. 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 26, pl. iii. figs. 1–3, pl. v. figs. 25–27.

This simple form is represented in the Rhætic washings by one example only, although many of the irregular flask-shaped aggregates common in the sand are probably the arenaceous tests of similar organisms. The specimen resembles very closely the figure given by Dr. Brady in the 'Challenger' Report in pl. xxx. fig. 5. *R. difflugiformis* has been lately described by Dr. Hæusler from the Upper Jurassic beds of Switzerland; and it is also known as a fossil from beds of post-tertiary age.

In recent soundings it is unrestricted as regards depth.

From the Rhætic of bed no. 2, Wedmore; one specimen.

Haplophragmium, Reuss, 1860.

2. *Haplophragmium agglutinans* (d'Orbigny). (Pl. XI. figs. 2 *a*, *b*.)

Spirolina agglutinans, d'Orbigny, 1846, Foram. Foss. Vienne, p. 137, pl. vii. figs. 10–12.

Spirolina simplex, Reuss, 1855, Sitzungsb. k. Ak. Wiss. Wien, vol. xviii. p. 232, pl. ii. fig. 30.

Haplophragmium rectum, Brady, 1876, Monogr. Carb. and Perm. Foram. (Pal. Soc.) p. 66, pl. viii. figs. 8, 9.

Haplophragmium agglutinans, Brady, 1884, Chall. Rep. vol. ix. p. 301, pl. xxxii. figs. 19–26; Sherborn and Chapman, 1889, Journ. Roy. Micr. Soc. p. 484, pl. xi. fig. 8; Hæusler, 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 26, pl. iii. figs. 32–36, pl. iv. figs. 5, 6, 18; Chapman, 1892, Journ. Roy. Micr. Soc. p. 324, pl. v. fig. 14.

The Rhætic specimens of *H. agglutinans* closely resemble the forms which Dr. Brady described from Carboniferous rocks, but differ in many slight details from those of later ages. The species is known from nearly all fossiliferous strata from the Carboniferous formation upwards.

Occurs in the Rhætic of Wedmore, in bed no. 2; rare.

3. *Haplophragmium rhæticum*, sp. n.
(Pl. XI. figs. 3, 4.)

Test free, compressed, consisting of an involute plano-spiral series of chambers, which in their later growth take on a linear arrangement. The sutures of the chambers are well-marked superficially, and the edge of the dorsal margin is constricted at the sutural points, thus giving the test an angulated appearance. Shell-texture coarsely arenaceous. Length of a perfect specimen $\frac{1}{16}$ inch (1·6 millim.); breadth of spiral portion $\frac{1}{30}$ inch (·85 millim.).

This species resembles *H. elegans* * of the Gault in the angulate contour of the test; the morphological types of the two forms are, however, quite distinct, since the Rhætic species is strongly compressed on the umbilical axis and the segments are in the later growth disposed in a linear manner. The crozier-like shape of the test of *H. rhæticum* recalls the form of *H. agglutinans*; but in the latter the spiral series of chambers is evolute.

H. rhæticum is found in the Rhætic series at Wedmore, in bed no. 2, where it is rare, and in no. 6, very rare.

4. *Haplophragmium canariense* (d'Orbigny).
(Pl. XI. figs. 5 *a*, *b*.)

Nonionina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 128, pl. ii. figs. 33, 34.
Lituola nautiloidea, var. *canariensis* (pars), Parker and Jones, 1865, Phil. Trans. vol. clv. p. 406, pl. xv. figs. 45 *a*, *b*.
Haplophragmium canariense, Brady, 1884, Chall. Rep. vol. ix. p. 310, pl. xxxv. figs. 1–5; Hæusler, 1885, Neues Jahrb. f. Min., Beil. Bd. iv. p. 12, pl. i. figs. 17–20; id. 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 34, pl. iv. figs. 1–3.

The oldest fossil deposits in which the above species has hitherto occurred are those of the Middle Lias. Some of the specimens found in the Neocomian beds of Surrey, and described under the name of *Haplophragmium nonioninoides*, Reuss, are perhaps referable to the above species †. In the Rhætic specimen the sutural lines are rather obscure; otherwise it is comparable with typical examples.

H. canariense was found in the Rhætic of bed no. 6, at Wedmore. One specimen.

* Chapman, 1892, Journ. Roy. Micr. Soc. p. 322, pl. v. fig. 10.
† Chapman, Quart. Journ. Geol. Soc. vol. l. (1894) p. 695.

5. *Haplophragmium emaciatum*, Brady.
(Pl. XI. fig. 6.)

Haplophragmium emaciatum, Brady, 1884, Chall. Rep. vol. ix. p. 305, pl. xxxiii. figs. 26–28; Hæusler, 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 37, pl. iv. figs. 8–10.

Dr. Hæusler has found this species in the Upper Jurassic beds of Switzerland, and it has also occurred in the Lower Greensand of Guildford *. It is represented in recent soundings from the West Indies and the Arabian Sea, and is found at moderate depths.

One specimen of *H. emaciatum* was found in bed no. 2 of the Rhætic series at Wedmore.

6. *Haplophragmium neocomianum*, Chapman.
(Pl. XI. fig. 7.)

Haplophragmium neocomianum, Chapman, Quart. Journ. Geol. Soc. vol. l. (1894) p. 695, pl. xxxiv. figs. 2 *a*, *b*.

In the Rhætic washings innumerable thin brown platy aggregates occur with more or less regular outlines. On rendering these transparent by immersion in Canada balsam or turpentine, their foraminiferal nature is easily recognized. The septation of the test is seen to be perfectly regular in many specimens, and the commencing involute spiral can also be made out. These obscure organisms differ in no essential character from the Neocomian specimens of the Lower Greensand in the neighbourhood of Dorking, and, like them, these Rhætic examples are always of a ferruginous-brown colour.

H. neocomianum occurs in the Rhætic clays of Wedmore, in bed no. 2, rare; no. 3, frequent; no. 4, very abundant; no. 5, very abundant; no. 6, frequent.

Subfamily *Trochammininæ*.

Ammodiscus, Reuss, 1861.

7. *Ammodiscus incertus* (d'Orbigny).
(Pl. XI. figs. 8, 9.)

Operculina incerta, d'Orbigny, 1839, Foram. Cuba, p. 49, pl. vi. figs. 16, 17.

Orbis infimus, Strickland, 1848, Quart. Journ. Geol. Soc. vol. ii. p. 30, fig. *a*.

Involutina silicea, Terquem, 1862, Mém. Acad. Imp. Metz for 1861–1862, p. 450, pl. vi. fig. 11 (Deuxième Mém. Foram. du Lias).

* Chapman, Quart. Journ. Geol. Soc. vol. l. (1894) p. 694.

Involutina aspera, Terquem, 1863, ibid. for 1862-1863, p. 221, pl. x. fig. 21 (Troisième Mém. Foram. du Lias).

Cornuspira oolithica, Schwager, 1867, in Waagen's Ueber die Zone des *Amm. Sowerbyi*, vol. i. pt. iii. p. 655, pl. xxxiv. (xi.) fig. 4.

Trochammina incerta, Parker, Jones, and Kirkby, 1869, Ann. & Mag. Nat. Hist. ser. 4, vol. iv. p. 388, pl. xiii. fig. 1.

Cornuspira helvetica, *C. eichbergenensis*, *C. elliptica*, &c., Kübler and Zwingli, 1870, Foram. Schweiz. Jura, pp. 13, 17, 24. Figures distributed in pls. ii., iii., and iv.

Cornuspira granulosa, *C. infraoolithica*, &c., Terquem, 1870, Troisième Mém. Foram. du Syst. Oolithique, pp. 242-244, pl. xxv. figs. 12-20.

Trochammina incerta, Brady, 1876, Monogr. Carb. and Perm. Foram. (Pal. Soc.), p. 71, pl. ii. figs. 10-14; Tate and Blake, 1876, The Yorkshire Lias, p. 452, pl. xvii. fig. 17; Hæusler, 1883, Neues Jahrb. f. Min. Bd. i. p. 59, pl. iv. fig. 1.

Ammodiscus incertus, Brady, 1884, Chall. Rep. vol. ix. p. 330, pl. xxxviii. figs. 1-3; L. G. Bornemann, 1886, Beiträge zur Kenntniss des Muschelkalks, Jahrb. k. preuss. geol. Landesanst., Berlin, p. 293, pl. xiii. figs. 3, 4; Hæusler, 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 55, pl. ix. figs. 1-21; Crick and Sherborn, 1891, Journ. Northampton Nat. Hist. Soc. vol. vi. p. 209, fig. 1.

The above synonymy refers to the more important notices of *Ammodiscus incertus*, and relates chiefly to its occurrence in Palæozoic and Jurassic strata. The specimens of *A. incertus* from the Rhætic beds of Wedmore often show a tendency to depart from the ordinary plano-spiral and circular form, being more or less elliptical and irregularly coiled; in the latter character they closely approach *A. gordialis*. These features are not unusual with many of the Carboniferous and Permian examples recorded by Dr. H. B. Brady, and also in the Jurassic forms described by Dr. Hæusler. In the Rhætic specimens the tests are composed of fine quartzose sand, and some of the fossils have a conspicuously opaque white appearance in the washings, whilst others, more obscure in their general external characters, are of a brown colour.

This species occurs commonly in many British Carboniferous limestones, in the Permian magnesian limestones of England, and in the Zechstein and Muschelkalk of Germany. It is also abundant in Jurassic strata, and is met with in nearly all later fossiliferous deposits.

Frequent in the Rhætic of Wedmore, bed no. 2.

8. *Ammodiscus anceps* (Brady).
(Pl. XI. figs. 10 *a*, *b*.)

Trochammina anceps, Brady, 1876, Monogr. of Carb. and Perm. Foram. (Pal. Soc.) p. 76, pl. iii. figs. 8 *a*, *b*.

The characters of this species as given by Dr. H. B. Brady apply very nearly to the Rhætic specimens, and are as

follows :—" Test free, convoluted, discoidal, thin, consisting of a spuriously septate tube coiled in one plane. Septa marked externally by oblique slightly depressed lines. Diameter $\frac{1}{60}$ inch (·4 millim.)."

This species was regarded by Brady as a transitional form between *A. incertus* and the septate Trochamminæ of the type *T. inflata*. Since the arenaceous tube is not definitely septate, the species is here placed in the genus *Ammodiscus*. In the Rhætic specimens the peripheral edge of the test is somewhat sharper than that of the Carboniferous examples, and its diameter averages $\frac{1}{75}$ inch (0·34 millim.).

The occurrence of *A. anceps* in beds of Rhætic age is of exceptional interest, seeing that it was described by Dr. Brady from the Carboniferous rocks of England and Scotland, and was there very rarely met with. I have since found this form in the Upper Lias of Northampton.

Found in bed no. 2 of the Rhætic series at Wedmore, very common.

9. *Ammodiscus centrifugus* (Brady).
(Pl. XI. fig. 11.)

Trochammina centrifuga, Brady, 1873, Mem. Geol. Survey Scotland, Expl. Sheet 23, p. 95; id. 1873 (in Young and Armstrong's Catal.), Trans. Geol. Soc. Glasgow, vol. iv. p. 271; id. 1876, Monogr. of Carb. and Perm. Foram. (Pal. Soc.) p. 74, pl. ii. figs. 15–20.

This form is probably only a variety of *A. incertus*, as was suggested by Dr. Brady, the only difference consisting in the straight extension of the last turn of the coiled shell. The Rhætic specimens have the surface of the test much wrinkled.

A. centrifugus was found in the Lower Carboniferous Limestone of England and Scotland, at which horizon it occurred rarely, and in the Upper Carboniferous Limestone of both countries frequently. One or two examples, probably referable to this form, have also occurred in washings of Upper Lias clay from Northampton.

This species occurs in the Rhætic series of Wedmore in bed no. 2, where it is rare.

10. *Ammodiscus milioloides* (Jones, Parker, and Kirkby).
(Pl. XI. figs. 12, 13.)

Trochammina milioloides, J., P., & K., 1869, Ann. & Mag. Nat. Hist. ser. 4, vol. iv. p. 390, pl. xiii. figs. 9–14; Brady, 1876, Monogr. Carb. and Perm. Foram. (Pal. Soc.) p. 79, pl. iii. figs. 11–15.

This species was hitherto essentially Permian, found in the

Lower and Middle Magnesian Limestone of the North of England.

The specimens of *A. milioloides* from Wedmore are more compressed than those obtained from Permian deposits, but they agree in the general plan of growth. The Rhætic specimens are also much smaller than those of Permian age, measuring only $\frac{1}{45}$ inch (0·56 millim.) in length, whilst the latter are $\frac{1}{14}$ inch (1·75 millim.).

A. milioloides occurs in the Rhætic clay, bed no. 2, at Wedmore, and is common.

11. *Ammodiscus pusillus* (Geinitz). (Pl. XI. fig. 14.)

Serpula pusilla, Geinitz, 1848, Verstein. Zechst. Roth. p. 6, pl. iii. figs. 3–6.

Foraminites serpuloides, King, 1848, Cat. Perm. Foss. Northumb. p. 6.

Serpula? pusilla, Jones, 1850, in King's Monogr. Perm. Fossils, p. 57, pl. vi. figs. 7–9, pl. xviii. figs. *a–d.*

Trochammina pusilla, Jones, Parker, and Kirkby, 1869, Ann. & Mag. Nat. Hist. ser. 4, vol iv. p. 390, pl. xiii. figs. 4–6 &c.; Brady, 1876, Monogr. Carb. and Perm. Foram. (Pal. Soc.) p. 78, pl. iii. figs. 4, 5; Hæusler, 1882, Ann. & Mag. Nat. Hist. ser. 5, vol. x. p. 58, pl. iv. figs. 27–30; L. G. Bornemann, 1885, Jahrb. k. preuss. geol. Landesanst., Berlin, p. 293, pl. xiii. figs. 6, 7.

Ammodiscus pusillus, Hæusler, 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 60, pl. ix. figs. 39–43.

The Rhætic examples of the above species are both rare and very small; the test is finely arenaceous, as is the case with most of the specimens from the black Rhætic clay.

A. pusillus is a common form in the Permian (lower and middle Magnesian Limestone) of the north of England (associated with *A. milioloides*); it is also recorded from the Zechstein of Germany; also from Triassic rocks in Thuringia by L. G. Bornemann; and from the Upper Jurassic beds of Switzerland by Hæusler.

Found rarely in bed no. 2 of the Rhætic series at Wedmore.

12. *Ammodiscus Robertsoni* (Brady). (Pl. XI. figs. 15, 16, 17 *a*, *b*.)

Trochammina Robertsoni, Brady, 1876, Monogr. Carb. and Perm. Foram. (Pal. Soc.) p. 80, pl. iii. figs. 6, 7.

One of the commoner forms in the washings of the black Rhætic clay of Wedmore is the elegant little species of *Ammodiscus* which Dr. Brady found in the Carboniferous shales of the west of Scotland. The finely arenaceous texture of the test of the Rhætic specimens exactly accords with the

original description of the type forms. I have also found this form in the Upper Lias clay of Northampton.

The species might easily be mistaken for a minute sandy Quinqueloculine form; but the tube is merely constricted at each turn by an infolding of the shell-wall, and is not truly septate.

Found in bed no. 2 at Wedmore, common.

13. *Ammodiscus auricula*, sp. n.
(Pl. XI. figs. 18 *a*, *b*.)

Test free, ear-shaped, greatly compressed, consisting of a coiled tube, which is spuriously septate at intervals. The test sometimes exhibits a central inflated kidney-shaped pseudo-chamber. The peripheral edge is usually thinner than the rest of the test, so that the margin is flange-like. Aperture a slit, situated vertically, on the lower edge of the termination of the compressed tube, at its junction with the previous whorl. Test arenaceous, thin, and delicate. Length about $\frac{1}{40}$ inch (0·63 millim.).

This form is not common in the Rhætic washings, but several characteristic examples were found. Its nearest representative is *A. Robertsoni*, but it differs from that species in the peculiar shape and the extreme compression of the test.

From the Rhætic, bed no. 2, Wedmore; frequent.

14. *Ammodiscus jurassicus*, Hæusler.
(Pl. XI. fig. 19.)

Trochammina jurassica, Hæusler, 1882, Ann. & Mag. Nat. Hist. ser. 5, vol. x. p. 58, pl. iv. figs. 31–40; id. 1882, Neues Jahrb. f. Min. p. 59, pl. iv. fig. 4.

Ammodiscus jurassicus, Hæusler, 1885, Neues Jahrb. f. Min., Beil. Bd. iv. p. 26, pl. iii. figs. 33, 34; id. 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 61, pl. ix. figs. 44–47.

This is not a common foraminifer in the Rhætic washings. Fairly typical examples were, however, met with at various horizons. Dr. Hæusler records *A. jurassicus* from the Upper Jurassic beds of Switzerland, and he also notes it from the Lower Cretaceous.

This species was found in the Rhætic of Wedmore, in bed no. 2, rare; no. 5, frequent; no. 6, very rare.

15. *Ammodiscus fusiformis*, sp. n.
(Pl. XI. figs. 20 *a*, *b*.)

Test free, spindle-shaped, and sometimes curved; consisting of a tube sharply bent on itself at each end of the

longer axis, with the coil twisted through several planes during its growth, so that the test has a Quinqueloculine aspect. The tube forming the test is also constricted at various points between the two extremities. Texture of shell finely arenaceous. Aperture a circular orifice, formed by the open end of the tube; the aperture is angulated or margined in the specimen taken for figuring. Length $\frac{1}{52}$ inch (0·48 millim.).

This species is related to *A. Robertsoni* in the general Quinqueloculine plan of growth; but the cross section of the test of the latter species would show a considerably greater amount of lateral compression and breadth.

A. fusiformis was found in the Rhætic clay of bed no. 2, at Wedmore; common.

Subfamily *Endothyrinæ*.

Nodosinella, Brady, 1876.

General characters (after Brady, emended).—Test free, straight, arcuate, or crooked, never spiral; formed either of a tube constricted at intervals, or of a single series of segments variously combined. Test arenaceous, often smooth externally, imperforate, but sometimes having pustulate orifices at various points on the surface. Wall of test thick, with a labyrinthic structure. Aperture variable, simple or compound.

16. *Nodosinella wedmoriensis*, sp. n.
(Pl. XI. figs. 21–24.)

(?) *Psammosiphon elongatus*, Vine, 1882, Quart. Journ. Geol. Soc. vol. xxxviii. p. 390.

Test more or less cylindrical, tapering towards the ends, straight, arcuate, or sharply recurved; sometimes flattened or outspread at the distal end. The interior divided at intervals by partitions, forming a series of chambers; no indications of internal septation visible on the surface of the test. Texture finely arenaceous; the test of a brown colour; the outer surface smooth, but with evidences of foreign substances, such as the impressions of crystals which were used to build up the test. Wall of test thick and labyrinthic in structure. Length of longest specimen found $\frac{1}{4}$ inch (6·25 millim.), breadth $\frac{1}{20}$ inch (1·25 millim.).

A large number of this species were selected from the Rhætic washings. They invariably show the septation of the tube when cut through longitudinally, and it was owing

to this fact, and also to its peculiar form, that it was at first thought probable that we were dealing with some ancestral form of the recent *Aschemonella*. When the true nature of the labyrinthic test was worked out it was seen that the fossil form had characters in common with *Nodosinella*, a genus hitherto known through Dr. Brady's researches on the Carboniferous Foraminifera. The present species, *N. wedmoriensis*, differs materially from the Carboniferous *N. cylindrica* * in the absence of external evidences of septation and in having a more irregular form, sometimes being even bent at right angles.

This species occurs in bed no. 3 of the Rhætic at Wedmore, very rare; bed no. 5, very common.

Stacheia, Brady, 1876.

"Plaques des Rayonnés," &c., Terquem and Berthelin, 1875.
Psammosiphon, Vine, 1882.

General characters (after Brady, emended).—Test adherent or free; composed of numerous segments subdivided in their interior, or of an acervuline mass of chamberlets, sometimes arranged in layers, sometimes confused, or of a thick-walled test with acervuline or labyrinthic structure, and with the interior subdivided into numerous elongate sinuous cavities (the latter characters especially applying to the Rhætic representatives of the genus). Apertures simple, but irregular, terminal or scattered over the surface of the test. Texture subarenaceous, composed of fine sand, sometimes admixed with coarser material, and with a calcareous or chitinous cement; imperforate.

The above genus was proposed by Dr. H. B. Brady in 1876 to include some adherent subarenaceous Foraminifera which he had discovered in the Carboniferous Limestone formation of England and Scotland, and which had affinities morphologically pertaining to the genera *Polytrema*, *Tinoporus*, and other perforate types.

In his 'Monograph of the Carboniferous and Permian Foraminifera' Dr. Brady lays particular stress upon the fact that in the Carboniferous strata *Stacheia* is always parasitic (adherent); and such is undoubtedly the case with the specimens from that formation. In the Rhætic assemblage the tests are more often perfectly free in their mode of growth. The flat complanate or frondose form (*S. dispansa*) is by far

* Brady, 1876, Monogr. Carb. and Perm. Foram. (Pal. Soc.) p. 104, pl. vii. figs. 4–7.

the best represented species, in point of numbers, in the Rhætic washings; and this form appears to have flourished on the sea-bottom, spreading horizontally and growing so numerously as to make quite a separation band at frequent intervals in the clay deposits.

There are, however, a few examples of *Stacheia* from the Rhætic beds which were without doubt attached forms; and this feature is especially characteristic of *S. cuspidata* and *S. intermedia*.

It will also be seen from the reference given above that the genus is represented in the Lias by fossils which have been referred to parts of Echinodermata.

17. *Stacheia intermedia*, sp. n. (Pl. XI. fig. 25.)

Test normally attached or sometimes free, irregularly cylindrical, and often turned outwardly at one end, thus forming a base of attachment. Subdivided internally in an irregular manner; with a terminal aperture, and also some other orifices of an irregularly stellate outline opening out upon the surface of the test. Texture subarenaceous. Wall of test of considerable thickness and with a finely labyrinthic structure. Colour pale brown. Length about $\frac{1}{4}$ inch (6·25 millim.).

S. intermedia may be an irregularly cylindrical modification of the flat wild-growing form *S. dispansa*; but the apparently attached mode of growth of the former organism seems to justify its separation under a distinct specific name.

It occurs in bed no. 3 of the Rhætic at Wedmore, very rare; bed no. 5, frequent.

18. *Stacheia congesta*, Brady. (Pl. XII. figs. 1, 2.)

Stacheia congesta, Brady, 1876, Monogr. Carb. and Perm. Foram. (Pal. Soc.) p. 117, pl. ix. figs. 1–5.

Characters (after Brady, emended).—Test elongate, subcylindrical, rounded or fusiform; either adherent, clustering around foreign bodies, or free. Chambers very numerous, irregular in shape, closely packed, confused in arrangement; the boundary-walls of those composing the superficial layer sometimes indicated by the areolation of portions of the exterior of the test. Surface otherwise granular or nearly smooth. Apertures at the extremities of the fusiform varieties or disposed over the surface in an irregular manner. Length of the Rhætic specimens about $\frac{1}{10}$ inch (2·5 millim.).

Many examples from Wedmore are exactly comparable in

form with those figured by Dr. Brady from the Carboniferous Limestone of England and Scotland. The specimens from the latter formation are somewhat smaller than those from the Rhætic beds.

S. congesta occurs in bed no. 3 of the Rhætic series at Wedmore, common; bed no. 5, common.

19. *Stacheia triradiata*, sp. n. (Pl. XII. figs. 3–5.)

"*Asteracanthion*," Terquem and Berthelin, 1875, Mém. Soc. Géol. France, sér. 2, vol. x., Mém. no. 3, p. 103, pl. ix. figs. 1 *a–c*.

Test free, consisting of three somewhat short and irregularly cylindrical arms, radiating nearly at right angles to one another; surface smooth or finely granular and of a pale brown colour. Interior having an irregular central cavity; the tubular arms divided at intervals by transverse septa. Wall of test thick and with distinct labyrinthic structure; texture finely arenaceous. Each arm terminates in a small orifice, which leads back into a larger cavity. Average diameter of test $\frac{1}{8}$ inch (3·125 millim.).

Amongst the specimens of "*Psammosiphon*" in the Vine collection at the Royal College of Science there is one undoubted example of *Stacheia triradiata* collected from the Wenlock Shales, so that this form, as well as *S. amplexa*, ranges back into the Silurian strata.

S. triradiata was found at Wedmore in bed no. 5, frequent.

20. *Stacheia amplexa* (Vine). (Pl. XII. figs. 6, 7.)

Psammosiphon amplexus, Vine, 1882, Quart. Journ. Geol. Soc. vol. xxxviii. p. 391, pl. xv. fig. 8.

Test free or attached, in the latter case having a flattened base. Irregularly subspherical in form, with a warty surface, caused by the numerous papillose terminations to the tubular system of the interior. Interior traversed by cylindrical tubes, which are disposed in a sinuous manner. Wall of test thick and with labyrinthic structure. The Rhætic specimens are of a pale brown colour, and the shell-texture is subarenaceous, consisting of a fine sand, mixed with coarser material and crystalline aggregates, cemented together by material which was formerly chitinous. Length about $\frac{1}{5}$ inch (5 millim.).

S. amplexa has been recorded by Vine under the name of *Psammosiphon amplexus* from the Wenlock Shales (the Coalbrookdale and the Tickwood beds); and the same author notes it also from the Hairmyres shales of Carboniferous age

in material collected by Mr. John Young, of the Hunterian Museum, Glasgow. It also occurs in the Silurian clay of the island of Gothland. The arenaceous material constituting the test of the Silurian specimens, unlike that of Rhætic examples, is cemented by calcareous matter.

The tests of *S. amplexa* from Wedmore have been largely constructed of the crystalline aggregates to which reference has previously been made, and of which only moulds now remain to testify to their former existence. These crystalline bodies were also used in the construction of the tests of the other large subarenaceous species from the Rhætic washings, belonging to the genera *Nodosinella* and *Stacheia*; but they occur in *S. amplexa* in particular abundance.

S. amplexa was found in the Rhætic series at Wedmore, in bed no. 3, frequent; no. 5, common.

21. *Stacheia dispansa*, sp. n. (Pl. XII. fig. 8.)

Test free, compressed, and generally irregular in outline; some more or less perfect examples, however, have a leaf-like form with deeply incised margins. Interior traversed by irregular sinuous cavities, which are at intervals transversely divided. The positions of the apertures in this compressed form are—(1) around the margin, appearing as an interrupted slit communicating directly with the interior, and constituting a plane of weakness through the median plane of the test; (2) disposed over the surfaces of the test as a series of irregularly circular orifices, which are often siphonate, that is, borne on the end of a short tube projecting at right angles from the general surface, the latter being in some cases modified by lateral compression, thus giving the orifice an elliptical or slit-like form. Wall of test very thick and with a finely labyrinthic structure. Length of one of the more perfect specimens $\frac{1}{2}$ inch (12·5 millim.), breadth $\frac{1}{4}$ inch (6·25 millim.), thickness $\frac{1}{25}$ inch (1 millim.).

The fragmentary remains of this species constitute a large proportion of the washed material from one stratum of the Rhætic series at Wedmore. *S. dispansa* does not seem to have ever been attached to any foreign bodies like some of its congeners, but to have lived on the surface of the deposit forming at that time. One of the specimens found has a very definite outline, taking a form such as one would imagine to arise from the extrusion of the sarcode in an amœbiform or lobulate manner. The majority of the specimens of *S. dispansa* have, however, no very distinct shape, and are always more or less fragmentary, since the mere separation of the

clay from the coarser particles, although very carefully conducted, is sufficient to break up the excessively friable tests.

Moulds of crystals observed in the other subarenaceous forms of the Rhætic Foraminifera are also present in the test of *S. dispansa*, but they do not seem to have been so largely utilized in this form.

The test of this species, as previously noted, has a tendency to split horizontally along the median plane. This is owing to the restriction of the internal cavities exactly to the median portion of the test and to the marginal series of apertures, with which the chambers communicate.

The above species was found in bed no. 3 of the Rhætic series at Wedmore, frequent; bed no. 5, very common.

22. *Stacheia cuspidata*, sp. n. (Pl. XII. figs. 9, 10.)

"Plaques des Rayonnés," Terquem and Berthelin, 1875, Mém. Soc. Géol. France, sér. 2, vol. x., Mém. no. 3, p. 105, pl. ix. figs. 3 *a–f*.

Test normally adherent, compressed, and irregularly discoid, but having the peripheral edge indented or cuspidate. The lower, attached surface slightly concave, and the shell-wall of that surface thin, so that the figure of the central stellate cavity can be seen through the shell. Test somewhat coarsely arenaceous, and the wall moderately thick and having a finely labyrinthic structure. The apertures are arranged almost as in *S. dispansa*, some orifices appearing on the peripheral margin, whilst others, curiously shaped and of a cuspid outline, are seen on the superior face of the test; in some cases these are lengthened out to an extraordinary degree. Diameter of test $\frac{1}{9}$ inch (2·8 millim.), thickness of test $\frac{1}{40}$ inch (0·63 millim.), more or less.

This is a discoidal variety closely allied to *S. dispansa*. It is fairly constant in its essential characters, and, unlike *S. dispansa*, always shows the adherent modification of the inferior surface, although no specimens were found actually attached to foreign objects.

The forms figured by Terquem and Berthelin from the Lias, and referred to above, are very variable, but exhibit the essential features of the species.

S. cuspidata occurs in bed no. 5 of the Rhætic series at Wedmore, frequent.

Family **Textulariidæ**.

Subfamily *Buliminin*æ.

Bulimina, d'Orbigny, 1826.

23. *Bulimina pyrula*, d'Orbigny. (Pl. XII. fig. 11.)

Bulimina pyrula, d'Orbigny, 1846, Foram. Foss. Vien. p. 184, pl. xi. figs. 9, 10; Brady, 1884, Chall. Rep. vol. ix. p. 399, pl. l. figs. 7–10.

This species has hitherto been known from Liassic strata, and it occurs commonly in nearly all Tertiary beds.

The Rhætic specimen undoubtedly belongs to this type, which is perhaps the most rudimentary form of the genus. The test of the example found is finely arenaceous.

One specimen, from bed no. 2, at Wedmore.

Family **Lagenidæ**.

Subfamily *Lagenin*æ.

Nodosaria, Lamarck, 1816.

24. *Nodosaria radicula* (L.). (Pl. XII. fig. 12.)

Nautilus radicula, Linné, 1767, Syst. Nat. 12th ed. vol. ii. p. 1164. no. 285; Montagu, 1803, Test. Brit. p. 197, pl. vi. fig. 4.

Nodosaria Geinitzi, Reuss, 1854, Jahresb. Wetterauer Gesellsch. vol. for 1851–1853, p. 77, fig. 12; Richter, 1855, Zeitschr. deutsch. geol. Gesellsch. vol. vii. p. 532, pl. xxvi. fig. 26.

Nodosaria radicula, Parker and Jones, 1859, Ann. & Mag. Nat. Hist. ser. 3, vol. iii. p. 476; id. ibid. vol. iv. p. 344; id. ibid. 1863, vol. xii. p. 209.

Nodosaria Geinitzi, Reuss, 1861, in Geinitz's Dyas, Heft i. p. 121, pl. xx. fig. 28.

Nodosaria Kingi, id. ibid. p. 121, pl. xx. fig. 29.

Nodosaria Kirkbyi, Richter, ibid. p. 121, pl. xx. fig. 30.

Nodosaria Jonesi, id. ibid. p. 121, pl. xx. fig. 31.

Nodosaria radicula, Jones and Parker, 1860, Quart. Journ. Geol. Soc. vol. xvi. p. 453, figs. 1–5; Brady, 1867, Proc. Somerset Arch. and Nat. Hist. Soc. vol. xiii. p. 106, pl. i. fig. 4; Tate and Blake, 1876, Yorkshire Lias, p. 456, pl. xviii. fig. 17; Brady, 1876, Monogr. of Carb. and Perm. Foram. (Pal. Soc.) p. 124, pl. x. figs. 6–16; id. 1884, Chall. Rep. vol. ix. p. 495, pl. lxi. figs. 28–31; Sherborn and Chapman, 1886, Journ. Roy. Micr. Soc. p. 746, pl. xiv. fig. 24; Hæusler, 1887, Neues Jahrb. f. Min. vol. i. p. 179, pl. v. figs. 40, 45, 48, 49; id. 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 92, pl. xiii. figs. 31–33, 39–60, pl. xiv. figs. 1, 3–5, 16.

This species, which is so well distributed through the Secondary and Tertiary formations, is not known from strata earlier than the Permian. It is one of the few hyaline Foraminifera which were noticed in thin sections of the "Wedmore

Stone." In some parts the test exhibits the tubulation of the calcareous wall characteristic of the group.

Three specimens of *Nodosaria radicula* were seen in the limestone (bed no. 9) of Wedmore.

Marginulina, d'Orbigny, 1826.

25. *Marginulina glabra* (?), d'Orbigny.
(Pl. XII. fig. 13.)

Marginulina glabra, d'Orbigny, 1826, Ann. Sci. Nat. vol. vii. p. 259, no. 6, Modèle, no. 55; Parker, Jones, and Brady, 1865, Ann. & Mag. Nat. Hist. ser. 3, vol. xvi. p. 27, pl. i. fig. 36; Brady, 1867, Proc. Somerset Arch. and Nat. Hist. Soc. vol. xiii. p. 109, pl. ii. fig. 22; Hæusler, 1890, Abhandl. Schweiz. palæontogr. Gesellsch. vol. xvii. p. 106, pl. xiv. figs. 35–40, 42, 43.

The above species has been noticed from various strata of Secondary age. There is not much doubt that the Wedmore specimen is referable to the same type, although it is not safe to speak with certainty, since we have only the vertical section of the test in the thin rock-slice.

This specimen was found in the porous-textured rock, and the test has been apparently dissolved away in places, leaving a cavity of the exact outline of the fossil; and into this space numerous minute scalenohedra of calcite project from each wall. Other parts of the test show tubulation of the calcareous shell.

One example from the limestone of bed no. 9 at Wedmore.

Family **Rotaliidæ**.

Subfamily *Rotaliinæ*.

Truncatulina, d'Orbigny, 1826.

26. *Truncatulina stelligera*, sp. n.
(Pl. XII. figs. 14 *a*, *b*.)

Superior face flat, with three whorls, the initial chamber spherical and prominent; inferior face strongly convex. Surface of test distinctly punctate. The convex face has raised lines of shell-substance radiating from the umbilicus; the rays are thickest in the middle and taper towards the ends. Peripheral edge rounded. Diameter of test $\frac{1}{50}$ inch (0·5 millim.), height $\frac{1}{120}$ inch (0·21 millim.).

The genus *Truncatulina* is represented in strata as old as the Carboniferous Limestone. The above species differs from any form previously described chiefly in the sutural ornamentation of the inferior face, and which resembles that seen

in *Nonionina stelligera*, d'Orbigny. *T. stelligera* is the only example amongst the hyaline Foraminifera which was found in the washings of the Wedmore clays.

One specimen from the Rhætic of bed no. 2 at Wedmore.

EXPLANATION OF THE PLATES.

Plate XI.

Fig. 1. *Reophax difflugiformis*, Brady. × 33.
Fig. 2. *Haplophragmium agglutinans* (d'Orb.). *a*, lateral aspect; *b*, peripheral aspect. × 40.
Fig. 3. *Haplophragmium rhæticum*, sp. n. Lateral aspect. × 20.
Fig. 4. Ditto. Ditto. × 33.
Fig. 5. *Haplophragmium canariense* (d'Orb.). *a*, lateral aspect; *b*, peripheral aspect. × 13.
Fig. 6. *Haplophragmium emaciatum*, Brady. Lateral aspect. × 33.
Fig. 7. *Haplophragmium neocomianum*, Chapman. Lateral aspect. × 13.
Fig. 8. *Ammodiscus incertus* (d'Orb.). Lateral aspect. × 33.
Fig. 9. *Ammodiscus incertus* (d'Orb.), near *A. gordialis* (Parker and Jones). Lateral aspect. × 33.
Fig. 10. *Ammodiscus anceps* (Brady). *a*, lateral aspect; *b*, peripheral aspect. × 40.
Fig. 11. *Ammodiscus centrifugus* (Brady). Lateral aspect. × 40.
Fig. 12. *Ammodiscus milioloides* (Jones, Parker, and Kirkby). Lateral aspect. × 33.
Fig. 13. Ditto. Distorted specimen. × 33.
Fig. 14. *Ammodiscus pusillus* (Geinitz). Lateral aspect. × 33.
Fig. 15. *Ammodiscus Robertsoni* (Brady). Lateral aspect. × 40.
Fig. 16. Ditto. Another specimen; lateral aspect. × 33.
Fig. 17. Ditto. Compressed variety: *a*, lateral aspect; *b*, peripheral aspect. × 33.
Fig. 18. *Ammodiscus auricula*, sp. n. *a*, lateral aspect; *b*, peripheral aspect. × 33.
Fig. 19. *Ammodiscus jurassicus*, Hæusler. Lateral aspect. × 27.
Fig. 20. *Ammodiscus fusiformis*, sp. n. *a*, lateral aspect; *b*, oral aspect. × 33.
Fig. 21. *Nodosinella wedmoriensis*, sp. n. × 8.
Fig. 22. Ditto. Test laid open longitudinally, showing the septate interior of the test and thickness of the shell-wall. × 7.
Fig. 23. Ditto. An example with an outspread termination. × 8.
Fig. 24. Ditto. Curved specimen, showing crystal impressions at one end. × 8.
Fig. 25. *Stacheia intermedia*, sp. n. × 7.

Plate XII.

Fig. 1. *Stacheia congesta*, Brady. Typical form. × 10.
Fig. 2. Ditto. An example similar to one from the Carboniferous Limestone. × 8.
Fig. 3. *Stacheia triradiata*, sp. n. × 10.
Fig. 4. Ditto. A horizontal section of the test, showing the central cavity and constricted apertures. × 13.
Fig. 5. Ditto. A section of the test, showing the areolate character of the cementing tissue of the shell-wall. × 200.

Fig. 6. *Stacheia amplexa* (Vine). × 5.
Fig. 7. Ditto. Test broken open, showing the impressions of crystals once included in the shell-structure. × 7.
Fig. 8. *Stacheia dispansa*, sp. n. A nearly perfect example, showing the sinuous outline of the platy test. × 3.
Fig. 9. *Stacheia cuspidata*, sp. n. *a*, superior aspect; *b*, inferior aspect. × 10.
Fig. 10. Ditto. An example with an elongate aperture on the upper surface. × 7.
Fig. 11. *Bulimina pyrula*, d'Orbigny. × 33.
Fig. 12. *Nodosaria radicula* (L.). A longitudinal section in the "Wedmore Stone." × 20.
Fig. 13. *Marginulina glabra* (?), d'Orbigny. A longitudinal section in the "Wedmore Stone." × 10.
Fig. 14. *Truncatulina stelligera*, sp. n. *a*, superior aspect; *b*, inferior aspect. × 33.

XLV.—*On the* Geometridæ, Pyralidæ, *and allied Families of Heterocera of the Lesser Antilles.* By G. F. Hampson, B.A., F.E.S.

The following paper on the Uraniidæ, Geometridæ, Thyrididæ, Pyralidæ, and Sesiidæ collected by Mr. H. H. Smith in the islands of Grenada, St. Vincent, and the Grenadines for the West-India Exploration Committee of the Royal Society and British Association is a continuation of the series of papers already published on the Coleoptera, parasitic Hymenoptera, Formicidæ, Odonata, and other groups.

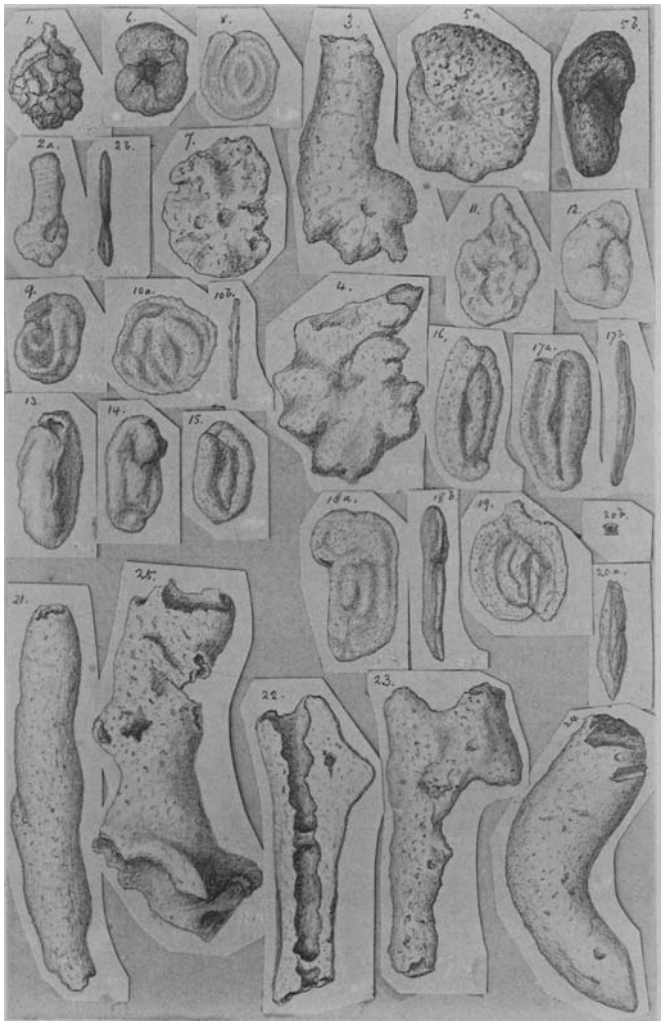
The Geometridæ are represented by very few species in the Lesser Antilles compared with the large numbers that exist in other parts of the Neotropical Region both north and south of the isthmus; and almost all the species are identical with those found on the mainland.

The Pyralidæ are represented by a much greater diversity of species; but these, as in other parts of the world, are very wide-ranging, most of the species being also found in Brazil and Venezuela, some being identical with forms found in the United States, whilst others range down to Chili, others again being spread throughout nearly the whole tropical zone; whilst, even of the species described as new, several are represented in the British Museum or other collections by specimens from continental localities.

Uraniidæ.

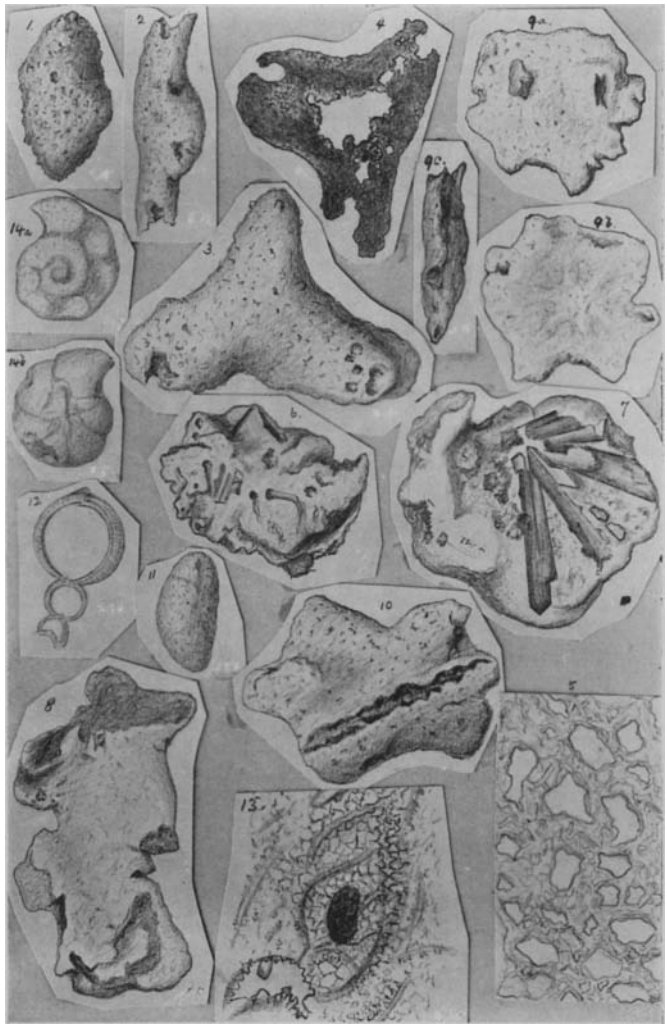
Psamathia obliteraria, Wlk. xxiii. 845.

St. Vincent, windward side.



F. CHAPMAN, del.

RHÆTIC FORAMINIFERA.



F. CHAPMAN, del.

RHÆTIC FORAMINIFERA.