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TRANSACTIONS OF THE SOCIETY.

I.—*The Foraminifera of the Gault of Folkestone.*—VIII.

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PLATES I. AND II.

CRISTELLARIA—continued.

Cristellaria turgidula Reuss, plate I. fig. 1 *a, b.*

C. turgidula Reuss, 1862, Sitzungsab. d. k. Ak. Wiss. Wien, vol. xlv. p. 73, plate viii. fig. 4 *a, b.* *C. ingenua* Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 54, plate iii. figs. 20, 21.

The above species may be regarded as one of the modifications of the type *C. cultrata*, so numerously represented in the Cretaceous deposits of this and other countries. It shows fairly constant characters by which it can be distinguished from the other feebly developed examples of a similar type occurring in the younger fossiliferous

EXPLANATION OF PLATES.

PLATE I.

- Fig. 1.—*Cristellaria turgidula* Reuss: *a*, lateral aspect; *b*, front peripheral aspect. × 60.
„ 2.—*C. circumcidanea* Berthelin: *a*, lateral aspect; *b*, front peripheral aspect. × 60.
„ 3.—*C. subalata* Reuss: *a*, lateral aspect; *b*, front peripheral aspect. × 45.
„ 4.—*C. secans* Reuss var. *angulosa* nov.: *a*, lateral aspect; *b*, front peripheral aspect. × 45.
„ 5.—*C. nodosa* Reuss sp.: *a*, lateral aspect; *b*, front peripheral aspect. × 45.
„ 6.—*C. convergens* Bornemann: *a*, lateral aspect; *b*, front peripheral aspect, × 60.
„ 7.—*C. gibba* d'Orbigny: *a*, lateral aspect; *b*, front peripheral aspect. × 60.
„ 8.—*C. rotulata* Lamarck sp.: *a*, lateral aspect; *b*, front peripheral aspect. × 30.
„ 9.—*C. rotulata* var. *macrodiscus* Reuss: *a*, lateral aspect; *b*, front peripheral aspect. × 30.
„ 10.—*C. gaultina* Berthelin: *a*, lateral aspect; *b*, front peripheral aspect. × 30.
„ 11.—*C. gaultina* Berthelin: specimen of redundant growth. × 16.
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deposits; and it appears worthy of being retained, under the above name, for its value as a Cretaceous form.

Examples have been figured by Berthelin under the name of *C. ingenua*, which are apparently inseparable from Reuss' type, although the earlier figure given by Reuss is not quite so typical as might be desired.

The specimens from the French Gault are more compressed than that figured by Reuss, but the difference is not sufficiently marked amongst a number of specimens to warrant the retention of both names.

The example here figured from the Gault of Folkestone does not show the slight umbilical depression usually seen, but that feature is not wanting in many of the Folkestone-Gault specimens.

As regards the Lower Cretaceous of Germany, *C. turgidula* has been recorded from the *Milletianus*-clay near Peine, and in the *Minimus*-clay near Söhlde between Peine and Salzgitter (Reuss). In France it was found in the Gault of Montcley (Berthelin).

C. turgidula was found at Folkestone in zone iii., very rare; zone iv., very rare; zone xi., 40 ft. from the top, very rare; 6 ft., frequent.

Cristellaria circumcidanea Berthelin, plate I. fig. 2 *a*, *b*.

C. circumcidanea Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 52, plate iii. fig 1 *a*, *b*.

The peripheral edge of the test of *C. circumcidanea* is sub-angulate, and flattened into a narrow but tolerably sharp keel. The sutural margin of each chamber in succession slightly overlaps the preceding, thus giving an illusive appearance of sutural limbation or shell thickening. This latter feature may cause it to be confounded at first sight with *C. subalata*, in which the sutures are actually

PLATE II.

- Fig. 1.—*Cristellaria sternalis* Berthelin: *a*, lateral aspect; *b*, front peripheral aspect
× 23.
„ 2.—*C. diademata* Berthelin: *a*, lateral aspect; *b*, front peripheral aspect.
× 20.
„ 3.—*Polymorphina lactea* Walker and Jacob sp.: *b*, aboral end. × 30.
„ 4.—*P. lactea*, fistulose form. × 45.
„ 5.—*P. gibba* d'Orbigny: *b*, transverse sectional view. × 60.
„ 6.—*P. gibba*, fistulose form; *b*, oral aspect. × 45.
„ 7.—*P. gutta* d'Orbigny: *b*, transverse sectional view. × 60.
„ 8.—*P. gutta*, fistulose form. × 45.
„ 9.—*P. fusiformis* Roemer sp.: *b*, transverse sectional view. × 45.
„ 10.—*P. fusiformis*, fistulose form. × 45.
„ 11.—*P. sororia* Reuss: *b*, oral aspect. × 60.
„ 12.—*P. sororia*, fistulose form × 50.
„ 13.—*P. sororia* var. *cuspidata* Brady. × 45.
„ 14.—*P. angusta* Egger. × 60.
„ 15.—*P. communis* d'Orbigny. × 45.
„ 16.—*P. compressa* d'Orbigny: *b*, transverse sectional view. × 45.

thickened. The test of *C. subalata*, moreover, is more inflated in the umbilical area. *C. circumcidanea* was found in the Gault of Montcley and l'Aube (Berthelin).

At Folkestone the species occurs in zone i., specimen b, frequent; zone ii., specimen b, very rare; zone iii., rare; zone ix., very rare; zone x., very rare; zone xi., 55 ft. from the top, very rare; 45 ft., very rare; 35 ft., very rare.

Cristellaria subalata Reuss, plate I. fig. 3 a, b.

C. subalata Reuss, 1854, Denkschr. k. Ak. Wiss. Wien, vol. vii. p. 68, plate xxv. fig. 13. *C. subalata* Reuss, 1862, Sitzungsab. d. k. Ak. Wiss. Wien, vol. xvi. p. 76, plate viii. fig. 10; plate ix. fig. 1. *C. megalopolitana* Reuss, 1855, Zeitschr. d. geol. Gesellsch., vol. vii. p. 267, plate ix. fig. 5. *C. megalopolitana* Sherborn and Chapman, 1886, Journ. Roy. Micr. Soc., ser. 2, vol. vi. p. 755, plate XV. fig. 30 a, b.

This is a neat little *Cristellarian* in the Gault series; the examples from other formations are not quite so circular in outline nor so swollen, although in their main characters agreeing very closely.

Reuss' specimens from the Neocomian of Germany apparently had no umbilical protuberance, whilst the specimens from Gosau (Upper Cretaceous) resemble those from the Folkestone Gault in possessing an umbilical boss.

This form has been recorded from the Speeton Clay and the *Minimus*-clay of North Germany (Reuss); from the Gault of Montcley and l'Aube, France (Berthelin); from the Gault of Folkestone (Reuss and Rupert Jones); from the Cretaceous Marls of Gosau, Eastern Alps (Reuss); and from the Eocene, London Clay (Sherborn and Chapman).

At Folkestone *C. subalata* was found in zone i., specimen b, very rare; zone ii., specimen c, very rare; zone ix., very rare.

Cristellaria secans Reuss var. *angulosa* nov., plate I. fig. 4 a, b.

The type species * of the above variety belongs to the thick-keeled group of *Cristellarians*, and is further distinguished by its strong and prominent sutural ribs.

The variety here figured is characterised by the flattening of the peripheral edge between the termini of the sutural costae, thus imparting a subangulate appearance to the test. Diam. 1/35 in.; thickness 1/64 in.

A somewhat analogous form was figured by Reuss as *C. subangulata*,† but this belongs rather to the *C. rotulata* type; and with lineate sutures instead of strong riblets, as in *C. secans*. A similar

* Sitzungsab. d. k. Ak. Wiss. Wien, xl. (1860) p. 214, pl. ix. fig. 7 a, b.

† Op. cit., xvi. (1862) p. 74, pl. viii. fig. 7 a, b; Denkschr. k. Ak. Wiss. Wien, xxv. (1865) p. 144, pl. iii. fig. 17.

subangulate variety, but of a somewhat different type (probably *C. rotulata* var. *macrodiscus* Reuss; has been figured and described under the name of *C. polygona*, by Dr. Perner,* from the Cenomanian strata of Bohemia.

The type-form *C. secans* was found in the *Minimus*-clay of the Rhine and other places by Reuss.

C. secans var. *angulosa* occurred in the Folkestone Gault in zone xi., 6 ft. from the top, rare.

Cristellaria nodosa Reuss sp., plate I. fig. 5 a, b.

Robulina nodosa Reuss, 1862, Sitzungs. d. k. Ak. Wiss. Wien, vol. xvi. p. 78, plate ix. fig. 6 a, b.

The specimens from the Upper Gault of Folkestone are very close in character to the figure given by Reuss. That author's specimens were obtained from the Upper Hils-clay of North Germany.

C. nodosa was found at Folkestone in zone xi., 20 ft. from the top, very rare; 6 ft., very rare.

Cristellaria convergens Bornemann, plate I. fig. 6 a, b.

C. convergens Bornemann, 1855, Zeitschr. d. deutsch. geol. Gesellsch., vol. vii. p. 327, plate xiii. figs. 16, 17. *C. convergens* Brady, 1884, Chall. Rep., vol. ix. p. 546, plate lxix. figs. 6, 7.

This is quite an uncommon form in the Gault, and is perhaps a deep-water variety of *C. oligostegia* in this instance, since the broad septal face resembles that of the latter species.

C. convergens has been recorded from the Pebble-beds of Neocomian age in Surrey (Chapman), and was originally described from the Tertiary of Hermsdorf (Bornemann). As a recent form, it is found in deep-water.

At Folkestone this species was collected from zone v., very rare; zone xi., 6 ft. from the top, rare.

Cristellaria gibba d'Orbigny, plate I. fig. 7 a, b.

C. gibba d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 292, No. 17. *C. gibba* Idem, 1839, Foram. Cuba, p. 40, plate vii. figs. 20, 21. *C. nuda* Reuss, 1861, Sitzungs. d. k. Ak. Wiss. Wien, vol. xlv. p. 328, plate vi. figs. 1-3. *C. nuda* (var. on plate VIII.) Idem, 1862, *ibid.*, p. 72, plate viii. fig. 2 a, b. *C. pulchella* Id., 1862, *ibid.*, p. 71, plate viii. fig. 1 a, b. *C. gibba* Brady, 1884, Chall. Rep., vol. ix. p. 546, plate lxix. figs. 8, 9. *C. gibba* Burrows, Sherborn, and Bailey, 1890, Journ. Roy. Micr. Soc., p. 559, plate X. figs. 19 a, b and 21. *C. gibba* Crick and Sherborn, 1891, Journ. Northamp. Nat. Hist. Soc., vol. vi. p. 212, plate, fig. 29.

C. gibba is a very widely distributed species, although at no time does it appear to have been very common. It belongs to the group

* 'Foraminifery Českého Cenomanu,' Prague, 1892, p. 63, pl. v. figs. 3, 4.

of *Cristellarians* of which *C. rotulata* is the type, and differs from that form in the general elongation of the test in the direction of the oral extremity. *C. gibba* is in its general characters intermediate between *C. rotulata* and *C. crepidula*. Gradational examples are found which pass insensibly into *C. planiuscula*, but this latter form is in typical specimens strongly compressed.

C. gibba has been recorded from strata as old as the Lias (Crick and Sherborn). As a Cretaceous form it has been found in the Upper Hils-clay and the Speeton Clay of Brunswick (recorded as *C. nuda* by Reuss); from the Speeton Clay and the *Minimus*-clay of Germany (as *C. pulchella* by Reuss); and from the Chalk of Rügen (as *C. nuda* by Reuss). In this country it has been noted from the Neocomian beds of Surrey (Chapman);* and from the Red Chalk of Speeton (Burrows, Sherborn, and Bailey).

The species has apparently not yet been noticed in Tertiary deposits, for we can scarcely include under this specific name *C. exacta* Bornemann,† which has been placed in the synonymy of the species in the Report on the 'Challenger' Foraminifera.‡

At Folkestone the occurrences of *C. gibba* in the Gault were:—
Zone i., spec. b., frequent; zone iii., rare; zone iv., very rare; zone v., frequent; zone vii., very rare; zone viii., very rare; zone x., rare; zone xi., 55 ft. from the top, rare; 50 ft., rare; 45 ft., rare; 40 ft., frequent; 35 ft., rare; 25 ft., rare; 12 ft., frequent; 6 ft., rare.

Cristellaria rotulata Lamark sp., plate I. fig. 8 a, b.

Lenticulites rotulata Lamark, 1804, Annales du Muséum, vol. v. p. 188, No. 3; Tableau Encycl. et Méth., pl. cccclxvi. fig. 5. *Cristellaria rotulata* d'Orbigny, 1840, Mém. Soc. géol. France, sér. 1. vol. iv. p. 26, pl. ii. figs. 15–18. *Robulina Münsteri* Römer, 1841, Verstein. norddeutsch. Kreidegeb., pt. 2, p. 98, pl. xv. fig. 30. *Cristellaria rotulata* Reuss, 1846, Verstein. böhm. Kreidef., pt. i. p. 34, pl. viii. figs. 50 a, b, 70. *C. münsteri* Reuss, 1862, Sitzungsber. d. k. Ak. Wiss. Wien, vol. xlv. p. 77, pl. ix. figs. 3 a, b, 4 a, b. *C. rotulata* Brady, 1884, Chall. Rep., vol. ix. p. 547, pl. lxix. fig. 13 a, b. *C. rotulata* Perner, 1892, Foraminifery Českého Cenomanu, p. 62, pl. iv. figs. 1–11.

Among the *Cristellarians* from the Gault there are numerous varieties which, from a biological standpoint, should be relegated to the well-known cosmopolitan form *C. rotulata*. The examples from Cretaceous deposits have unfortunately been split up into innumerable so-called species, many of which have no claim to stand, even as varieties, on account of their close relationship and even identity with one another; and this is especially evident when a large number of specimens are examined.

* Quart. Journ. Geol. Soc., l. (1894) p. 714.

† Zeitschr. d. deutsch. geol. Gesell., vii. (1855) p. 328, pl. ii. figs. 19, 20.

‡ Vol. ix. (1884) p. 546.

Only a few of the more important references to Cretaceous examples of the above species are here given, although the synonymy is very large. Some of the forms here retained as species distinct from *C. rotulata* are treated thus not because of any virtual specific differences, but since they have been already figured and described they may serve a useful purpose in elucidating the distribution of these minute fossils in the various horizons of the Gault.

C. rotulata is well distributed through the various horizons of the Gault; and it has been recorded from nearly all important fossiliferous deposits from the Lias upwards. For our present purpose it is only necessary to mention the occurrences of the above species in the strata immediately below and above the Gault.

In this country it has been recorded from the Lower Greensand and the Gault of Meux's well-boring (C. Moore); from the Speeton Clay of Yorkshire and the Lower Greensand of Faringdon, Berkshire (Reuss); from the Lower Greensand of Surrey (Chapman); from the Gault of Folkestone (Reuss and Rupert Jones); from the Greensand of Warminster (Reuss); and from the Phosphatic beds of Cambridge (G. R. Vine). In France it was found in the Gault of Montelely, Wissant, and l'Aube (Berthelin). In North Germany it has been recorded from the Speeton Clay, the *Minimus*-clay and the Flammenmergel (Reuss). In Bohemia it was found in Cenomanian strata (Perner). This species has many records from the Chalk strata, and it is probably to be met with at all horizons.

C. rotulata has also been recorded from the Red Chalk of Speeton by Messrs. Burrows, Sherborn, and Bailey; one of the figures* given under the above name, however, appears to agree more closely with the form *C. rotulata* var. *macrodiscus*, referred to below.

In the Folkestone Gault *C. rotulata* occurred as follows:—Zone i., spec. a, rare; zone i., spec. b, rare; zone ii., spec. a, rare; zone ii., spec. b, very rare; zone ii., spec. c, very rare; zone iii., frequent; zone iv., common; zone v., rare; zone viii., rare; zone x., very rare; zone xi., 50 ft. from the top, very rare; 25 ft., very rare; 20 ft., frequent; 12 ft., frequent; 6 ft., rare.

Cristellaria rotulata (Lamarek) var. *macrodiscus* Reuss,
plate I. fig. 9 a, b.

C. macrodisca Reuss, 1862, Sitzungsber. d. k. Ak. Wiss. Wien, vol. xlv. p. 78, pl. ix. fig. 5 a, b. *C. macrodisca* Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 48, pl. iii. figs. 6–11 and 14 a, b. *C. rotulata* Burrows, Sherborn, and Bailey, 1890, Journ. Roy. Micr. Soc., p. 559, pl. x. fig. 17 a, b.

The above variety, which hardly possesses the specific differences seen in it by previous authors, is distinguished from the type form by the nearly circular periphery, the greater breadth of the chambers,

* Journ. Roy. Micr. Soc., 1890, pl. x. fig. 17 a, b.

and the greater width across the test. The latter point is perhaps the most constant character, and is 1.3 if the width of *C. rotulata* is taken as a unit. The central boss is usually large and transparent. It is very probable that, under the interpretation of the duality of form or dimorphism in the Foraminifera, we have here the microspheric *C. rotulata* and the megalospheric *C. rotulata* var. *macrodiscus* representing one species.

This variety appears to be nearly as well distributed through the Gault as the type form. It has been recorded from the Upper Hilsclay and the *Tardefurcatus*-clay of North Germany (Reuss); and from the Gault of Monteley, Wissant, and l'Aube (Berthelin); also from the Red Chalk of Speeton (as *C. rotulata* by Burrows, Sherborn, and Bailey).

C. rotulata var. *macrodiscus* was found in the Folkestone Gault in zone ii., spec. b, very rare; zone ii., spec. c., frequent; zone iii., very rare; zone iv., rare; zone v., rare; zone vi., rare; zone vii., very rare; zone x., very rare; zone xi., 50 ft. from the top, rare; 45 ft., frequent; 40 ft., rare; 35 ft., rare; 30 ft., rare; 25 ft., frequent; 20 ft., rare; 12 ft., frequent; 6 ft., rare.

Cristellaria gaultina Berthelin, plate I. figs. 10 a, b, 11.

C. gaultina Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 49, pl. iii. figs. 15–19. *C. cultrata* Burrows, Sherborn, and Bailey, 1890, Journ. Roy. Micr. Soc., p. 559, pl. x. fig. 18 a, b.

This species is one of the commonest in the Gault series, and is very distinct in its characters. It is easily recognised by the rapid increase in size of the last chambers, which gives a sub-oval outline to the test; by the produced extremity of the last chamber, and by the compressed form of the test seen in edge view. *C. gaultina*, more than any other *Cristellarian* from the Gault, shows a tendency in well-grown individuals to take on a wild irregular growth; an example of this is given in plate I. fig. 11. In this particular specimen, the earlier and normal portion of the test (comparing it with other well-grown individuals), differs from the later portion, and it is evident that the plan of growth was subsequently somewhat changed after the fracture of the fragile apical extremity of the typical part of the test. It appears as if a resuscitation of life for the creature ensued by the accidental adherence of a growing fragment of another form to its broken oral apex. This aberrant mode of growth is also seen in other species occurring in the Gault.

C. gaultina was originally recorded from the Gault of Monteley, Wissant, and l'Aube (Berthelin), and under the name of *C. cultrata* has been figured from the Red Chalk of Speeton (Burrows, Sherborn, and Bailey).

This species was found in the Gault of Folkestone in zone i., specimen a, very rare; zone i., specimen b, frequent; zone ii., speci-

men *a*, rare; zone ii., specimen *b*, rare; zone iii., very common; zone iv., common; zone v., rare; zone vi., very common; zone vii., frequent; zone viii., frequent; zone ix., common; zone x., common; zone xi., 55 ft. from the top, very rare; 50 ft., frequent; 45 ft., frequent; 40 ft., frequent; 35 ft., common; 30 ft., frequent; 25 ft., common; 20 ft., very common; 12 ft., frequent; 6 ft., common.

Cristellaria sternalis Berthelin, plate II. fig. 1 *a*, *b*.

C. sternalis Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 54, plate iii. fig. 2 *a*, *b*.

This form is perhaps more correctly to be regarded as a variety of *C. cultrata*, but since it bears some few distinct characters of its own, exhibited in all of the Gault specimens of this type, it may here be retained under the above name.

The width of the test in *C. sternalis* is much greater than in typical specimens of *C. cultrata*, and the chambers are less numerous. The keel is always well developed, and the central boss very large.

C. sternalis has been described from the Gault of Monteley, Wissant, and l'Aube (Berthelin). It occurs at Folkestone in zone i., specimen *b*, very rare; zone ii., specimen *b*, very rare; zone ii., specimen *c*, rare; zone iii., very rare; zone v., very rare; zone vi., frequent; zone viii., rare; zone x., rare; zone xi., 55 ft. from the top, rare; 50 ft., rare; 45 ft., very rare; 35 ft., frequent; 30 ft., very rare; 25 ft., very rare; 12 ft., very rare; 6 ft., very rare.

Cristellaria diademata Berthelin, plate II. fig. 2 *a*, *b*.

C. diademata Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 51, plate iii. figs. 4, 5, 12, and 13.

The above name was given to the Gault form, which, although approximating to that of *C. cassis* (Fichtel and Moll) * in many particulars, yet differs essentially in having a more swollen test, and by the absence of the thickened and often beaded septal lines seen in typical recent examples of that species.

The undulate keel-edge of *C. diademata* is always more or less irregular in its outline, apart from the fractures which a thin flange-like structure would be likely to sustain in a fossil-deposit laid down in moderately shallow water.

C. diademata was described from the Gault of Monteley, Wissant, and l'Aube (Berthelin).

At Folkestone it was found in zone i., specimen *a*, rare; zone i., specimen *b*, rare; zone ii., specimen *c*, very rare; zone iii., very rare; zone v., very rare; zone vi., common; zone vii., rare; zone viii., rare; zone ix., rare; zone x., common; zone xi., 55 ft. from the top, rare; 50 ft., very rare; 45 ft., very rare; 40 ft., very rare; 35 ft., rare; 30 ft., frequent; 25 ft., rare; 20 ft., rare; 12 ft., rare.

* Test. Micr., 1798, p. 95, pl. xvii. figs. *a-l*; pl. xviii. figs. *a-c*.

F. Chapman del. ad nat.

West, Newman lith.

Folkestone-Gault Foraminifera.

Sub-family POLYMORPHININÆ.

POLYMORPHINA d'Orbigny [1826].

Polymorphina lactea Walker and Jacob sp., plate II. fig. 3.

Serpula lactea Walker and Jacob, 1798 (*vide* Kanmacher). Adams' Essays, 2nd ed., p. 634, plate xxiv. fig. 4. *Globulina lacrima* Reuss, 1845, Verstein. böhm. Kreidef., part i. pp. 40, 110, plate xii. fig. 6 a-c; plate xiii. fig. 83 a, b. *Polymorphina lactea* Brady, 1884, Chall. Rep., vol. ix. p. 559, plate lxxi. fig. 11. Burrows, Sherborn, and Bailey, 1890, p. 561. Journ. Roy. Micr. Soc., p. 561, plate xi. fig. 9. *P. amygdaloides* Idem, *ibid.*, plate xi. fig. 12.

FISTULOSE FORM, plate II. fig. 4.

Misilus aquatifer Montfort, 1808, Conch. Syst., vol. i. p. 294, 74^e genre. *Polymorphina horrida* Wright, 1875, Rep. and Proc. Belf. Nat. Field Club, vol. for 1873-4, Appendix, p. 85, plate iii. fig. 14. *P. praelonga* Terquem, 1878, Mém. Soc. géol. France, sér. 3, vol. i. No. 3, p. 39, plate iii. fig. 21. *P. amygdaloides* Idem, *ibid.*, p. 39, plate iii. fig. 28. *P. solidula* Idem, *ibid.*, p. 40, plate iii. fig. 33.

The Gault form of *P. lactea* is rather shorter and stouter than the better known and more typical specimens which are met with in later Tertiary and recent deposits. It is distinguished typically by its ovate or subpyriform, inflated test. The Gault variety is not far removed from *P. gibba*, from which it differs only in being slightly longer and more compressed.

P. lactea has been recorded from Jurassic beds of the south of England (Parker and Jones); from the Gault of Monteley (as *P. lacryma* (Berthelin); from the Red Chalk of Speeton (Burrows, Sherborn, and Bailey); from the Cretaceous of Bohemia and Russia; and from many important fossiliferous strata of Tertiary age.

As a recent form *P. lactea* affects shallow to moderately-shallow waters.

The fistulose examples of this species from the Gault have the outgrowths confined to the apical region of the test.

The ordinary form of this species was found in the Gault of Folkestone in zone xi., 45 ft. from the top, very rare; 35 ft. from the top, very rare.

The fistulose modification was found in zone xi., 12 ft. from the top, very rare; 6 ft., very rare.

Polymorphina gibba d'Orbigny, plate II. fig. 5.

Polymorphina (Globulina) gibba d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 266, No. 20; Modèle No. 63. *Globulina gibba* d'Orbigny 1846, Foram. Foss. Vienne, p. 227, plate xiii. figs. 13, 14. *Polymorphina gibba* Jones, Parker, and Brady, 1866, Monogr. Crag

Foram., plate i. figs. 49-51. *P. subsphærica* Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 58, plate iii. fig. 18 *a, b*. *P. gibba* Brady, 1884, Chall. Rep., vol. ix. p. 561, plate lxxi. fig. 12. *Polymorpha* [*Polymorphina*] *ovata* Perner, 1892, Foraminifery Českého Cenomanu, p. 64, plate viii. figs. 14-16.

FISTULOSE FORM, plate II. fig. 6.

Globulina tubulosa d'Orbigny, 1846, Foram. Foss. Vienne, p. 228, plate xiii. figs. 15, 16. *Polymorphina tubulosa* Jones, Parker, and Brady, 1866, Monogr. Foram. Crag, plate i. figs. 70, 72, 73. *P. gibba* fistulose form, Brady, 1884, Chall. Rep., vol. ix. p. 562, plate lxxiii. fig. 16. Wright, 1886, Proc. Belf. Nat. Field Club, Appendix, 1885-86, p. 324, plate xxvi. fig. 11. *P. gibba* Goës, 1894, Kongl. Svenska Vetenskaps-Ak. Handlingar, vol. xxv. No. 9, p. 55, plate ix. fig. 522.

P. gibba in its typical form is more nearly spherical than *P. lactea*, and the segments are never prominent as in the latter species, although the sutural lines are sometimes rather deeply impressed, as in d'Orbigny's figure of a specimen from the Vienna Tertiaries, and Berthelin's *P. subsphærica* from the French Gault.

The fistulose variety of *P. gibba* from the Gault series, of which a characteristic example is here figured, is apparently always of the same type, the outgrowth being confined to the apical region of the test.

P. gibba has been recorded from strata as old as the Kimeridgian, and it is further found in nearly all fossiliferous strata of later date.

The ordinary form of this species was found in the Folkestone Gault in zone xi., 45 ft. from the top, rare; 40 ft., very rare; 25 ft., very rare; 12 ft. rare; 6 ft., common.

The fistulose form was found in zone xi., 45 ft. from the top, frequent; 6 ft., very rare.

Polymorphina gutta d'Orbigny, plate II. fig. 7.

Polymorphina (*Pyrulina*) *gutta* d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 267, No. 28, plate xii. figs. 5, 6; Modèle No. 30. *Pyrulina obtusa* Reuss, 1862, Sitzungsber. d. k. Ak. Wiss. Wien, vol. xlv. p. 79, plate ix. fig. 9. *Polymorphina gutta* Jones, Parker, and Brady, 1866, Monogr. Crag Foram., plate i. figs. 46, 47.

FISTULOSE FORM, plate II. fig. 8.

Globulina horrida Reuss, 1845, Verstein. böhm. Kreidef., pt. ii. p. 110, plate xliii. fig. 14. *Polymorphina Roemeri* Reuss, 1870, Sitzungsber. d. k. Ak. Wiss. Wien, vol. lxii. p. 35; Schlich, 1870, Foram. Pietzpuhl, plate xxxiv. figs. 4-12, 14.

The specimens from the Gault series are very variable; and gradational forms are found ranging from the typical *P. gutta* to

broader and more regularly oval forms resembling very closely those known as *P. turgida* (Reuss)* and *P. rotundata* Bornemann.†

P. gutta has been recorded from the Hils-clay of North Germany (Reuss); from the Neocomian beds of Surrey (Chapman); and from Tertiary clays of North Italy and Germany, the Barton beds of the Isle of Wight and the Crag of Suffolk (Parker, Jones, and Brady).

The usual character of the fistulose modification of *P. gutta* from the Gault is that of scattered tubules disposed evenly but sparsely over the whole of the test. Those figured by Schlicht are fistulose in the apical region of the test.

The ordinary type of this species was found in the Gault in zone xi., 55 ft. from the top, very rare; 45 ft., very rare.

The occurrences of the fistulose examples are:—Zone xi., 12 ft. from the top, frequent; 6 ft., rare.

Polymorphina fusiformis Roemer, plate II. fig. 9.

Polymorphina (Globulina) fusiformis Roemer, 1838, Neues Jahrb. f. Min., p. 386, plate iii. fig. 37. *P. liassica* Strickland, 1845, Quart. Journ. Geol. Soc., vol. ii. p. 30, fig. b. *P. lanceolata* Reuss, 1851, Zeitschr. deutsch. geol. Gesellsch., vol. ii. p. 83, plate vi. fig. 50, *Globulina prisca* Reuss, 1862, Sitzungsab. d. k. Ak. Wiss. Wien, vol. xvi. p. 79, plate ix. fig. 8 a, b. *Polymorphina prisca* Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 57, plate iv. fig. 20 a, b. *P. lactea* (elongate variety) Brady, 1884, Chall. Rep., vol. ix. p. 559, plate lxxi. fig. 14. *P. lactea* Burrows, Sherborn, and Bailey, 1890, Journ. Roy. Micr. Soc., p. 561, plate xi. fig. 10.

FISTULOSE FORM, plate II. fig. 10.

Polymorphina horrida Wright, 1875, Rep. and Proc. Belf. Nat. Field Club for 1873–4, Appendix 1875, p. 85, plate iii. fig. 14. *P. prisca* Berthelin, 1880, Mém. Soc. géol. France, sér. 3, vol. i. No. 5, p. 57, plate iv. fig. 21. *P. horrida* Burrows, Sherborn, and Bailey, 1890, Journ. Roy. Micr. Soc., p. 561, plate xi. fig. 14.

This form has been described under many different names, but although a variable species, it possesses certain marked characters by which it can be readily recognised. *P. fusiformis* has an ovate elongate test, tapering to the oral end, and with a more or less pointed aboral extremity. The transverse section of the test is broadly oval to nearly circular. Occasionally specimens are met with in which the breadth of the test is much greater than is usual in more typical specimens, and it is thus seen to pass almost insensibly into the heavier, more turgid, and inequilateral form of *P. sororia*. Some of the specimens from the Gault have their surfaces studded with fine prickles.

* *Guttulina turgida* Reuss, 1856, Sitzungsab. d. k. Ak. Wiss. Wien, xviii. p. 246, pl. vi. fig. 66.

† Zeitschr. Deutsch. Geol. Gesell., vii. (1855) p. 366, pl. xviii. fig. 3.

P. fusiformis has been found in the Lower Lias of England, France, and Germany. It has also been recorded from the Upper Hils-clay and the *Minimus*-clay of North Germany (Reuss); from the Gault of Montelely, Wissant, and l'Aube (as *P. prisca* Berthelin); from the Red Chalk of Speeton (as *P. lactea*, Burrows, Sherborn, and Bailey); from various strata in the Upper Cretaceous series; and from many Tertiary deposits. The figure referred to as *P. lactea* (elongate variety) in the Report on the 'Challenger' Foraminifera, taking it as an example of *P. fusiformis*, appears to be the only record of the species from a recent sounding.

It is a noteworthy fact that the fistulose modification based upon this type is almost invariably of a uniform character, namely, an apical aggregate of short tubular processes radiating and turning downwards, and always short. In each of these characters it differs from the original figures of *P. horrida* (Reuss)* in that the latter form has longer, recurved, outgrowing tubules, and attached to a fundamental form like that of *P. gutta* d'Orbigny. These differences are, however, intrinsically small, and are probably modified according to the shape of the early form of the test.

The ordinary form of this species was found at Folkestone in zone iii., very rare; zone v., very rare; zone xi., 50 ft. from the top, rare; 45 ft., frequent; 40 ft., very rare; 35 ft., very rare; 30 ft., very rare; 25 ft., rare; 12 ft., frequent.

The fistulose variety of *P. fusiformis* occurred in zone v., very rare; zone xi., 50 ft. from the top, rare; 25 ft., very rare; 20 ft., very rare; 12 ft., very rare.

Polymorphina sororia Reuss, plate II. fig. 11.

Polymorphina (*Guttulina*) *sororia* Reuss, 1862, Bull. Acad. Roy. Belg., sér. 2, vol. xv. p. 121, plate ii. figs. 25-9. Id., 1870, Sitzungsab. d. k. Ak. Wiss. Wien, vol. lxii. p. 487, No. 9. Schlicht, 1870, Foram. Pietzpuhl, plate xxvi. figs. 4-12, 16, 18. Brady, 1884, Chall. Rep., vol. ix. p. 562, plate lxxi. figs. 15, 16.

FISTULOSE FORM, plate II. fig. 12.

Aulostomella pediculus Alth, 1850, Haidinger's Naturw. Abhandl., vol. iii. p. 264, plate xiii. fig. 17. *Polymorphina sororia*, fistulose form, Brady, 1884, Chall. Rep., vol. ix. p. 562, plate lxxiii. fig. 15.

The test of *P. sororia* is in its typical condition more inflated and rounder in transverse section than *P. fusiformis*, and the arrangement and development of the chambers is also more irregular, one side of the test being in consequence of a greater convexity than the other. The aboral end of the test is usually more or less acuminate, thus

* *Globulina horrida* Reuss, 1845, Verstein. böhm. Kreidef., pt. ii. p. 110, pl. xliii. fig. 14.

separating it from the species with rounded extremities, as *P. lactea* (F. and M.), *P. gutta* d'Orb., or *P. rotundata* Bornemann.

P. sororia is also frequently found in the fistulose condition, the outgrowth consisting of a few short radiating tubules.

This species has been recorded from the Cretaceous beds of Lemberg (Alth); from the Chalk of Taplow (Chapman); and the Tertiary beds of Pietzpuhl (Schlicht). The recent form appears to be widely distributed.

The ordinary form of *P. sororia* was found at Folkestone in zone iii., rare; zone ix., very rare; zone xi., 50 ft. from the top, very rare; 45 ft., very rare; 35 ft., very rare; 30 ft., rare; 25 ft., rare; 20 ft., very rare; 12 ft., very rare.

The fistulose form was met with in zone xi., 12 ft. from the top, very rare.

Polymorphina sororia var. *cuspidata* Brady, plate II. fig. 13.

Polymorphina sororia var. *cuspidata* Brady, 1884, Chall. Rep., vol. ix. p. 563, plate lxxi. figs. 17-19; plate lxxii. fig. 4. *Polymorphina* sp., Burrows, Sherborn, and Bailey, 1890, Journ. Roy. Micr. Soc., p. 561, plate xi. fig. 15.

This variety was described from recent specimens obtained from the N. Atlantic at depths of 808 and 1443 fathoms, and from a point between the Cape of Good Hope and Kerguelen Id. at 1375 fathoms (Brady). As a fossil it has been recorded from the Neocomian Pebble-beds of Guildford (Chapman);* and it has also occurred in the Red Chalk of Speeton (Burrows, Sherborn, and Bailey).

P. sororia var. *cuspidata* occurs in the Gault of Folkestone in zone v., very rare; zone xi., 6 ft. from the top, rare.

Polymorphina angusta Egger, plate II. fig. 14.

Polymorphina (*Globulina*) *angusta* Egger, 1857, Neues Jahrb. f. Min., p. 290, plate xiii. figs. 13-15. *P. angusta* Brady, 1884, Chall. Rep., vol. ix. p. 563, plate lxxii. figs. 1-3. This species has been described from the Lower Miocene of Bavaria (Egger), and from the Septaria Clay of Pietzpuhl (as *P. lanceolata* Reuss and Schlicht). In recent deposits it generally affects deep water.

P. angusta was found in the Gault in zone iii., very rare; zone iv. very rare; zone vii., very rare.

Polymorphina communis d'Orbigny, plate II. fig. 15.

Polymorphina (*Guttulina*) *communis* d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 266, plate xii. figs. 1-4; Modèle No. 62. *Guttulina cretacea* Alth, 1849, Haidinger's Naturw. Abhandl., vol. iii. p. 262, plate xiii. fig. 14. *Polymorphina communis* Brady, 1884, Chall. Rep., vol. ix. p. 568, plate lxxii. fig. 19. *P. gibba* Burrows,

* Quart. Journ. Geol. Soc., I. (1894) p. 715.

Sherborn, and Bailey, 1890, Journ. Roy. Micr. Soc., p. 561, plate xi. fig. 13.

This well-known form has been recorded from the Lias of Yorkshire (Blake); from the Neocomian beds of Guildford (Chapman); from the Gault of Montcley (as *P. cretacea* Berthelin); from the Red Chalk of Speeton (as *P. gibba* Burrows, Sherborn, and Bailey); and from many beds of Upper Cretaceous and Tertiary ages. The greatest depths for its occurrence in recent deposits is 155 fathoms.

P. communis occurs in the Gault in zone xi., 45 ft., from the top, very rare; 6 ft., frequent.

Polymorphina compressa d'Orbigny, plate II. fig. 16.

Polymorphina compressa d'Orbigny, 1846, Foram. Foss. Vien., p. 233, plate xii. figs. 32-4. Brady, Parker, and Jones, 1870, Trans. Linn. Soc. Lond., vol. xxvii. p. 227, plate xl. fig. 12 a-f. Brady, 1884, Chall. Rep., vol. ix. p. 565, plate lxxii. figs. 9-11. *P. communis* Burrows, Sherborn, and Bailey, 1890, Journ. Roy. Micr. Soc., p. 561, plate xi. fig. 11.

This species somewhat resembles the longer forms of *P. lactea*, but is easily distinguished by the compressed form of its test.

Its geological range is extensive, it being recorded from the Lias and occurring in all of the more important fossiliferous strata of the Cretaceous and Tertiary systems. It is found in shallow-water deposits at the present day.

P. compressa was found at Folkestone in zone xi., 50 ft. from the top, rare: 45 ft., very rare.