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No. VII.—JULY, 1914.

ORIGINAL ARTICLES.

I.—The Foraminifera of the Speeton Clay of Yorkshire.

By R. L. Sherlock, D.Sc., A.R.C.Sc., F.G.S.

(PLATE XIX.)

(*Concluded from the June Number, p. 265.*)

Family ROTALIIDÆ.

Sub-family ROTALIINÆ.

Pulvinulina, Parker & Jones.

Pulvinulina repanda (Fichtel & Moll). (Pl. XIX, Fig. 14.)

Nautilus repandus, Fichtel & Moll, 1803: Test. Micr., p. 35, pl. iii, figs. *a, d*.
Pulvinulina repanda, Brady, 1884: Chall. Rep., vol. ix, p. 684, pl. civ, figs. 18*a–c*.

Remarks.—This species is recorded from the Tertiary formations of Italy by Parker & Jones and Seguenza, and is still living. Usually it occurs at depths less than 200 fathoms, but is known from 1,000 fathoms (Brady).

Horizon.—Found in B base *c*. Two specimens.

Pulvinulina caracolla (Roemer). (Pl. XIX, Fig. 15.)

Gyroidina caracolla, Roemer, 1840–1: Verst. n. d. Kreide, p. 97, pl. xv, fig. 22.
Rotalia caracolla, Reuss, 1862: Sitzungsb. d. k. Ak. Wiss. Wien, vol. xlvi, p. 84, pl. x, fig. 6.
Pulvinulina caracolla, Chapman, 1897: Journ. Roy. Micr. Soc., p. 7, pl. i, figs. 9*a–c*.

Remarks.—The species is recorded from the Jurassic (Crick and Sherborn, Journ. Northants. Nat. Hist. Soc., vol. vii, p. 71, pl. vii (ii), figs. 26*a–c*, 1892) and from the Middle Hils and Speeton Clay of North Germany by Reuss. It is unknown in the Tertiary formation.

This is the most abundant species in the Speeton Clay of Yorkshire and the only Foraminifer that has been previously recorded from it. There are specimens named by Rupert Jones in the British Museum and the Museum of Practical Geology. Mr. Lamplugh refers to the occurrence of Foraminifera cemented together in small hard pellets (Q.J.G.S., vol. xlv, p. 596, 1889).

The numerous specimens show a considerable amount of variation. Some have the inferior surface greatly produced into a cone (Pl. XIX, Figs. 15*a, b*) with a mass of callus at the apex of the cone. The septa are very thick and the upper surface of the cells relatively thin, so that, when waterworn, a curious mulberry-like form is produced. Practically all the shells are more or less broken, and some of the specimens show the mode of arrangement of the earliest formed cells. Two varieties exist, microspheric and megalospheric forms respectively (Pl. XIX, Figs. 15*c*, *d*). The dimorphic condition of the allied *P. partschiana*, d'Orb. (*Rotalia pleurostomata*, Schlumb.), was noted by Schlumberger ("Sur le *Biloculina depressa*, d'Orb., au point de vu du dimorphisme des Foraminifères": Assoc. Française, Rouen, 1883 (1884), p. 526), who merely states that there is a great difference in the size of the initial cell in the two varieties of that species. In *P. caracolla* the initial cell in a microspheric shell has a diameter of about ·0088 mm., and in a megalospheric shell a diameter of ·055 mm., or about 6·25 times as much.

Certain specimens show an approach to *P. reticulata* (Reuss), but have not been separated from *P. caracolla*.

The depth at which *P. caracolla* lived is not known, as the species is extinct; but the strongly limbate group of *Pulvinulinæ* to which it belongs are now found at depths of from 70–1,000 fathoms (Brady, Chall. Rep.).

Horizon.—B base *b*, B base *c*, C_2, C_3, C_7, D_2 (base), D_2 (top), D_6. Very abundant.

Pulvinulina lamplughi, sp. nov. (Pl. XIX, Fig. 16.)

Description.—Test free, rotaliform, obtusely conical, the inferior surface nearly flat, the periphery acute and very slightly lobulated. Three convolutions, with usually five segments in the last. Sutures limbate, except the last. The cells, as viewed from the superior surface, are plano-convex, or very slightly concavo-convex in outline. The species belongs to the *P. elegans* group and is isomorphous with *Discorbina isabelleana* (d'Orb.). The nearest ally is *P. carpenteri*, Reuss. Width of test at widest about ·42 mm. (·017 in.). The depth from apex to base is about ·22 mm. (·0085 in.). I have named the species after Mr. G. W. Lamplugh, F.R.S., whose name will always be associated with the Speeton Clay.

Horizon.—Found in B base *c*, C_2, and C_3. One specimen in B base *c*, common in C_2 and C_3.

General Conclusions.

In all forty-four species (one of which has been only generically named, and will not, therefore, be further considered) and one variety have been recognized in the Speeton Clay. Of these, two species and the variety are new. Of the remaining forty-one species, twenty-three are still living, and seventeen of these are known from Jurassic or older deposits, one from the Lower Greensand, one from the Gault, and four from Tertiary deposits. Of the eighteen extinct species previously known, two range from the Jurassic to the Gault, but sixteen have only been found in Cretaceous strata. Including with these the two new species, it appears that eighteen, or 42 per cent, are Cretaceous only. Further, five species, or 11 per cent of the whole, are, so far as is known, confined to Lower Cretaceous beds.

Many species are represented by a single or very few specimens. If we consider not only the number of species but the number of individuals, it appears that the Speeton Clay of Yorkshire is characterized by the great abundance of *Pulvinulina caracolla* (Roemer), which is so plentiful that individuals of this species are probably at least as numerous as those of all the other species put together. Next in importance, numerically, is *Cristellaria rotulata* (Lamarck), a species which ranges from Jurassic to Recent times and has no stratigraphical value. The genus *Cristellaria* is relatively very abundant, and this genus is characteristically Cretaceous.

As the question of the Jurassic, or Cretaceous, age of the zone of *Belemnites lateralis*, Phil., is unsettled,[1] it is worthy of note that three of the seven species of Foraminifera from that zone are only known from Cretaceous rocks; the other four having a wide range in time.

The number of species in each genus represented in the Speeton Clay is given below, together with the corresponding figures for the Hils of Germany as given by Reuss (op. cit., p. 12). Reuss' classification and nomenclature have been modernized to enable the comparison to be more easily made.

Genus.	Speeton Clay of Yorkshire.	Hils of Germany.
Reophax	1	—
Haplophragmium	1	1
Ammodiscus	1	—
Textularia	1	1
Bigenerina	1	—
Gaudryina	1	—
Bulimina	1	—
Bolivina	—	1
Lagena	3	—
Nodosaria	9	12
Frondicularia	1	2
Rhabdogonium	1	4
Marginulina	4	7
Vaginulina	1	13
Cristellaria	13	22
Polymorphina	2	1
Amphimorphina	—	1
Dentalinopsis	—	1
Pulvinulina	3	1
	16 genera, 44 species.	13 genera, 67 species.

In both deposits *Cristellaria* is represented by more species than any other genus. The next best represented genus in the Hils, however, is *Vaginulina*, but in Yorkshire only a few fragments have been found, belonging to probably at least two species, although only one has been determined. *Nodosaria* is about equally well represented in both deposits, but it is remarkable that *Lagena*, which is fairly common in Yorkshire, has not been recorded from the Hils. Another noticeable difference is the presence of seven arenaceous genera in the Yorkshire Speeton Clay, as against two in the Hils.

Of the forty-four species from the Speeton Clay of Yorkshire, eleven, or 25 per cent, are known from the Hils of Germany. The presence at Speeton of *Rhabdogonium insigne*, Reuss, of the well-marked *Cristellaria gracillissima*, Reuss, both previously known only from the Upper Hils, and of *C. orbiculata* (Roemer), which Roemer described from the Speeton Clay of Germany, but which Reuss did not find, are interesting links between the deposits of the two countries.

[1] G. W. Lamplugh, "On the Subdivisions of the Speeton Clay": Q.J.G.S., vol. xlv, p. 589, 1889.

Compared with the Red Chalk of Speeton (described by Burrows, Sherborn, & Bailey), which is of the same age as the Gault, we find that fifteen out of forty-three species, or 35 per cent, occur in both deposits. If we compare the Speeton Clay with the Gault of Folkestone (described by F. Chapman) we find that twenty-five out of the forty-three species, or 58·5 per cent, occur also at Folkestone. Finally, comparing the Speeton Clay with the Bargate Beds of Surrey, described by Chapman, and of Lower Cretaceous age, there are seventeen out of forty-three species, or 40 per cent in common.

The fact that a higher percentage of species found in the Speeton Clay occurs in the Gault of Folkestone than in the Lower Cretaceous of Germany or Surrey, is to some extent, at least, due to the much greater abundance of Foraminifera in the Gault.

Little can be learnt from the Foraminifera as to the depths of the sea in which the Speeton Clay was laid down. At two horizons only are the species sufficiently numerous to throw any light on this question. Of the thirteen species from B (base) which are still living, four are at present found in water under 100 fathoms in depth. In the case of C_2, of the thirteen species which are still living five are at present found in water under 100 fathoms deep. The remaining species in each case are found in both shallow and deep seas.

Note.—A considerable number of the specimens are found to differ to a small extent from published figures of the species. These differences are too slight to justify varietal names, but in view of their presence it seems desirable to figure the species as found at Speeton. It is interesting to note that in Chalk forms which have been examined these differences are not found, showing that they represent real modifications of the types and are not due to imperfect drawings.

Summary.

1. The Speeton Clay of Yorkshire contains abundant Foraminifera in the beds named by Mr. Lamplugh B (base), C_{10}, and C_2; but the specimens examined from the other subdivisions of F, E, D, and C either do not contain any Foraminifera or they are present in small numbers only.

2. Two new species, *Cristellaria chapmani*, *Pulvinulina lamplughi*, and a new variety, *Lagena apiculata*, var. *danfordi*, occur and are described. Forty-four species belonging to sixteen genera have been found.

3. The characteristic of the Foraminiferal fauna of the Speeton Clay is the great predominance of *Pulvinulina caracolla* (Roemer) over all other species.

4. Twenty-five per cent of the species of Foraminifera occur also in the Hils of North Germany, 35 per cent in the Red Chalk of Speeton, 40 per cent in the Bargate Beds of Surrey, and 58·5 per cent in the Gault of Folkestone.

5. Dimorphism is clearly shown by *P. caracolla* (Roemer). Previously it has been stated to occur among the *Pulvinulinæ* in *P. partschiana*, d'Orb., but no case has been described.

6. Notes are given on the microscopical characters of the sediments.

TABLE I.—DISTRIBUTION OF FORAMINIFERA IN THE VARIOUS SUBDIVISIONS OF THE SPEETON CLAY OF YORKSHIRE.

The presence of a species in any subdivision is indicated by the number of the species being placed in the corresponding column.

SPECIES.	B base *b*.	B base *c*.	C_1.	Upper C_2 (?).	Upper C_3 (?).	C_7.	C_9.	C_{10}.	D_2.	D_3.	D_6 (mid).
1. *Reophax scorpiurus*, Montfort . . .				1							
2. *Haplophragmium latidorsatum* (Bornemann)		2									
3. *Ammodiscus gordialis* (Jones & Parker)				3							
4. *Textularia agglutinans*, d'Orb. . .		4									
5. *Bigenerina nodosaria* (?), d'Orb. . .		5									
6. *Gaudryina filiformis*, Berthelin . .		6									
7. *Bulimina* sp.									7		
8. *Lagena globosa* (Montagu)			8	8				8			
9. *L. apiculata*, Reuss		9	9	9			? 9	9			
10. *L. apiculata*, var. *danfordi*, var. nov.				10							
11. *L. lævis* (Montagu)		11									
12. *Nodosaria* (*Glandulina*) *lævigata*, var. *strobilus*, Reuss								12			
13. *N. hispida*, d'Orb.	13										
14. *N. calomorpha*, Reuss		14									
15. *N.* (*Dentalina*) *siliqua* (?), Reuss . .		15									
16. *N.* (*D.*) *fontannesi*, Berthelin . .				16							
17. *N.* (*D.*) *lorneiana*, d'Orb.				17							
18. *N.* (*D.*) *legumen*, Reuss		18									
19. *N.* (*D.*) *communis*, d'Orb.				19							
20. *N.* (*D.*) *roemeri*, Neugeboren . . .				20							
21. *Frondicularia gaultina* (?), Reuss .				21							
22. *Rhabdogonium insigne*, Reuss . .											22
23. *Marginulina linearis*, Reuss . . .				23							
24. *M. glabra*, d'Orb.		24									
25. *M. jonesi*, Reuss	25			25							25
26. *M. debilis*, Berthelin				26							
27. *Vaginulina incompta* (?), Reuss . .				27							
28. *Cristellaria gracillissima*, Reuss . .		28									
29. *C. acutauricularis* (Fichtel & Moll) .		29	29								29
30. *C. gibba*, d'Orb.				30	30			30			
31. *C. cephalotes*, Reuss	31										
32. *C. scitula*, Berthelin		32									
33. *C. chapmani*, sp. nov.		33		33							
34. *C. crepidula* (Fichtel & Moll) . . .		34		34							
35. *C. turgidula*, Reuss			35	35							
36. *C. cultrata* (Montfort)									? 36		36
37. *C. gaultina*, Berthelin		37									37
38. *C. sternalis*, Berthelin		38									
39. *C. orbiculata* (Roemer)		39									
40. *C. rotulata* (Lamarck)	40	40	40	40	40		40		? 40	40	40
41. *Polymorphina fusiformis*, Roemer .		41		41							
42. *P. problema*, d'Orb.				42							
43. *Pulvinulina repanda* (Fichtel & Moll)		43									
44. *P. caracolla* (Roemer)	44	44		44	44	44			44		44
45. *P. lamplughi*, sp. nov.		45		45	45						

TABLE II.—DISTRIBUTION OF THE FORAMINIFERA OF THE

The presence of a species in any deposit is indicated by the

Species.	Range in time as previously known.
1. *Reophax scorpiurus*, Montfort	Jurassic–Recent
2. *Haplophragmium latidorsatum* (Bornemann)	Mid. Tertiary–Recent
3. *Ammodiscus gordialis* (Jones & Parker)	Carboniferous–Recent
4. *Textularia agglutinans*, d'Orb.	–Recent
5. *Bigenerina nodosaria*, d'Orb.	Miocene–Recent
6. *Gaudryina filiformis*, Berthelin	Gault–Recent
8. *Lagena globosa* (Montagu)	Oolite–Recent
9. *L. apiculata*, Reuss	Lias–Recent
11. *L. lævis* (Montagu)	Wenlock–Recent
12. *Nodosaria* (*Glandulina*) *lævigata*, d'Orb.	Jurassic–Tertiary
13. *N. hispida*, d'Orb.	Lias–Recent
14. *N. calomorpha*, Reuss	Tertiary–Recent
15. *N.* (*Dentalina*) *siliqua* (?), Reuss	L. Cretaceous–Chalk
16. *N.* (*D.*) *fontannesi*, Berthelin	L. Cretaceous–Gault
17. *N.* (*D.*) *lorneiana*, d'Orb.	Gault–Chalk
18. *N.* (*D.*) *legumen*, Reuss	Gault–Chalk
19. *N.* (*D.*) *communis*, d'Orb.	Permian–Recent
20. *N.* (*D.*) *roemeri*, Neugeboren (= *D. nana*, Reuss)	L. Cretaceous–Recent
21. *Frondicularia gaultina* (?), Reuss	Gault
22. *Rhabdogonium insigne*, Reuss	Lower Cretaceous
23. *Marginulina linearis*, Reuss	L. Cretaceous–Gault
24. *M. glabra*, d'Orb.	Rhætic–Recent
25. *M. jonesi*, Reuss	L. Cret.–Chalk Marl
26. *M. debilis*, Berthelin	L. Cretaceous–Gault
27. *Vaginulina incompta* (?), Reuss	Lower Cretaceous
28. *Cristellaria gracillissima*, Reuss	Lower Cretaceous
29. *C. acutauricularis* (Fichtel & Moll)	? Lias–Recent
30. *C. gibba*, d'Orb.	Lias–Recent
31. *C. cephalotes*, Reuss	Oxfordian–Gault
32. *C. scitula*, Berthelin	Gault
34. *C. crepidula* (Fichtel & Moll)	Lias–Recent
35. *C. turgidula*, Reuss (= *D. ingenua*, Reuss)	Gault
36. *C. cultrata* (Montfort)	Lias–Recent
37. *C. gaultina*, Berthelin (= *C. cultrata*, B., S., & B.)	Gault–Chalk
38. *C. sternalis*, Berthelin	Gault
39. *C. orbiculata* (Roemer)	Speeton Clay, Germany
40. *C. rotulata* (Lamarck)	Jurassic–Recent
41. *Polymorphina fusiformis*, Roemer (= *P. lactea*, B., S., & B.; = *P. prisca*, Berthelin)	Lias–Recent
42. *P. problema*, d'Orb.	Lias–Recent
43. *Pulvinulina repanda* (Fichtel & Moll)	Mid. Tertiary–Recent
44. *P. caracolla* (Roemer)	Lias–Gault

Speeton Clay of Yorkshire in some other Deposits.

number of the species being placed in the corresponding column.

Bargate Beds, Lower Cretaceous.	Germany.							Red Chalk, Speeton.	Gault, Folkestone.	Gault, Monte'ey, France.	*Challenger* Expedition.	Depth in fathoms now living.
	Middle Hils.	Upper Hils *a*.	Upper Hils *c*.	Speeton Clay.	*Tardefurcatus*-clay.	*Milletianus*-clay.	*Minimus*-clay.					
									1		1	any
									2		2	
3											3	50–2,000
4								4	4		4	
											5	7–1,630
6									6	6	6	to 620
8								8			8	any
9								9			9	any
11								11			11	any
								12			12	50–1,375
									13		13	95–450
								14			14	6–2,200
			15									
16									16	16		
							17		17			
									18	18		
								19	19		19	any
20			20		20		20		20	20	20	under 400
							21	21	21			
		22										
23							23		23	23		
							24	24	24		24	any
25		25							25	25		
26									26	26		
		27										
		28										
29											29	95–2,750
30			30	30				30	30		30	under 500
		31					31					
									32	32		
34		34				34		34	34		34	generally shallow to 2,350
						35	35		35	35		
36											36	rare under 100
								37	37	37		
									38	38		
				39								
40	40	40	40	40				40	40	40	40	any
			41				41	41	41	41	41	to 2,400
42								42	42	42	42	to 155
											43	to 1,000, usually under 200
	44			44					44			

EXPLANATION OF PLATE XIX.

All figures are magnified 50 diameters except Figs. 15*c* and 15*d*.

FIG. 1. *Cristellaria turgidula*, Reuss.
,, 2. *C. acutauricularis* (Fichtel & Moll).
,, 3. *C. sternalis*, Berthelin.
,, 4. *C. cultrata* (Montfort).
,, 5. *C. scitula*, Berthelin.
,, 6. *C. orbiculata* (Roemer).
,, 7*a*–*c*. *C. chapmani*, sp. nov. 7*a*, lateral aspect; 7*b*, the same differently illuminated; 7*c*, oral aspect.
,, 8. *C. crepidula* (Fichtel & Moll).
,, 9. *C. gibba*, d'Orb. 9*a*, lateral aspect; 9*b*, oral aspect.
,, 10. *Vaginulina incompta* (?), Reuss.
,, 11. *Frondicularia gaultina* (?), Reuss. Broken specimen.
,, 12. *Polymorphina fusiformis*, Roemer.
,, 13. *P. problema*, d'Orb.
,, 14. *Pulvinulina repanda* (Fichtel & Moll). 14*a*, superior aspect; 14*b*, inferior aspect.
,, 15. *P. caracolla* (Roemer). 15*a*, thin specimen; 15*b*, thick specimen; 15*c*, broken specimen showing megalospheric commencement, × 42; 15*d*, broken specimen showing microspheric commencement, × 42.
,, 16. *P. lamplughi*, sp. nov. 16*a*, superior aspect; 16*b*, inferior aspect; 16*c*, peripheral aspect.

II.—THE SGÙRR OF EIGG.

By E. B. BAILEY, B.A., F.G.S.

(PLATE XXII.)

THE Sgùrr of Eigg first attained to geological prominence in 1865, when Sir Archibald Geikie in his delightful account of the *Scenery of Scotland* offered a novel and altogether captivating theory to account for its origin [1].[1] According to Geikie, as all well know, the precipitous ridge of pitchstone, which culminates at its eastern extremity in the Sgùrr, is the inverse of an ancient valley sunk by a winding river in the basaltic plateau of the west. Before the development of this river channel, so the theory runs, the sources which had supplied the basalt lava of the plateau had already become extinct; but volcanic activity was not yet entirely banished from the region, and presently a great outpouring of acid lava, entering the valley, flowed for miles along its course, gradually choking it, perhaps even to the brim. The resulting pitchstone has stood the test of time much more securely than the neighbouring basalts, for while these latter have wasted to a level in general lower than that of the old valley floor, the pitchstone itself still remains in large measure unaffected, and thus furnishes a somewhat battered cast of the erstwhile hollow.

The artistic appeal of Sir Archibald Geikie's conception has been admitted on every hand; but, very properly, its credentials have been subjected to a dispassionate and searching scrutiny. In 1906 Dr. Harker, after mapping the district for the Geological Survey, published an alternative interpretation of the pitchstone ridge [3]. We are now asked to abandon the cherished notion of a lava moulded upon the uneven contours of a river valley, and to accept instead that of an intrusive sill irregular and transgressive in its own right.

[1] Footnote numbers in square brackets refer to Bibliography, p. 305.

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