

Transverse sections of mature individuals (fig. 4-6) showed a growth pattern that is quinqueloculine in the early stages, then triloculine, and finally biloculine. About 8 to 10 biloculine chambers maximally were found to be present, the final ones with 25 to 30 chamberlets.

Some specimens, probably the microspheric ones, begin with a proloculum of about 0,012 mm diameter, followed by a quinqueloculine and triloculine series of 15 to 16 chambers. Another group, probably the megalospheric individuals, have a proloculum of about 0,060 mm diameter, and a series of about 6 to 8 quinqueloculine and triloculine chambers.

Length of the holotype, 1,50 mm; breadth, 1,10 mm; thickness, 0,70 mm.

Remarks. — In external view this species reminds of *Fabularia howchini* SCHLUMBERGER (1891, Trans. Roy. South Australia, Proc., vol. 14, pp. 347-349, tf. 1-8) from the Lower Pliocene of Australia, which differs in the less developed quinqueloculine and triloculine series, and the fewer chamberlets per chamber.

Fabularia discolites DEFRANCE (1825, in BRONN, System Urwelt. Pflanzenthiere, Heidelberg, p. 43, pl. 7, f. 13), from the Lutetian of the Paris basin, differs by its more globular form. SCHLUMBERGER (1905, Bull. Soc. Géol. France, ser. 4, vol. 5, p. 139, pl. 3, f. 37, 38, tf. 22-25) published a number of transverse sections of *F. discolites*. There is a rather striking resemblance between the supposed microspheric forms of *F. discolites* and *F. bella*. However, the figures of the supposed megalospheric individuals of the French species show a distinct biloculine chamber arrangement throughout.

Type locality. — Bambrugge, the abandoned quarry « Steenberg » our sample ZD 1014.

Type level. — Sands of Lede. These Sands are generally regarded to be of Late Eocene age.

Distribution. — Belgium : Sands of Lede, Sands of Wemmel, Clays of Asse.

Depository. — The holotype and paratypoids are stored in the collections of the Geological Institute of Utrecht (S 11643).

FAMILY PENEROPLIDAE

SUBFAMILY SPIROLININAE

Genus RENULINA LAMARCK, 1804

Type species RENULITES OPERCULARIA LAMARCK, 1804

Renulina opercularia (LAMARCK)

Pl. VI, fig. 7; 161

Renulites opercularia LAMARCK, 1804, Ann. Mus. Hist. Nat., vol. 5, p. 354; 1807, ibid., vol. 9, pl. 17, f. 6 (Lutetian; Paris basin).

Peneroplis opercularis (LAMARCK), D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 286; TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 50, pl. 2, f. 29.

Renulina opercularia (LAMARCK), Y. LE CALVEZ, 1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 31, pl. 3, f. 38.

Distribution. — Belgium : Sands of Lede;
France : Lutetian.

Genus SPIROLINA LAMARCK, 1804

Type species SPIROLINITES CYLINDRACEA LAMARCK, 1804

Spirolina spp.

188

Remarks. — From the Lutetian of the Paris basin a number of *Spirolina* species were described by TERQUEM (1882) and Y. LE CALVEZ (1952).

Y. LE CALVEZ mentioned :

- Spirolina cylindracea* (LAMARCK) (1804, Ann. Mus. Hist. Nat., vol. 5, p. 243; 1806, vol. 8, pl. 62, f. 15),
Spirolina cylindracea (LAMARCK) var. *glabra* Y. LE CALVEZ (1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 22, pl. 2, f. 13, 14),
Spirolina laevigata D'ORBIGNY (1850, Prodrome Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407; FORNASINI, 1904, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, p. 8, pl. 2, f. 3),
Spirolina pedum D'ORBIGNY (1850, Prodrome Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407; FORNASINI, 1904, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, p. 8, pl. 2, f. 4, 5),
Spirolina striata D'ORBIGNY (1850, Prodrome Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 406; FORNASINI, 1904, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, p. 8, pl. 2, f. 2), and
Spirolina mariei Y. LE CALVEZ (1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 25, pl. 2, f. 17, 18).

We found specimens of all these types in our material from Grignon. Regarding these specimens it is considered likely that the specific differences between *Spirolina mariei* and *S. striata* are not distinct. They possibly represent variants of a single species.

In the Eocene material of Belgium no specimens of *Spirolina* were found. GULLENTOPS (1956, Mém. Inst. Géol. Univ. Louvain, vol. 20, p. 16, pl. 1, f. 13) and BATJES (1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 107, pl. 2, f. 6) recorded *Spirolina*, possibly *S. cylindracea*, from the Lower Oligocene of Belgium.

Distribution. — France : Lutetian.

Genus DENDRITINA D'ORBIGNY, 1826

Type species DENDRITINA ARBUSCULA D'ORBIGNY, 1826

Dendritina depressa (LAMARCK)

151 and 167

- Spirolinities depressa* LAMARCK, 1804, Ann. Mus. Hist. Nat., vol. 5, p. 245; 1806, ibid., vol. 8, pl. 62, f. 14 (Lutetian; Paris basin).
Spirolina depressa (LAMARCK), TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 53, pl. 3, f. 10.
Dendritina depressa (LAMARCK), Y. LE CALVEZ, 1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 25, pl. 3, f. 25-28.

Remarks. — Some small specimens from samples of the Upper Eocene of Belgium probably belong to this common species of the Lutetian of the Paris basin.

In our French material we found representatives of three more *Dendritina* species which had already been recorded from the Lutetian of the Paris basin. Figures and redescriptions of these species had been given by Y. LE CALVEZ (1952, Mém. Expl. Carte Géol. dét. France, pt. 4, pp. 25-28, pl. 2, f. 21-24, pl. 3, f. 25-30) :

Dendritina juleana D'ORBIGNY (1846, Foram. foss. Vienne, p. 134, pl. 7, f. 3, 4) was found in considerable numbers in our material from Grignon;

Dendritina laevigata TERQUEM (1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 51, pl. 3, f. 2, 3) and

Dendritina elegans D'ORBIGNY (1846, Foram. foss. Vienne, p. 135, pl. 7, f. 5, 6) were present as single specimens.

Distribution. — Belgium : Sands of Lede, Sands of Wemmél (in both some scattered individuals of *Dendritina depressa*);

France : Lutetian.

SUBFAMILY ORBITOLITINAE

Genus ORBITOLITES LAMARCK, 1801

Type species ORBITOLITES COMPLANATUS LAMARCK, 1801

Orbitolites complanatus LAMARCK

169

Orbitolites complanatus LAMARCK, 1801, Syst. Anim. sans Vert., p. 376 (Lutetian; Paris basin); TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 125, pl. 13, f. 5; DOUVILLÉ, 1902, Bull. Soc. Géol. France, ser. 4, vol. 2, p. 296; HENSON, 1950, Middle Eastern Tert. Peneroplidae, thesis Leiden, p. 57; Y. LE CALVEZ, 1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 28.

Remarks. — In addition to the numerous individuals derived from the Lutetian of Grignon, we found the species rather scarcely represented in our Belgian Eocene material. Mostly fragments were encountered; well-preserved specimens are very rare.

Distribution. — Belgium : Sands of Lede, Sands of Wemmél (one sample of the basal layers);

France : Lutetian.

FAMILY ALVEOLINIDAE

Genus ALVEOLINA D'ORBIGNY, 1826

Type species ORYZARIA BOSCHII DEFRANCE, 1825

Alveolina spp.

Remarks. — A number of samples of the Belgian Upper Eocene contained fragments of *Alveolina*. Their state of preservation did not allow a definite determination. Possibly they belong to the same species as the specimens that occur in the Lutetian of the Paris basin, and which were reported by Y. LE CALVEZ (1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 41) as :

Alveolina boschii (DEFRANCE) (*Oryzaria boschii* DEFRANCE, 1825, in BRONN, System Urwelt. Pflanzenthiere, Heidelberg, p. 44, pl. 7, f. 17) and

Alveolina elongata D'ORBIGNY (1828, in DESHAYES, Ann. Sci. Nat., ser. 1, vol. 14, p. 234; FORNASINI, 1904, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, p. 15, pl. 4, f. 14).

Distribution. — Belgium : Sands of Lede, Sands of Wemmél;
France : Lutetian.

FAMILY LAGENIDAE

SUBFAMILY LENTICULININAE

Genus LENTICULINA LAMARCK, 1804

Type species LENTICULINA ROTULATA LAMARCK, 1804

Lenticulina spp.

Pl. VII, fig. 1-9; 22

Remarks. — Since BARTENSTEIN's paper (1948, Senckenbergiana, vol. 29, pp. 41-65) there has been a tendency to use *Lenticulina* as a generic name for all involute lagenids.

Several species may be present in the Belgian Eocene, but we failed to find constant distinctive characteristics. Only the species of *Lenticulina* (*Astacolus*) and *Lenticulina* (*Margulinopsis*) could be separated.

The Ieper Clays and the Sands of Mons-en-Pévèle appeared fairly rich in *Lenticulina* specimens. Especially the samples of the boring Woensdrecht yielded many of them. Such types as our *Lenticulina* (*Darbyella*) sp. cf. *Darbyella wilcoxensis*, *L.* sp. cf. *L. umbonata* (REUSS), etc., appeared to be characteristic for these units.

The Roncq Clays, the Sandy Clays of Anderlecht and the Vlierzele Sands appeared to be devoid of *Lenticulina*. The genus is again represented in the Sands of Brussels, but in small numbers, and without distinctive species.

The Sands of Lede also had scarce, indistinct *Lenticulina* specimens. They became somewhat more numerous in the Wemmél Sands and the Asse Clays. The latter member had a slightly more diversified association than the Wemmél Sands. It contained, amongst others, *L.* sp. cf. *L. jugosa* (CUSHMAN and THOMAS) as a distinctive species (also in one sample of the Lede Sands of the Hoboken boring; contamination?).

The most important types are :

Lenticulina sp. cf. *L. alatolimbata* (GÜMBEL) (cf. *Robulina alato-limbata* GÜMBEL, 1868, Abh. K. Bayer. Akad. Wiss., Math.-Physik. Cl., vol. 10, pt. 2, p. 641, pl. 1, f. 70 — Eocene; Germany); pl. VII, fig. 1, 2.

Specimens resembling this species were found in the material of the Ieper Clays, Roubaix Clays and Mons-en-Pévèle Sands, but others with less numerous chambers (five to seven instead of seven to nine) resemble *Lenticulina limbata* (BORNEMANN) (*Robulina limbata* BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 335, pl. 15, f. 4-6) and *Lenticulina inornata* (D'ORBIGNY) (*Robulina inornata* D'ORBIGNY, 1846, Foram. foss. Vienne, p. 102, pl. 4, f. 25, 26). The latter types were found throughout our Eocene series.

Lenticulina sp. cf. *L. austriaca* (D'ORBIGNY) (cf. *Robulina austriaca* D'ORBIGNY, 1846, Foram. foss. Vienne, p. 103, pl. 15, f. 1, 2 — Miocene; Vienna basin).

A number of specimens of the Lede and Asse formations possibly belong to this species, which was also reported from the Lutetian of the Paris basin (Y. LE CALVEZ, 1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 40). This form with about ten chambers and a rather indistinct keel grades into that of our *Lenticulina* sp. cf. *alatolimbata*.

Lenticulina sp. cf. *L. limbosa* (REUSS) (cf. *Cristellaria limbosa* REUSS, 1863, Sitz. ber. K. Akad. Wiss. Wien, Math.-Naturw. Cl., vol. 48, pt. 1, p. 55, pl. 6, f. 69 — Oligocene; Germany).

Specimens that resemble this species were especially met with in the Ieper Clays and the Sands of Mons-en-Pévèle. Similar specimens occur in younger deposits; they were partly determined as *Lenticulina* sp. cf. *L. austriaca*.

Not all the specimens show the distinct keel as it was figured by REUSS. Occasional forms with more than nine to ten chambers resemble *Lenticulina clypeiformis* (D'ORBIGNY) (*Robulina clypeiformis* D'ORBIGNY, 1846, Foram. foss. Vienne, p. 101, pl. 4, f. 23, 24).

The specimens of the Wemmelsands and the Asse Clays show the type described by many authors as *Lenticulina cultrata* (MONTFORT) (*Robulus cultratus* MONTFORT, 1808, Conch. Syst., vol. 1, p. 215, tf.), which type figure, however, is indistinct. These specimens have a distinct keel and lesser chambers than typical *L. limbosa*.

Lenticulina sp. cf. *L. costata* (D'ORBIGNY) (cf. *Robulina costata* D'ORBIGNY, 1902, in FORNASINI, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. 10, p. 43, tf. 44-recent; Adriatic, Italy), pl. VII, fig. 3.

The specimens of the Ieper formation resemble our *Lenticulina* sp. cf. *L. ellisori*, but they show the distinct limbate sutures of *L. costata*.

Lenticulina sp. cf. *L. ellisori* BOWEN (cf. *Lenticulina ellisori* BOWEN, 1954, Proc. Geol. Assoc., vol. 65, p. 146, pl. A, f. 12 — London Clay; England), pl. VII, fig. 4.

This type was only found in the Ieper Clays.

Some variation is found in the thickening of the sutures, especially in the specimens resembling *Lenticulina* sp. cf. *L. costata*.

Lenticulina sp. cf. *L. jugosa* (CUSHMAN and THOMAS) (cf. *Robulus jugosus* CUSHMAN and THOMAS, 1930, Jour. Pal., vol. 4, p. 36, pl. 3, f. 4 — Eocene; Texas), pl. VII, fig. 5.

Only specimens from the Asse Clays resemble this species. The earlier sutures are often nodose, the later ones raised. Our specimens also resemble *Lenticulina baconica* (HANTKEN) (*Robulina baconica* HANTKEN, 1875, Jahrb. K. Ungar. Géol. Anst., Mitt., vol. 4, pt. 1, p. 58, pl. 14, f. 9), but the latter species shows more chambers and less limbate sutures.

Lenticulina sp. cf. *L. pseudovortex* (COLE) (cf. *Robulus pseudovortex* COLE, 1927, Bull. Am. Pal., vol. 14, no. 51, p. 19, pl. 1, f. 12 — Eocene; Mexico), pl. VII, fig. 6.

Most specimens show a slight keel, which is nearly absent in the original specimen of COLE.

The individuals of the Lede Sands and the Wemmelsands resemble our *Lenticulina* sp. cf. *L. yaguatensis*, which has more chambers and somewhat less curved sutures.

Lenticulina sp. cf. *L. umbonata* (REUSS) (cf. *Robulina umbonata* REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 68, pl. 4, f. 24 — Oligocene; Germany).

A number of small specimens, characterized by six chambers and the very large, thick umbo, were met with in some samples from the Ieper Clays of the Woensdrecht boring.

Lenticulina sp. cf. *L. yaguatensis* (BERMUDEZ) (cf. *Robulus yaguatensis* BERMUDEZ, 1949, Cushman Lab. Foram. Res., Spec. Publ. no. 25, p. 132, pl. 7, f. 29, 30 — Oligocene; Dominican Republic), pl. VII, fig. 8, 9.

This is one of the most frequent species in the Lede and Asse formations. The individuals are characterized by about seven chambers with broadly curved sutures that are flush with the surface. The earlier chambers are often visible through the transparent umbo.

Lenticulina (Darbyella) sp. cf. *Lenticulina (Darbyella) wilcoxensis* (CUSHMAN and GARRETT) (cf. *Darbyella wilcoxensis* CUSHMAN and GARRETT, 1939, Contr. Cushman Lab. Foram. Res., vol. 15, p. 79, pl. 13, f. 11, 12 — Eocene; Alabama), pl. VII, fig. 7.

A small number of specimens was found in the Ieper Clays and the Mons-en-Pévèle Sands.

Our individuals differ from *Lenticulina (Darbyella) wilcoxensis* by the less raised sutures and the usually lower number of chambers.

Subgenus ASTACOLUS MONTFORT, 1808

Type species NAUTILUS CREPIDULA FICHEL and MOLL, 1798

Lenticulina (Astacolus) decorata (REUSS)

Pl. VII, fig. 10, 11; 209

Cristellaria decorata REUSS, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 269, pl. 8, f. 16, pl. 9, f. 1, 2 (Upper Eocene; Germany).

Marginulina decorata (REUSS), STAESCHE and HILTERMANN, 1940, Abh. Reichst. f. Bodenf., New Series, vol. 201, p. 16, pl. 42, f. 4.

Vaginulinopsis decorata (REUSS), TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 101, pl. 2, f. 12, 13.

Remarks. — Most of our variable specimens agree fairly well with the more or less schematic figures of REUSS. There may be some doubt about the subgeneric position of our specimens. The sutures of the last formed chambers often curve back to the spiral part of the test, thus fitting the diagnosis of *Astacolus*. Other specimens show the tendency to become distinctly uncoiling; they better resemble *Vaginulinopsis* or *Marginulinopsis*.

The ornamentation is variable. Most specimens show limbate, raised sutures, partly developed as a series of distinct tubercles of variable length. The test may further be ornamented by more or less longitudinal costae, which always become less apparent near the aperture. Granules may be present in between the costae.

Distribution. — Belgium: Sands of Lede, Sands of Wemmél, Clays of Asse; Netherlands (Woensdrecht): Sands of Lede, Sands of Wemmél.

Lenticulina (Astacolus) sp. cf. *L. decorata* (REUSS)

34

cf. *Cristellaria decorata* REUSS, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 269, pl. 8, f. 16, pl. 9, f. 1, 2 (Upper Eocene; Germany).

Remarks. — In a number of samples of the Ieper formation we found many specimens resembling our *Lenticulina decorata* of the Upper Eocene. However, most of them are

more slender and some show a *Marginulinopsis*-like test. Perhaps some younger individuals of *Lenticulina* (*Marginulinopsis*) *enbornensis* without the typical ornamentation of that species have been included.

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle;
 England : London Clay;
 Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle.

Subgenus MARGINULINOPSIS SILVESTRI, 1904

Type species MARGINULINOPSIS DENSICOSTATA THALMANN, 1937

Lenticulina (*Marginulinopsis*) *enbornensis* (BOWEN)

Pl. VII, fig. 12, 13; 35

Marginulina enbornensis BOWEN, 1954, Proc. Geol. Ass., vol. 65, p. 149, pl. B, f. 1-4 (London Clay; England).

Remarks. — In the material of the Woensdrecht boring many specimens were found with the same variable ornamentation as described by BOWEN. The aperture is always eccentric on a stout neck. BOWEN figured specimens without a distinct spiral part. In our material types with and without such a spiral part are present.

Distribution. — Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle.

Genus MARGINULINA D'ORBIGNY, 1826

Type species MARGINULINA GLABRA D'ORBIGNY, 1826

Marginulina pediformis BORNEMANN

28

Marginulina pediformis BORNEMANN, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 326, pl. 13, f. 13 (Oligocene; Germany); HAGN, 1956, Palaeontographica, vol. 107, pt. A, p. 132, pl. 11, f. 13.

Distribution. — Belgium : Clays of Ieper (one sample);
 Netherlands (Woensdrecht) : Clays of Ieper (one sample).

Genus DENTALINA D'ORBIGNY, 1839

Type species NODOSARIA OBLIQUA D'ORBIGNY, 1826

Dentalina megalopolitana REUSS

Pl. VII, fig. 14; 10

Dentalina megalopolitana REUSS, 1855, Zschr. Deu. Geol. Ges., vol. 7, pt. 1, p. 267, pl. 8, f. 10 (Upper Eocene; Germany).

Dentalina approximata TEN DAM (not REUSS), 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 91, pl. 2, f. 10 (Paleocene; Netherlands).

R e m a r k s . — Our specimens lack the initial spine, but in the other features they closely resemble the species described by REUSS. They are somewhat variable in the relative height of the chambers and the thickness of the sutures.

Dentalina approximata (REUSS) (*Nodosaria approximata* REUSS, 1866, Denkschr. K. Akad. Wiss. Wien, Math.-Naturw. Cl., vol. 25, pt. 1, p. 134, pl. 2, f. 22) from the Oligocene of Germany is a more slender type with higher chambers.

Some resemblance is found with American types, such as those of *Dentalina colei* CUSHMAN and DUSENBURY (1943, Contr. Cushman Lab. Foram. Res., vol. 19, p. 54, pl. 17, f. 10-12), *D. cooperensis* CUSHMAN var. *nonapicalis* BANDY (1949, Bull. Am. Pal., vol. 32, no. 131, p. 52, pl. 7, f. 1), *D. eocenica* CUSHMAN (1944, Contr. Cushman Lab. Foram. Res., vol. 20, p. 36, pl. 6, f. 1) and *D. jarvisi* CUSHMAN and TODD (1945, Cushman Lab. Foram. Res., Spec. Publ. no. 15, p. 22, pl. 3, f. 22).

D i s t r i b u t i o n . — Netherlands (Woensdrecht): Clays of Ieper, Sands of Mons-en-Pévèle.

***Dentalina* sp. cf. *D. ewaldi* (REUSS)**

Pl. VII, fig. 15, 16; 20

cf. *Nodosaria ewaldi* REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 58, pl. 2, f. 2 (Oligocene; Germany); BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 117.

R e m a r k s . — There are a number of fragments of *Dentalina*-like specimens with more or less elongate chambers.

The specimens of the Upper Eocene resemble *Dentalina ewaldi* as figured by REUSS, but individuals closer to *D. consobrina* D'ORBIGNY (1846, Foram. foss. Vienne, p. 46, pl. 2, f. 1-3) are present as well.

The fragments from the Lower Eocene, especially from the Clays of Ieper in the boring Woensdrecht, have about the same morphological range, but there are fragments with very elongate chambers. They resemble *Nodosaria longiscata* D'ORBIGNY (1846, Foram. foss. Vienne, p. 32, pl. 1, f. 10-12). They were recorded under this name by TEN DAM (1944, Meded. Geol. Stichting, ser. C., vol. 5, no. 3, p. 95) from the Ypresian of the Netherlands.

D i s t r i b u t i o n . — Belgium : Sands of Wemmels, Clays of Asse; Netherlands (Woensdrecht) : Clays of Ieper.

***Dentalina elegans* D'ORBIGNY**

Pl. VII, fig. 17; 49

Dentalina elegans D'ORBIGNY, 1846, Foram. foss. Vienne, p. 45, pl. 1, f. 52-56 (Miocene; Vienna basin); TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 36, pl. 1, f. 40; TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 92; Y. LE CALVEZ, 1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 39.

R e m a r k s . — Specimens resembling the typical ones from the Miocene of Austria are relatively scarce in our material, but they occur throughout.

The chambers are often less inflated; such specimens resemble *Dentalina pauperata* D'ORBIGNY (1846, Foram. foss. Vienne, p. 46, pl. 1, f. 57, 58). The sutures are generally straight and distinct, but specimens with slightly oblique sutures were found as well. They approach the indistinct boundary with *D. inornata* D'ORBIGNY, which shows distinctly oblique sutures. The specific difference between these two species is somewhat questionable.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmél, Clays of Asse;

Netherlands (Woensdrecht) : Clays of Ieper.

Dentalina inornata D'ORBIGNY

Pl. VII, fig. 18, 19; 67

Dentalina inornata D'ORBIGNY, 1846, Foram. foss. Vienne, p. 44, pl. 1, f. 50, 51 (Miocene; Vienna basin); TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 37, pl. 1, f. 41 (42 ?); Y. LE CALVEZ, 1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 39.

Remarks. — MARKS (1951, Contr. Cushm. Found. Foram. Res., vol. 2, p. 45) regarded *Dentalina inornata* as a synonym of *D. communis* (D'ORBIGNY) (*Nodosaria communis* D'ORBIGNY, 1840, Mém. Soc. Géol. France, vol. 4, no. 1, p. 13, pl. 1, f. 4), which had originally been described from the Adriatic, Italy. However, the type figures of the latter species are too bad to prove such an assumption.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmél, Clays of Asse;

Netherlands (Woensdrecht) : Clays of Ieper, Lower Panisel beds.

Dentalina sp. cf. **D. baltica** REUSS

224

cf. *Dentalina baltica* REUSS, 1855, Zschr. Deu. Geol. Ges., vol. 7, p. 269, pl. 8, f. 15 (Upper Eocene; Germany).

Remarks. — Variation especially concerns the development of the costae, which are often distinct and heavy, and in other cases absent on the middle part of the chambers.

Distribution. — Belgium : Sands of Wemmél, Clays of Asse.

Genus **NODOSARIA** LAMARCK, 1812

Type species NAUTILUS RADICULUS LINNÉ, 1758

Nodosaria sp. cf. **N. elegantissima** HANTKEN

Pl. VII, fig. 20; 26

cf. *Nodosaria elegantissima* HANTKEN, 1875, Jahrb. K. Ungar. Geol. Anst., Mitt., vol. 4, pt. 1, p. 24, pl. 12, f. 16 (Upper Eocene; Hungary).

cf. *Stilostomella* cf. *elegantissima* (HANTKEN), HAGN, 1956, Palaeontographica, vol. 107, pt. A, p. 155, pl. 13, f. 24.

Nodosaria spinulosa (MONTAGU), TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 95, pl. 2, f. 8; BOWEN, 1954, Proc. Geol. Ass., vol. 65, p. 155.

Remarks. — Our specimens, always fragmentary, fairly well resemble the figures given by HAGN. The apertural characters are indistinct, and our specimens are provisionally described as *Nodosaria*. In the original figures of HANTKEN the upper part of the chambers is smooth, which is unlike our specimens. Our Dutch individuals resemble the specimens figured by TEN DAM as *N. spinulosa*. However, *Nautilus spinulosus* MONTAGU (1808, Test. Brit., Suppl.,

p. 86, pl. 19, f. 5) shows a smooth upper part of the chambers and a spinose lower part. The longitudinal costae ending in spinose projections are absent in MONTAGU's figures.

Externally there is no difference from *Ellipsonodosaria midwayensis* CUSHMAN and TODD (1946, Contr. Cushm. Lab. Foram. Res., vol. 22, p. 61, pl. 10, f. 25) from the Paleocene of Arkansas and Texas. However, owing to lack of specimens with a preserved apertural part, the generic determination of our specimens remains uncertain.

Distribution. — Netherlands (Woensdrecht) : Clays of Ieper.

***Nodosaria minor* HANTKEN**

Pl. VII, fig. 21; 41

Nodosaria bacillum DEFRANCE var. *minor* HANTKEN, 1875, Jahrb. K. Ungar. Geol. Anst., Mitt., vol. 4, pt. 1, p. 26, pl. 2, f. 7 (Upper Eocene; Hungary); STAESCHE and HILTERMANN, 1940, Abh. Reichstelle f. Bodenforschung, New Series, vol. 201, pl. 39, f. 3.

Remarks. — Specimens, such as those figured by HANTKEN and by STAESCHE and HILTERMANN, were rather frequently met with. They are always accompanied by *Nodosaria latejugata*. Possibly both types are only variants of one species, but *N. latejugata* differs by the more inflated chambers and the more strongly developed costae.

Distribution. — Belgium : Clays of Ieper, Lower Panisel beds;
Netherlands (Woensdrecht) : Clays of Ieper.

***Nodosaria latejugata* GÜMBEL**

Pl. VII, fig. 22; 36

Nodosaria latejugata GÜMBEL, 1870, Abh. Bayr. Ak. Wiss., vol. 10, p. 619, pl. 1, f. 32 (Eocene; Bavaria, Germany); TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 94; HAGN, 1956, Palaeontographica, vol. 107, pt. A, p. 137, pl. 12, f. 11, pl. 13, f. 1.

Remarks. — *Nodosaria latejugata* is considered to be different from *N. minor* by the distinctly inflated chambers and the heavier costae.

Distribution. — Belgium : Sands of Mons-en-Pévèle;
Netherlands (Woensdrecht) : Clays of Ieper.

***Nodosaria ludwigi* REUSS**

Pl. VII, fig. 23; 228

Nodosaria ludwigi REUSS, 1866, Denkschr. K. Akad. Wiss. Wien, vol. 25, p. 135, pl. 2, f. 23 (Oligocene; Germany); BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 116, pl. 3, f. 15, 16.

Remarks. — Our few specimens are in all features identical with the specimens described by BATJES from the Oligocene.

Distribution. — Belgium : Sands of Wemmel, Clays of Asse.

Nodosaria natchitochensis (Howe)

Pl. VII, fig. 24; 25

Dentalina natchitochensis HOWE, 1939, Louisiana Dept. Conserv., Geol. Surv., Bull. no. 14, p. 45, pl. 6, f. 6 (Eocene; Louisiana).

Nodosaria natchitochensis (HOWE), BOWEN, 1954, Proc. Geol. Ass., vol. 65, p. 154.

Remarks. — Like the specimens from the London Clay, recorded by BOWEN, our individuals differ from the original one by the rectilinear instead of the curvilinear shape of the test.

Some variation was found in the size of the first chamber. It is sometimes distinctly bigger than the second one, but mostly the chambers gradually increase in size as added.

Distribution. — Netherlands (Woensdrecht) : Clays of Ieper.

Nodosaria spp.

27

Remarks. — Indeterminable fragments of *Nodosaria* species were found in many samples of the Woensdrecht boring. Most frequent are fragments resembling *Nodosaria spinescens* REUSS (1851, Zschr. Deu. Geol. Ges., vol. 3, p. 62, pl. 3, f. 10).

Distribution. — Netherlands (Woensdrecht) : Clays of Ieper.

SUBFAMILY LAGENINAE

Genus LAGENA WALKER and JACOB, 1798

Type species SERPULA SULCATA WALKER and JACOB, 1798

Lagena isabella (D'ORBIGNY)

Pl. VII, fig. 25; 105

Oolina isabella D'ORBIGNY, 1839, Voy. Amér. MÉR., Foram., vol. 5, pt. 5, p. 20, pl. 5, f. 7, 8 (recent; Falkland Islands, Atlantic).

Lagena isabella (D'ORBIGNY), BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 119, pl. 3, f. 11.

Lagena elegantissima (BORNEMANN), MATTHES, 1939, Palaeontographica, vol. 90, pt. A, p. 58, pl. 3, f. 13, 14.

Remarks. — Our specimens are completely within the range of variation found by BATJES in the Oligocene. We only encountered single individuals in a number of samples.

Specimens like ours, were often referred to as *Lagena acuticosta* REUSS (1862, Sitz. Ber. K. Akad. Wiss. Wien, vol. 44, pt. 1, p. 305, pl. 1, f. 4) and *L. sulcata* (WALKER and JACOB) [*Serpula* (*Lagena*) *sulcata* WALKER and JACOB, 1798, in Kanm., Adams' Essays, p. 634, pl. 14, f. 5].

Distribution. — Belgium : Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Clays of Asse.

Lagena striata (D'ORBIGNY)

Pl. VII, fig. 26; 70

Oolina striata D'ORBIGNY, 1839, Voy. Amér. Mér., Foram., vol. 5, pt. 5, p. 21, pl. 5, f. 12 (recent; Falkland Islands, Atlantic).

Lagena striata (D'ORBIGNY), BOWEN, 1954, Proc. Geol. Ass., vol. 65, p. 143; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 119, pl. 3, f. 6.

Remarks. — All the individuals we assigned to this species are characterized by the presence of fine, longitudinal striae. The shape of the test ranges from globular to pear-shaped. Mostly there is a terminal neck, but never with a series of rings. When the neck is absent, the test is pear-shaped.

CUSHMAN and McCULLOCH (1950, Allan Hancock Pacific Exp., vol. 6, no. 6, p. 350, pl. 47, f. 1-4) seem to interpret the species as characterized by the rings on the elongate apertural neck. Forms without such rings they placed in *Lagena sulcata* (WALKER and JACOB) and varieties. However, the type of *L. sulcata* possesses fewer and heavier costae.

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle, Sands of Wemmel, Clays of Asse;

England : Barton beds.

Lagena globosa (MONTAGU)

Pl. VII, fig. 27; 50

Vermiculum globosum MONTAGU, 1803, Test. Brit., p. 523 (recent; England).

Lagena globosa (MONTAGU), BOWEN, 1954, Proc. Geol. Ass., vol. 65, p. 142.

Lagena vulgaris TERQUEM (not WILLIAMSON), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 25, pl. 1, f. 3; Y. LE CALVEZ, 1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 39.

Remarks. — *Lagena vulgaris* was described by WILLIAMSON (1858, Rec. Foram. Great Brit., p. 4, pl. 1, f. 5) as a smooth, very elongate, pear-shaped species.

Our specimens, as well as the one figured by TERQUEM and redescribed by Y. LE CALVEZ, show globular tests, which resemble the original figures of *Lagena globosa* very well.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

Netherlands (Woensdrecht) : Clays of Ieper.

Lagena spp.

118

Remarks. — In addition to the three described species, scarce individuals of some others were found. The following names may be applied to them :

Lagena squamosa (MONTAGU) var. *hexagona* (WILLIAMSON) [*Entosolenia squamosa* (MONTAGU) var. *hexagona* WILLIAMSON, 1848, Ann. Mag. Nat. Hist., ser. 2, vol. 1, p. 20, pl. 2, f. 23 — recent; Great Britain].

Single specimens in Woensdrecht 403 m (Lower Panisel beds), WA 1139 and ND 411 (Sands of Brussels), and BRB 237 (Clays of Asse).

Lagena hispidula CUSHMAN (1913, U. S. Nat. Mus., Bull. 71, pt. 3, p. 14, pl. 5, f. 2, 3 — recent; Pacific).

A single specimen in BRB 237 (Clays of Asse).

Lagena striatopunctata PARKER and JONES (*Lagena sulcata* (WALKER and JACOB) var. *striatopunctata* PARKER and JONES, 1865, Philos. Trans., vol. 155, p. 350, pl. 13, f. 25-27 — recent; Atlantic and Indian Oceans; Lutetian, France).

Single specimens in BC 115 and WA 1139 (Sands of Brussels), and in Wemmels 14-10,50 m (Sands of Wemmels).

Genus ENTOSOLENIA EHRENBERG, 1848

Type species ENTOSOLENIA LINEATA WILLIAMSON, 1848

Entosolenia marginata (WALKER and BOYS)

Pl. VII, fig. 28; 181

Serpula marginata WALKER and BOYS, 1784, Test. Min., p. 2, pl. 1, f. 7 (recent; Great Britain).

Lagena marginata (WALKER and BOYS), CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 35, pl. 6, f. 9.

Entosolenia marginata (WALKER and BOYS), Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 41.

Remarks. — Our few specimens show some variation in the size of the carina.

Distribution. — Belgium : Sands of Lede, Sands of Wemmels, Clays of Asse; France : Lutetian.

Entosolenia orbignyana (SEGUENZA)

Pl. VII, fig. 29; 90

Fissurina orbignyana SEGUENZA, 1862, Foram. Monothal. Mioc. Messina, p. 66, pl. 2, f. 25, 26 (Miocene; Italy).

Lagena (Entosolenia) orbignyana (SEGUENZA), BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 118.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmels.

Entosolenia spp.

127

Remarks. — In addition to the above two species we encountered a few specimens of some others. The following specific names could be applied for them :

Entosolenia laevigata (REUSS) (*Fissurina laevigata* REUSS, 1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 366, pl. 46, f. 1 — Miocene; Vienna basin).

LK 163 (Sands of Brussels).

Entosolenia bicarinata (TERQUEM) (*Fissurina bicarinata* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 31, pl. 1, f. 24 — Lutetian; Paris basin).

BD 391 (Sands of Brussels).

FAMILY POLYMORPHINIDAE

Genus GUTTULINA D'ORBIGNY, 1839

Type species POLYMORPHINA PROBLEMA D'ORBIGNY, 1826

Guttulina problema (D'ORBIGNY)

Pl. VII, fig. 30, 31, 32, pl. VIII, fig. 1; 58

Polymorphina (Guttulina) problema D'ORBIGNY, 1846, Foram. foss. Vienne, p. 224, pl. 12, f. 26-28 (Pliocene; Italy).

Guttulina problema (D'ORBIGNY), CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 19, pl. 2, f. 1-6, pl. 3, f. 1; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 11, pl. 1, f. 7-9; BATJES (part), 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 121, pl. 4, f. 10, 11 (not 12).

Polymorphina communis D'ORBIGNY, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 266, pl. 12, f. 1-4 (Eocene; Paris basin).

Guttulina communis (D'ORBIGNY), Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 13, pl. 1, f. 13-15.

Remarks. — *Guttulina problema* is one of the most common species of the Belgian Eocene with numerous representatives throughout the whole column.

It appeared impossible to separate *Guttulina problema*, *G. communis* and specimens similar to *G. austriaca* D'ORBIGNY (1846, Foram. foss. Vienne, p. 223, pl. 12, f. 23-25). Variants that resemble the latter species are scarce; most of them were found in samples from the Lede Sands, Wemmel Sands and Asse Clays.

The separation of young individuals of *Guttulina problema* and *G. irregularis* appeared to be difficult, and sometimes impossible. The same difficulty was encountered with young specimens of *G. lactea* and of *Pyrulina* species.

Among the numerous specimens of the Asse formation some may be assigned to *Guttulina frankei* CUSHMAN and OZAWA (1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 28, pl. 4, f. 1), but a clear distinction between the latter species and *G. problema* was not observed. All specimens were united under *G. problema*, as BATJES did for the Oligocene ones.

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle, Clays of Roubaix, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England : Upper Bracklesham beds, Barton beds;

France : Lutetian;

Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel.

Guttulina irregularis (D'ORBIGNY)

Pl. VIII, fig. 2, 3; 57

Globulina irregularis D'ORBIGNY, 1846, Foram. foss. Vienne, p. 226, pl. 13, f. 9, 10 (Miocene; Vienna basin).

Guttulina irregularis (D'ORBIGNY), CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 25, pl. 3, f. 4, 5, pl. 7, f. 1, 2; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 14; MARKS, 1951, Contr. Cushman Found. Foram. Res., vol. 2, p. 47; BHATIA, 1955, Jour. Pal., vol. 29, no. 4, p. 676, pl. 67, f. 26.

Remarks. — Our specimens of *Guttulina irregularis* are rather variable in general appearance. They include forms as were figured by BHATIA as *G. bulloides* REUSS (BHATIA, 1955, op. cit., p. 676, pl. 67, f. 28). The type of *G. inaequalis* REUSS, as figured by BHATIA (1955, p. 676, pl. 67, f. 23) occurs among young specimens.

BATJES (1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 226, pl. 12, f. 12) included *Guttulina irregularis* as a variant of *G. problema*. The distinction between the two species is not always very clear, but in our Eocene material they are generally fairly well separable.

Distribution. — Belgium: Clays of Ieper, Sands of Mons-en-Pévèle, Clays of Roncq, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England: Upper Bracklesham beds, Barton beds;

France: Lutetian;

Netherlands (Woensdrecht): Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel.

Guttulina pulchella D'ORBIGNY

Pl. VIII, fig. 4; 69

Guttulina pulchella D'ORBIGNY, 1839, in DE LA SAGRA, Hist. Phys. Nat. Cuba, p. 134, vol. 8, pl. 2, f. 4-6 (recent; West Indies); CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, p. 157, pl. 40, f. 6; CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 33, pl. 5, f. 7.

Guttulina spicaeformis (ROEMER) var. *parisiensis* Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 15, pl. 1, f. 10-12 (Lutetian; Paris basin).

Remarks. — The Belgian and French specimens resemble the figures of *Guttulina pulchella* very well. They are considered conspecific with this recent Caribbean species. Most of our specimens are also in good accordance with the one figured by Y. LE CALVEZ as *G. spicaeformis* var. *parisiensis*. In our opinion this form is identical with *G. pulchella*.

A large number of variants in our material are smooth.

Distribution. — Belgium: Clays of Ieper, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England: Upper Bracklesham beds;

Netherlands (Woensdrecht): Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter, Sands of Brussels.

Guttulina lactea (WALKER and JACOB)

Pl. VIII, fig. 5; 113

Serpula lactea WALKER and JACOB, 1798, Adams' Essays, ed. 2, p. 634, pl. 14, f. 4 (recent; England).

Polymorphina lactea (WALKER and JACOB), CUSHMAN, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 146, pl. 39, f. 9 (not 11).

Guttulina lactea (WALKER and JACOB), CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 43, pl. 10, f. 1-4; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 14.

Remarks. — *Guttulina lactea* differs from *G. problema* by the elongate chambers and the slightly compressed test. In some specimens there is a tendency of the chambers to become arranged in a sigmoid series. This was noted earlier by CUSHMAN and OZAWA for recent specimens from the Atlantic.

Some specimens with shorter chambers hamper a clear separation from *Guttulina problema*.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel;
France : Lutetian;
Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels.

Genus GLOBULINA D'ORBIGNY, 1839

Type species POLYMORPHINA GIBBA D'ORBIGNY, 1826

Globulina gibba (D'ORBIGNY)

Pl. VIII, fig. 6, 7; 56

Polymorphina gibba D'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 227, pl. 13, f. 13, 14 (Miocene; Vienna basin).
Globulina gibba (D'ORBIGNY), TERQUEM, 1882, *Mém. Soc. Géol. France*, ser. 3, vol. 2, p. 130, pl. 13, f. 23-25 (not 22, 26, 27); CUSHMAN and OZAWA, 1930, *Proc. U. S. Nat. Mus.*, vol. 77, art. 6, p. 60, pl. 16, f. 1-4; Y. LE CALVEZ, 1950, *Mém. Expl. Carte Géol. dét. France*, pt. 3, p. 17; BATHES, 1958, *Mém. Inst. R. Sc. Nat. Belg.*, no. 143, p. 121, pl. 4, f. 9.
Globulina inaequalis REUSS, 1850, *Denkschr. K. Ak. Wiss. Wien*, vol. 1, p. 377, pl. 48, f. 9 (Miocene; Vienna basin); CUSHMAN and OZAWA, 1930, *Proc. U. S. Nat. Mus.*, vol. 77, art. 6, p. 73, pl. 18, f. 2-4.

Remarks. — Compressed forms, distinctly belonging to *Globulina inaequalis*, appeared to be rare in our abundant Eocene *Globulina* material, but they are present throughout the entire column. Intermediates with the more globular *G. gibba* are much more abundant. In our material *G. inaequalis* was regarded as a compressed variant of *G. gibba*.

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
England : Upper Bracklesham beds, Barton beds;
France : Sands of Cuise, Lutetian;
Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel.

Globulina gibba (D'ORBIGNY) var. punctata D'ORBIGNY

Pl. VIII, fig. 8, 9; 96

Globulina punctata D'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 229, pl. 13, f. 7, 8 (Miocene; Vienna basin).
Globulina gibba (D'ORBIGNY) var. *punctata* D'ORBIGNY, CUSHMAN and OZAWA, 1930, *Proc. U. S. Nat. Mus.*, vol. 77, art. 6, p. 69, pl. 17, f. 4, 5; Y. LE CALVEZ, 1950, *Mém. Expl. Carte Géol. dét. France*, pt. 3, p. 20.
Globulina rugosa D'ORBIGNY, 1846, *Foram. foss. Vienne*, p. 229, pl. 13, f. 19, 20.

Remarks. — The specimens of this variety are distinct *Globulina gibba* with small granules of variable quantity. Sometimes the granules are coarser. Such variants resemble *G. gibba* (D'ORBIGNY) var. *tuberculata* D'ORBIGNY (1846, *Foram. foss. Vienne*, p. 230, pl. 13, f. 21, 22), but specimens with tubercles as coarse as those of the specimens figured by CUSHMAN and OZAWA (1930, *Proc. U. S. Nat. Mus.*, vol. 77, art. 6, p. 68, pl. 17, f. 6, 7) are extremely rare in our material.

CUSHMAN and OZAWA recognized the identity of *Globulina punctata* D'ORBIGNY and *G. rugosa* D'ORBIGNY, both from the Miocene of the Vienna basin. In the latter the granules would have to be arranged in longitudinal rows, in which this form differs from *G. punctata* with haphazard dispersion. This variant is a minor constituent in our *punctata* collection.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England : Barton beds;

France : Lutetian;

Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Lede.

***Globulina gibba* (D'ORBIGNY) var. *myristiformis* (WILLIAMSON)**

Pl. VIII, fig. 10; 168

Polymorphina myristiformis WILLIAMSON, 1858, Recent Foram. Gr. Britain, p. 73, pl. 6, f. 156, 157 (recent; Br. Isles); BRADY, 1884, Rep. Voy. Challenger, Zoology, vol. 9, p. 571, pl. 73, f. 9, 10.

Globulina gibba (D'ORBIGNY) var. *myristiformis* (WILLIAMSON), CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 66, pl. 16, f. 8, pl. 20, f. 6; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 18.

Lagena costata TERQUEM (not WILLIAMSON), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 27, pl. 1, f. 11 (Lutetian; Paris basin).

Polymorphina sulcata D'ORBIGNY, 1902, in FORNASINI, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. 10, p. 50, tf. 52 (recent; France).

Globulina gibba (D'ORBIGNY) var. *sulcata* (D'ORBIGNY), Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 18, pl. 4, f. 54, 55.

Remarks. — CUSHMAN and OZAWA noted that specimens from the Lutetian deposits of Grignon show heavier costae than typical specimens from the seas around Great Britain. The same applies to most of our Belgian specimens.

Distribution. — Belgium : Sands of Lede, Sands of Wemmel;

France : Lutetian.

***Globulina gravida* (TERQUEM)**

Pl. VIII, fig. 11; 116

Guttulina gravida TERQUEM, 1878, Mém. Soc. Géol. France, ser. 3, vol. 1, p. 47, pl. 4, f. 28-32 (Pliocene; Rhodes, Mediterranean); 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 135, pl. 14, f. 20-21.

Globulina gravida (TERQUEM), Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 20, pl. 1, f. 16-18.

Remarks. — CUSHMAN and OZAWA (1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 61) regarded *Globulina gravida* as a synonym of *G. gibba*. However, this species is distinguished from *G. gibba* by the more elongate and flask-like shape and the thickened hyaline wall surrounding the distinct apertural tube.

Some broader variants resemble *Globulina ampulla* (JONES) (*Polymorphina ampulla* JONES, 1852, Quart. Journ. Geol. Soc., vol. 8, p. 267, pl. 16, f. 14).

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels, Sands of Lede.

Globulina gravida (TERQUEM) var. **lineata** nov. var.

Pl. VIII, fig. 12; 219

E t y m o l o g y . — From Latin : *lineatio* = marking with lines.

D e s c r i p t i o n . — Variety differing from *Globulina gravida* (TERQUEM) in having the test ornamented by numerous, faint, longitudinal striae.

Length of the holotype 0,39 mm.

R e m a r k s . — The striae are sometimes interrupted at the sutures.

T y p e l o c a l i t y . — Boring at the New Barracks of the Artillery at Mechelen (1905) : our sample Mechelen 51.

T y p e l e v e l . — Basal layers of the Asse Clays. The age of these deposits is generally regarded to be Late Eocene.

D i s t r i b u t i o n . — Belgium : Sands of Wemmél, Clays of Asse.

D e p o s i t o r y . — The holotype and the paratypoids are stored in the collections of the Geological Institute of Utrecht (S 9609).

Genus PYRULINA D'ORBIGNY, 1839

Type species POLYMORPHINA GUTTA D'ORBIGNY, 1826

Pyrulina gutta (D'ORBIGNY)

91

Polymorphina gutta D'ORBIGNY, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 267, pl. 12, f. 5, 6 (Pliocene; Italy).
Pyrulina gutta (D'ORBIGNY), CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 51, pl. 13, f. 1; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 16.

R e m a r k s . — Owing to the bad preservation the first chambers of most of our specimens are not clear. Many of the individuals are only young ones, in which the biserial part is not yet distinctly developed.

Some scarce specimens resembling *Pyrulina polita* (TERQUEM) (*Polymorphina polita* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 139, pl. 14, f. 23-25) have been included.

D i s t r i b u t i o n . — Belgium : Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmél;

France : Lutetian;

Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels.

Pyrulina thouini (D'ORBIGNY)

Pl. VIII, fig. 13, 14; 119

Polymorphina thouini D'ORBIGNY, 1865, in PARKER, JONES and BRADY, Ann. Mag. Nat. Hist., vol. 16, ser. 3, pl. 2, f. 49 (Eocene; Paris basin); TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 142, pl. 14, f. 33.

Pyrulina thouini (D'ORBIGNY), CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 57, pl. 14, f. 6; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 17.

Remarks. — According to CUSHMAN and OZAWA *Pyrulina thouini* is one of the best defined species of *Pyrulina*. However, in our material distinct types of *P. thouini*, with the elongate chambers in the slender test, intergrade with shorter specimens assignable to *P. cylindroides* (ROEMER) (*Polymorphina cylindroides* ROEMER, 1839, N. Jahrb. Min., etc., p. 385, pl. 3, f. 26) with less elongate chambers. There is also intergradation with individuals resembling *P. fusiformis* (ROEMER) (*Polymorphina fusiformis* ROEMER, 1838, op. cit., p. 386, pl. 3, f. 37), as described by BATJES (1958, Mém. Inst. R. Sci. Nat. Belg., no. 143, p. 122, pl. 4, f. 3).

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England : Barton beds;

Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels, Sands of Lede.

Genus PSEUDOPOLYMORPHINA CUSHMAN and OZAWA, 1928

Type species PSEUDOPOLYMORPHINA HANZAWAI CUSHMAN and OZAWA, 1928

Pseudopolymorphina spatulata (TERQUEM)

83

Polymorphina spatulata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 142, pl. 14, f. 32 (Lutetian; Paris basin).

Pseudopolymorphina spatulata (TERQUEM), CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 105, pl. 27, f. 4, 5; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 23.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels.

Genus SIGMOMORPHINA CUSHMAN and OZAWA, 1928

Type species SIGMOMORPHINA KAGAENSIS CUSHMAN and OZAWA, 1928

Sigmomorphina sp. cf. **S. bornemanni** CUSHMAN and OZAWA

Pl. VIII, fig. 15, 16; 139

cf. *Sigmomorphina bornemanni* CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 134, pl. 36, f. 3 (Oligocene; Germany).

cf. *Polymorphina dilatata* REUSS (not D'ORBIGNY), 1851, Zeitschr. Deu. Geol. Ges., vol. 3, p. 83, pl. 6, f. 49 (Oligocene; Germany).

Remarks. — Most of our specimens are more slender than the typical, broad specimens of *Sigmomorphina bornemanni*. They also resemble *S. regularis* (ROEMER) (*Polymorphina regularis* ROEMER, 1839, N. Jahrb. Min., etc., p. 385, pl. 3, f. 21) as described by BATJES (1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 125, pl. 4, f. 2). They have a more produced initial end, which is often developed as a distinct spine, as it was figured by Y. LE CALVEZ for *S. apiculata* Y. LE CALVEZ (1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 24, pl. 4, f. 51-53).

Our specimens lack the ornamentation of the latter species, except for a few which did show very faint striae on the early part of the test.

Some specimens resemble *Sigmoidella*, in which each chamber embraces the previous ones. Especially *S. plummerae* CUSHMAN and OZAWA (1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 142, pl. 39, f. 3) is similar, but it has the chambers in a contraclockwise series.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel; Netherlands (Woensdrecht) : Sands of Brussels, Sands of Lede.

***Sigmomorphina semitecta* (REUSS)**

115

Polymorphina semitecta REUSS, 1867, Sitz. Ber. K. Akad. Wiss. Wien, vol. 55, pt. 1, p. 91, pl. 3, f. 10 (Miocene; Poland).

Sigmorphina semitecta (REUSS), CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus, vol. 77, art. 6, p. 129, pl. 33, f. 6, 7.

Polymorphina amygdaloides TERQUEM (not REUSS), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 141, pl. 14, f. 30, 31 (Lutetian; Paris basin).

Sigmomorphina amygdaloides (TERQUEM), Y. LE CALVEZ 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 24.

Remarks. — In the Belgian material we found *Sigmomorphina semitecta* as well as its variant *terquemiana* (FORNASINI) (*Polymorphina amygdaloides* REUSS var. *terquemiana* FORNASINI, 1900, Boll. Soc. Geol. Ital., vol. 19, p. 136).

Our elongate variants are identical with the forms described as *Sigmomorphina amygdaloides* (TERQUEM) by Y. LE CALVEZ.

Distribution. — Belgium : Sands of Brussels, Sands of Lede; Netherlands (Woensdrecht) : Lower Panisel beds.

Genus GLANDULINA D'ORBIGNY, 1839

Type species NODOSARIA (GLANDULINA) LAEVIGATA D'ORBIGNY, 1826

***Glandulina laevigata* (D'ORBIGNY)**

Pl. VIII, fig. 17; 102

Nodosaria (Glandulina) laevigata D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 252, pl. 10, f. 1-3 (recent; Adriatic, and Pliocene; Italy).

Glandulina laevigata (D'ORBIGNY), D'ORBIGNY, 1846, Foram. foss. Vienne, p. 29, pl. 1, f. 4, 5; CUSHMAN and OZAWA, 1930, Proc. U. S. Nat. Mus., vol. 77, art. 6, p. 143, pl. 40, f. 1; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 123, pl. 4, f. 7, 8.

Remarks. — BATJES described the variability of the species by enumeration of a number of types of species of BORNEMANN and REUSS, which he had found in the Oligocene material. These types are also present in our material of the Eocene of Belgium and England. Furthermore we encountered individuals described by BANDY (1949, Bull. Am. Pal., vol. 32, no. 131) as *Glandulina elliptica* REUSS (p. 49, pl. 6, f. 12), *G. laevigata* (D'ORBIGNY) (p. 49, pl. 6, f. 13), *G. occidentalis* (CUSHMAN) (p. 49, pl. 6, f. 14) and *G. ovata* CUSHMAN (p. 50, pl. 6, f. 15), all from the Jackson Eocene of Alabama. It appeared impossible to make a specific distinction between these forms, which are all regarded as variants of *G. laevigata*.

Furthermore a number of single specimens was found, resembling *Glandulina aequalis* REUSS (1863, Sitz. ber. K. Akad. Wiss. Wien, vol. 48, p. 48, pl. 3, f. 28) as described by BATJES (1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 123, pl. 4, f. 5, 6). These forms occur together with those of *G. laevigata*. They may also be variants of our *G. laevigata*.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Lede, Sands of Wemmel, Clays of Asse;
England : Barton beds.

Genus DIMORPHINA D'ORBIGNY, 1826

Type species DIMORPHINA TUBEROSA D'ORBIGNY, 1826

Dimorphina sp.

Pl. VIII, fig. 18; 204

Remarks. — The microspheric specimens of this peculiar *Dimorphina* resemble *Dimorphina danvillensis* HOWE and WALLACE (1932, Louis. Dept. Cons., Geol. Bull., no. 2, p. 44, pl. 8, f. 1), but the initial end is more acuminate and the aperture is central, also in the uniserial stages, instead of eccentric as in the figure of HOWE and WALLACE.

The macrospheric specimens, however, lack the triserial stage and begin biserially like *Glandulina*. These specimens resemble *G. aequalis* REUSS, but the initial biserial part is much longer, and the chambers are mostly less high.

Distribution. — Belgium : Sands of Lede, Sands of Wemmel.

FAMILY BULIMINIDAE

SUBFAMILY TURRILININAE

Genus TURRILINA ANDREAE, 1884

Type species TURRILINA ALSATICA ANDREAE, 1884

Turrilina brevispira TEN DAM

Pl. IX, fig. 1; 61

Turrilina brevispira TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 110, pl. 3, f. 4 (Eocene; the Netherlands).

Remarks. — The final coil of our specimens is less high than it is in the individual figured by TEN DAM. The aperture at the base of the chamber is separated from the margin by a slight lip.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle;
Netherlands (Woensdrecht) : Clays of Ieper.

Genus BULIMINELLA CUSHMAN, 1911

Type species BULIMINA ELEGANTISSIMA D'ORBIGNY, 1839

Buliminella sp. cf. **B. pulchra** (TERQUEM)

Pl. IX, fig. 2; 77

cf. *Bulimina pulchra* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 114, pl. 12, f. 9-12 (Lutetian; Paris basin).

cf. *Buliminella pulchra* (TERQUEM), CUSHMAN and PARKER, 1947, U. S. Geol. Survey, Prof. Paper 210-D, p. 61, pl. 16, f. 5, 6; Y. LE CALVEZ, 1950, Mém. Expl. Carte Geol. dét. France, pt. 3, p. 33, pl. 2, f. 21, 22.

Remarks. — It appeared difficult to separate our ill-preserved specimens between *Buliminella pulchra* and *B. elegantissima* (D'ORBIGNY) (*Bulimina elegantissima* D'ORBIGNY, 1839, Voy. Am. Mér., Foram., vol. 5, pt. 5, p. 51, pl. 7, f. 13, 14), the latter as figured by BOWEN (1957, Micropal., vol. 3, p. 54, pl. 1, f. 17) from the Upper Eocene of England, and by BHATIA (1955, Jour. Pal., vol. 29, p. 679, pl. 66, f. 11) from the Oligocene of Wight.

Only some of the specimens of the Lede Sands and of the Wemmél Sands show the great relative size of the last coil with long and narrow chambers, as it is typical for *Buliminella pulchra*.

Distribution. — Belgium : Clays of Roubaix, Sands of Brussels, Sands of Lede, Sands of Wemmél;

France : Lutetian.

Buliminella striatopunctata (TERQUEM)

131

Bulimina striato-punctata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 116, pl. 12, f. 19 (Lutetian; Paris basin).

Buliminella striato-punctata (TERQUEM), Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 30, pl. 2, f. 29, 30.

Remarks. — This species is only represented by some young specimens.

Distribution. — Belgium : Sands of Brussels, Sands of Lede;

France : Lutetian.

Buliminella sp.

Remarks. — In two samples from the Sands of Mons-en-Pévèle at Mont-Saint-Aubert a number of *Buliminella* specimens was found, which resemble Cretaceous species, such as *B. imbricata* (REUSS) (*Bulimina imbricata* REUSS, 1851, Haidinger's Naturw. Abh., vol. 4, p. 22, pl. 3, f. 7) and *B. cushmani* SANDIDGE (1932, Jour. Pal., vol. 6, p. 280, pl. 42, f. 18, 19).

An exact specific determination is impossible, because all specimens are damaged and are without the early whorls.

Probably they had been redeposited from the Cretaceous. Both samples also contained a number of *Globotruncana* specimens.

SUBFAMILY BULIMININAE

Genus BULIMINA D'ORBIGNY, 1826

Type species BULIMINA MARGINATA D'ORBIGNY, 1826

Bulimina parisiensis nov. nom.

Pl. VIII, fig. 19, pl. IX, fig. 3, 4; 66

Bulimina trigona CUSHMAN and TODD (not TERQUEM), 1945, Contr. Cushm. Lab. Foram. Res., vol. 21, p. 17, pl. 4, f. 6 (Lutetian; Paris basin); CUSHMAN and PARKER, 1947, U. S. Geol. Survey, Prof. Paper 210-D, p. 91, pl. 21, f. 18; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 37, pl. 3, f. 35.

E t y m o l o g y . — Named after Paris.

R e m a r k s . — The type-specimens of *Bulimina trigona* TERQUEM (1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 110, pl. 11, f. 28, 29) were restudied by Y. LE CALVEZ. They appeared to belong to *Valvulina*. However, the name has also been used for a distinct *Bulimina* species.

This species is characterized by the great relative size of the last coil and by the rounded aperture.

In the Belgian Eocene material, however, there are some specimens with a less prominent last whorl, which are commonly also slightly more elongate. They resemble *Bulimina candida* TERQUEM (1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 111, pl. 11, f. 30, 31), as re-figured by Y. LE CALVEZ (1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 35, pl. 3, f. 39). Complete intergradation between these two types was found. Unfortunately *B. candida* in TERQUEM's collections appears to be based on a single broken specimen (Y. LE CALVEZ, p. 35). For this reason a new name is given to the *trigona* type, which is more general.

D i s t r i b u t i o n . — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

France : Lutetian;

Netherlands (Woensdrecht) : Sands of Aalter, Sands of Lede.

Bulimina tenuistriata TERQUEM

Pl. IX, fig. 5; 137

Bulimina tenui-striata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 118, pl. 12, f. 24, 25 (Lutetian; Paris basin); CUSHMAN and PARKER, 1947, U. S. Geol. Survey, Prof. Paper 210-D, p. 91, pl. 21, f. 17; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 36, pl. 3, f. 36, 37.

R e m a r k s . — Generally, the specimens of the Belgian Eocene and the Lutetian of the Paris basin are in good accordance with those figured in the references above. However, some specimens are slightly more elongate.

The generic determination of this species may be doubted. CUSHMAN and PARKER already remarked that it is not advisable to place *Bulimina tenuistriata* in *Buliminella*, because of the lack of a distinct spiral suture. The ventral face resembles that of species of *Glabratella* DORREEN, but our species is much more elongate.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel;
France : Lutetian;
Netherlands (Woensdrecht) : Sands of Brussels.

***Bulimina ovata* D'ORBIGNY**

Pl. IX, fig. 6; 225

Bulimina ovata D'ORBIGNY, 1846, Foram. foss. Vienne, p. 185, pl. 11, f. 13, 14 (Miocene; Vienna basin);
TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 111, pl. 3, f. 10, 11; CUSHMAN and
PARKER, 1947, U. S. Geol. Survey, Prof. Paper 210-D, p. 106, pl. 25, f. 8, 9; MARKS, 1951, Contr.
Cushm. Found. Foram. Res., vol. 2, p. 57.

Remarks. — MARKS found that in most Austrian Miocene specimens of *Bulimina ovata* the last whorl forms about half of the test. In our Eocene material this is often a much greater part, but specimens identical with those from Austria are present as well.

The lips on either side of the apertural slit are distinct in our material; furthermore a tooth is often discernible.

Distribution. — Belgium : Sands of Wemmel, Clays of Asse.

SUBFAMILY REUSSELLINAE

Genus REUSSELLA GALLOWAY, 1933

Type species VERNEUILINA SPINULOSA REUSS, 1850

***Reussella elongata* (TERQUEM)**

Pl. IX, fig. 7-9; 78

Verneuilina elongata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 106, pl. 11, f. 13 (Lutetian; Paris basin).

Reussella elongata (TERQUEM), CUSHMAN, 1945, Contr. Cushm. Lab. Foram. Res., vol. 21, p. 27, pl. 5, f. 10, 11; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 46, pl. 3, f. 45, 46.

Remarks. — Most of the Belgian Eocene specimens are shorter than those figured previously. However, such shorter individuals appeared to be also the most frequent forms in the type deposits of the Lutetian of the Paris basin. They more or less resemble the form figured by CUSHMAN (1945, Contr. Cushm. Lab. Foram. Res., vol. 21, pl. 5, f. 7) as *Reussella oberburgensis* (FREYER) (*Verneuilina oberburgensis* FREYER, 1864, in REUSS, Denkschr. K. Akad. Wiss. Wien, vol. 23, p. 6, pl. 1, f. 2).

The test is rather variable, especially in the character of the borders. Typical individuals seem to be angular, but specimens with more obtuse angles occur as well.

The apertural area is formed by the inflated tops of the last three chambers, which are covered by striae, which radiate from the apertural opening in the centre. Such striae occur also in *Reussella secans* Y. LE CALVEZ (1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 48, pl. 3, f. 47, 48), which is only a keeled variant of *R. elongata*.

Distribution. — Belgium : Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England : Upper Bracklesham beds, Barton beds;
 France : Lutetian;
 Netherlands (Woensdrecht) : Sands of Brussels.

Reussella limbata (TERQUEM)

Pl. VIII, fig. 20, 21, pl. IX, fig. 10; 184

Verneuilina limbata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 105, pl. 11, f. 12 (Lutetian; Paris basin).

Reussella limbata (TERQUEM), Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 47, pl. 3, f. 49, 50.

Remarks. — The triserial arrangement of the chambers gets lost in the later part of the test, in which the more or less uniserial arrangement is less distinct than it is in *Chrysalidinella*.

The apertural face of adult specimens is formed by two or by one chamber(s). In the first case the aperture is a slit in between the perforated, flattened tops of the two chambers. When only one chamber forms the apertural face it is formed by the perforated top with the slit-like aperture alongside. The slit is sometimes bordered by a thickened rim. The thin, finely perforated top is often broken, leaving a large opening, as it was figured by Y. LE CALVEZ.

The peripheral borders are mostly angular, and interrupted by downward projecting spines at the lower end of the chambers. Some specimens lack these interruptions, and the peripheral borders may be more or less rounded and thickened.

Distribution. — Belgium : Sands of Lede, Sands of Wemmel, Clays of Asse;
 France : Lutetian;
 Netherlands (Woensdrecht) : Sands of Lede.

Reussella terquemi CUSHMAN

Pl. IX, fig. 11; 123

Verneuilina spinulosa TERQUEM (not REUSS), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 107, pl. 11, f. 16 (Lutetian; Paris basin).

Reussella terquemi CUSHMAN, 1945, Contr. Cushm. Lab. Foram. Res., vol. 21, p. 28, pl. 5, f. 15, 16; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 48.

Remarks. — The species differs from *Reussella spinulosa* by its shorter test, its smaller size, and the less developed spinose projections. As in *R. spinulosa* (REUSS) (*Verneuilina spinulosa* REUSS, 1850, Denkschr. K. Ak. Wiss. Wien, vol. 1, p. 374, pl. 47, f. 12) the species includes spinulose forms and smoother types.

Distribution. — Belgium : Sands of Brussels, Sands of Lede;
 France : Lutetian.

Reussella obtusa (TERQUEM)

84

Verneuilina obtusa TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 106, pl. 11, f. 14, 15 (Lutetian; Paris basin).

Reussella obtusa (TERQUEM), CUSHMAN, 1945, Contr. Cushm. Lab. Foram. Res., vol. 21, p. 27, pl. 5, f. 12-14; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 48.

Distribution. — Belgium : Sands of Mons-en-Pévèle;
 France : Lutetian.

SUBFAMILY BOLIVININAE

Genus BOLIVINA D'ORBIGNY, 1839

Type species BOLIVINA PLICATA D'ORBIGNY, 1839

Bolivina carinata TERQUEM

Pl. IX, fig. 12-14; 88

Bolivina carinata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 149, pl. 15, f. 19 (Lutetian; Paris basin); CUSHMAN, 1937, Cushman Lab. Foramin. Res., Spec. Publ. no. 9, p. 46, pl. 6, f. 14-16; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 42.

Remarks. — Associated with relatively short individuals, as figured by TERQUEM and CUSHMAN, longer ones occur, with the greater breadth in the last part of the test. The slight median ridge, mentioned by CUSHMAN, was found in a number of specimens, but it appeared to be absent in most of our individuals, especially in younger ones. Usually the chambers fairly rapidly increase in size.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel;
France : Lutetian;
Netherlands (Woensdrecht) : Sands of Brussels.

Bolivina brabantica nov. sp.

Pl. VIII, fig. 22; 110

Etymology. — Named after the Belgian province Brabant.

Description. — Test about two to three times as long as broad; periphery rounded; chambers comparatively few, slightly, if at all inflated, increasing rapidly in relative height as added, in the last formed chambers height and breadth about equal; sutures distinct, oblique, slightly curved; wall strongly perforated, the early portion ornamented with numerous, very fine, longitudinal striae; aperture an elongate narrow opening, with a slight lip.

Length of the holotype, 0,42 mm, breadth, 0,19 mm, thickness 0,11 mm.

Remarks. — This new species differs from *Bolivina budensis* (HANTKEN) (*Textilaria budensis* HANTKEN, 1857, Magy. kir. földt. int. évkönyve, vol. 4, p. 57, pl. 15, f. 1) by the thicker test, the rounded periphery, the coarser perforations, and the presence of striae on the early portion of the test.

Some variants resemble *Bolivina jacksonensis* CUSHMAN and APPLIN (1926, Bull. Am. Ass. Petr. Geol., vol. 10, p. 167, pl. 7, f. 3, 4) and its variety *striatella* CUSHMAN and APPLIN (1926, ibid., p. 167, pl. 7, f. 5, 6), which, however, both have a subacute periphery, numerous chambers, and a finely perforated wall.

Type locality. — Quarry of the so-called « Grès de Gobertange », NE of Lathuy, Brabant (our sample WA 1139).

Type level. — The Sands of Brussels. These deposits are generally regarded as to be of Middle Eocene age.

Distribution. — Belgium : Sands of Brussels; Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels.

Depository. — The holotype and paratypoids are stored in the collections of the Geological Institute of Utrecht (S 10254, 10255).

***Bolivina crenulata* CUSHMAN**

Pl. IX, fig. 15-17; 78

Bolivina crenulata CUSHMAN, 1936, Cushm. Lab. Foram. Res., Spec. Publ. no. 6, p. 50, pl. 7, f. 13 (Eocene; Hungary); 1937, Cushm. Lab. Foram. Res., Spec. Publ. no. 9, p. 53, pl. 6, f. 33, 34.

Remarks. — Most of our specimens, considered to belong to this species, are more tapering than the individuals figured by CUSHMAN.

The re-entrants are always arranged in longitudinal rows, the ridges in between are sometimes obscure. Our specimens also resemble *Bolivina plicatella* CUSHMAN (1930, Florida State Geol. Survey, Bull. 4, p. 46, pl. 8, f. 10), and especially its variety *mera* CUSHMAN and PONTON (1932, Florida State Geol. Survey, Bull. 9, p. 82, pl. 12, f. 4), with less pronounced crenulate sculpture of the test.

Distribution. — Belgium : Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse; Netherlands (Woensdrecht) : Sands of Brussels.

***Bolivina anglica* CUSHMAN**

Pl. IX, fig. 18, 19; 48

Bolivina anglica CUSHMAN, 1936, Cushm. Lab. Foram. Res., Spec. Publ. no. 6, p. 50, pl. 7, f. 11 (Eocene; England); 1937, Cushm. Lab. Foram. Res., Spec. Publ. no. 9, p. 45, pl. 6, f. 10.

Bolivina punctata SHERBORN and CHAPMAN (not D'ORBIGNY), 1886, Journ. Roy. Micr. Soc., ser. 2, vol. 6, p. 743, pl. 14, f. 10 (Eocene; England); BOWEN, 1954, Proc. Geol. Ass., vol. 65, p. 139.

Remarks. — Our Eocene individuals are characterized by oblique to strongly oblique sutures, an elongate, tapering test, and a loop-shaped aperture. They resemble *Bolivina anglica* especially if the description is taken into account. BOWEN's *B. punctata* is considered to belong to *B. anglica*.

A number of our individuals described as *Bolivina pulchra* resemble *B. anglica*, but they have more or less crenulate and less oblique sutures.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse; Netherlands (Woensdrecht) : Clays of Ieper.

***Bolivina pulchra* (TERQUEM)**

Pl. VIII, fig. 23, 24; 75

Bulimina pulchra TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 114, pl. 12, f. 8 (Lutetian; Paris basin).

Bolivina pulchra (TERQUEM), Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 43, pl. 3, f. 43, 44.

R e m a r k s . — *Bolivina pulchra* is characterized by slightly crenulate sutures near the central axis. The sutures are often nearly horizontal and straight.

D i s t r i b u t i o n . — Belgium : Clays of Roubaix, Sands of Mons-en-Pévèle.

***Bolivina cookei* CUSHMAN**

Pl. VIII, fig. 25, 26; 218

Bolivina cookei CUSHMAN, 1922, U. S. Geol. Survey, Prof. Paper 129-F, p. 126, pl. 29, f. 1 (Oligocene; Mississippi); 1937, Cushm. Lab. Foram. Res., Spec. Publ. no. 9, p. 68, pl. 8, f. 15.

R e m a r k s . — Most of our specimens show slightly more curved sutures than is indicated by CUSHMAN, but in other features they closely resemble the original figures of the species.

Some variation was noted in the development of the costae. They may be thin, and only present on the earliest chambers. Mostly, however, they cover all chambers, with the exception of the last two. In a number of specimens, especially those from the Clays of Asse, they are very numerous and thus obscure the sutures. These variants are also somewhat more coarsely perforated and they show less curved sutures.

Bolivina cookei differs from *B. vaccki* SCHUBERT (1902, Beitr. Pal. Geol. Osterreich-Ungarns, etc., vol. 14, p. 25, pl. 1, f. 29) by the higher chambers, the less oblique sutures and the absence of a more strongly developed median ridge.

D i s t r i b u t i o n . — Belgium : Sands of Wemmél, Clays of Asse.

Genus LOXOSTOMUM EHRENBURG, 1854

Type species LOXOSTOMUM SUBROSTRATUM EHRENBURG, 1854

***Loxostomum teretum* CUSHMAN**

Pl. IX, fig. 20; 227

Loxostomum teretum CUSHMAN, 1936, Cushm. Lab. Foram. Res., Spec. Publ. no. 6, p. 60, pl. 8, f. 14 (Oligocene; France); 1937, Cushm. Lab. Foram. Res., Spec. Publ. no. 9, p. 179, pl. 21, f. 1, 2; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 133, pl. 5, f. 17.

R e m a r k s . — It is probable that the types of *Loxostomum teretum* are juvenile specimens. In our larger individuals the test is about six times as long as broad, and often slightly twisted. They resemble *Bolivina semistriata* HANTKEN (1868, Magy. Földt. tars. munk., vol. 4, p. 95, pl. 2, f. 34), which is different by the horizontal sutures and the rapid increase in relative height of the chambers.

D i s t r i b u t i o n . — Belgium : Sands of Wemmél, Clays of Asse.

SUBFAMILY UVIGERININAE

Genus UVIGERINA D'ORBIGNY, 1826

Type species UVIGERINA PIGMEA D'ORBIGNY, 1826

Uvigerina farinosa HANTKEN

Pl. IX, fig. 21; 212

Uvigerina farinosa HANTKEN, 1875, Jahrb. K. Ungar. Geol. Anstalt, Mitt., vol. 4, pt. 1, p. 62, pl. 7, f. 6 (Eocene; Hungary); CUSHMAN and EDWARDS, 1937, Contr. Cushman Lab. Foramin. Res., vol. 13, p. 58, pl. 8, f. 8, 9.

Remarks. — Our specimens show a hispid surface of the test, a relatively short apertural neck, and in adult specimens the tendency to become uniserial. Only some full-grown specimens of the Asse Clays show this last feature; in others the last-formed chambers are triserial or more or less biserial. Most specimens are distinctly hispid, but the granules may be arranged in more or less distinct, longitudinal rows, which resemble broken, longitudinal costae.

Smaller specimens are not distinctly different from *Uvigerina batjesi*, except for the wall which is less hispid in *U. batjesi*.

Distribution. — Belgium : Sands of Lede, Sands of Wemmel, Clays of Asse.

Uvigerina spinicostata CUSHMAN and JARVIS

Pl. IX, fig. 22; 225

Uvigerina spinicostata CUSHMAN and JARVIS, 1929, Contr. Cushman Lab. Foramin. Res., vol. 5, p. 12, pl. 3, f. 9, 10 (Eocene; Trinidad); CUSHMAN and EDWARDS, 1937, Contr. Cushman Lab. Foramin. Res., vol. 13, p. 83, pl. 12, f. 11, 12.

Remarks. — Just as our *Uvigerina farinosa*, the individuals of this species show the tendency to become uniserial or biserial in the adult. The costae on the basal portions of the chambers are sometimes broken up, forming short spines. This is also known of the American representatives of this species. Sometimes the surface of the last chamber lacks costae, being smooth or hispid.

The surface of the apertural neck has an ornamentation of oblique costae, just as may be seen in the figures of CUSHMAN and EDWARDS.

Probably *Uvigerina seriata* CUSHMAN and JARVIS (1929, Contr. Cushman Lab. Foramin. Res., vol. 5, p. 13, pl. 3, f. 11, 12) is a variant of *U. spinicostata* with a greater tendency to become uniserial and with less plate-like costae. Such individuals were also found in our material.

The relation with our similar *Uvigerina farinosa* is not clear. There is no intergradation.

Distribution. — Belgium : Sands of Wemmel, Clays of Asse.

Uvigerine batjesi nov. sp.

Pl. VIII, fig. 27, 28, pl. IX, fig. 23; 37

Uvigerina rugosa TEN DAM (not TERQUEM), 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 115, pl. 3, f. 13.

E t y m o l o g y . — Named after Dr. D. A. J. BATJES, author of the monograph on the Belgian Oligocene foraminifera.

D e s c r i p t i o n . — Test elongate, about three times as long as broad, initial end subacute to rounded, microspheric form tapering, macrospheric form quickly reaching its full breadth; periphery slightly lobulate; chambers numerous, inflated; sutures rather indistinct in the early portion, later distinct and depressed; wall smooth or finely hispid, very finely perforated; aperture with a short neck and a slight lip.

Dimensions of the holotype : length, 0,38 mm; breadth, 0,13 mm.

R e m a r k s . — TERQUEM (1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 120, pl. 12, f. 32) described *Uvigerina rugosa* as a species with a roughened surface and a short tubular neck. Y. LE CALVEZ (1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 49) restudied the types of the species and found them to be variants of *Angulogerina abbreviata* (TERQUEM), especially because of the terminal aperture without a neck.

The specimens of the Lower Eocene of Belgium show a looser arrangement of the more inflated chambers than *Angulogerina abbreviata*. They are more finely perforated and have a distinct apertural neck.

Uvigerina batjesi differs from *U. farinosa* HANTKEN by the absence of a more or less distinct longitudinal arrangement of the spinose projections. Young specimens of *U. farinosa* resemble *U. batjesi*, but differ in the rougher appearance of the wall.

Uvigerina batjesi differs from *U. minuta* CUSHMAN and STONE (1949, Contr. Cushman Lab. Foram. Res., vol. 25, p. 54, pl. 10, f. 5, 6) by the more elongate test and the less coarsely hispid wall.

T y p e l o c a l i t y . — A hollow roadside NE of Mont-Saint-Aubert; our sample DH 1210.

T y p e l e v e l . — The Sands of Mons-en-Pévèle. These deposits are generally regarded as to be of Early Eocene age.

D i s t r i b u t i o n . — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle;
Netherlands (Woensdrecht) : Clays of Ieper.

D e p o s i t o r y . — The holotype and the paratypoids are stored in the collections of the Geological Institute of Utrecht (S 10486-10488).

Genus *ANGULOGERINA* CUSHMAN, 1927Type species *UVIGERINA ANGULOSA* WILLIAMSON, 1848***Angulogerina abbreviata* (TERQUEM)**

Pl. VIII, fig. 29, 30, pl. IX, fig. 24; 46

Uvigerina abbreviata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 120, pl. 12, f. 33 (Lutetian; Paris basin); CUSHMAN and EDWARDS, 1937, Contr. Cushm. Lab. Foram. Res., vol. 13, p. 56, pl. 8, f. 6, 7.

Angulogerina abbreviata (TERQUEM), Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 49.

Uvigerina rugosa TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 120, pl. 12, f. 32 (Lutetian; Paris basin).

Remarks. — The aperture is surrounded by a more or less flaring lip.

Some of our specimens resemble *Uvigerina farinosa*, which, however, shows much more inflated chambers and a more roughened aspect of the wall.

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

France : Lutetian;

Netherlands (Woensdrecht) : Clays of Ieper, Sands of Brussels.

***Angulogerina abbreviata* (TERQUEM) var. *tubulifera* nov. var.**

Pl. X, fig. 1, 2; 207

Etymology. — From Latin : *tubulus* = small tube.

Description. — Variety differing from the species by the more elongate test, the crenulate sutures, and the distinct apertural neck.

Dimensions of the holotype : length, 0,47 mm; breadth, 0,14 mm.

Remarks. — Our variety differs from *Uvigerina wilcoxensis* CUSHMAN and GARRETT (1939, Contr. Cushm. Lab. Foram. Res., vol. 15, p. 82, pl. 14, f. 17, 18) by the more elongate test, and the absence of slight ridges on the lower part of the chambers. *Uvigerina alabamensis* CUSHMAN and GARRETT (1939, op. cit., vol. 15, p. 83, pl. 14, f. 26, 27) does not show the crenulations, nor does *U. russelli* HOWE (Louisiana Dept. Cons., Geol. Bull., no. 14, p. 71, pl. 8, f. 21, 22).

Type locality. — Claypit of the « N. V. Steenbakkerijen van Oedelem » at Oedelem : our sample BRB 237.

Type level. — The Clays of Asse. The age of these deposits is commonly regarded as to be Late Eocene.

Distribution. — Belgium : Sands of Lede, Sands of Wemmel, Clays of Asse; Netherlands (Woensdrecht) : Sands of Wemmel.

Depository. — The holotype and the paratypoids are stored in the collections of the Geological Institute at Utrecht (S 10412, 10413).

Angulogerina muralis (TERQUEM)

Pl. X, fig. 3, 4; 93

Uvigerina muralis TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 119, pl. 12, f. 26-29 (Lutetian; Paris basin).

Angulogerina muralis (TERQUEM), CUSHMAN, 1937, Contr. Cushm. Lab. Foram. Res., vol. 13, p. 55, pl. 8, f. 3-5; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 49.

Remarks. — Some variation was found in the excavations at the base of the chambers. In most specimens they are not as deep as they are in TERQUEM's figures. The angles of the test are more or less rounded.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels.

Angulogerina sp. cf. A. ovata (TERQUEM)

Pl. X, fig. 5; 124

cf. *Tritaxia ovata* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 105, pl. 11, f. 11 (Lutetian; Paris basin).

Remarks. — According to Y. LE CALVEZ (1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 18) the type of this species has been lost. Our specimens resemble both the description and the figures given by TERQUEM, and it seems very probable that TERQUEM's species is an *Angulogerina*.

Our individuals differ from the Upper Eocene *Trifarina* species by the lack of distinct uniserial chambers, although the tendency to become uniserial was noted among some elongate specimens. They furthermore lack the furrow along the peripheral angles, as well as the pores along the sutures.

The state of preservation of our specimens is too bad for a complete description.

Distribution. — Belgium : Sands of Brussels.

Genus TRIFARINA CUSHMAN, 1923

Type species TRIFARINA BRADYI CUSHMAN, 1923

Trifarina wilcoxensis (CUSHMAN and PONTON)

Pl. X, fig. 6, 7; 144

Pseudouvigerina wilcoxensis CUSHMAN and PONTON, 1932, Contr. Cushm. Lab. Foram. Res., vol. 8, p. 66, pl. 8, f. 18 (Eocene; Alabama).

Angulogerina wilcoxensis (CUSHMAN and PONTON), CUSHMAN and GARRETT, 1939, Contr. Cushm. Lab. Foram. Res., vol. 15, p. 84, pl. 14, f. 24, 25.

Trifarina wilcoxensis (CUSHMAN and PONTON), BANDY, 1949, Bull. Am. Pal., vol. 32, no. 131, p. 145, pl. 27, f. 1.

Remarks. — In adult specimens the last two or three chambers are distinctly uniserial.

BANDY remarked that this species is different from *Trifarina bradyi* CUSHMAN (1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 99, pl. 22, f. 3-9) and its variety *advena* CUSHMAN (1926, Contr. Cushm. Lab. Foram. Res., vol. 1, p. 87) in the canaliculate character of the periphery. This feature is distinct in almost all Belgian specimens, but the furrow begins anew along each chamber, and it is sometimes absent along the first-formed chambers. Our specimens resemble furthermore those of BANDY because of its distinct rows of pores along the strongly curved sutures.

Distribution. — Belgium : Sands of Lede, Sands of Wemmél, Clays of Asse;
France : Lutetian.

Genus TUBULOGENERINA CUSHMAN, 1927

Type species TEXTULARIA (BIGENERINA) TUBULIFERA PARKER and JONES, 1863

Tubulogenerina tubulifera (PARKER and JONES)

142

Textularia (Bigenerina) tubulifera PARKER and JONES, 1863, Ann. Mag. Nat. Hist., ser. 3, vol. 11, p. 94, tf. 2 (Lutetian; Paris basin).

Tubulogenerina tubulifera (PARKER and JONES), CUSHMAN, 1937, Cushm. Lab. Foram. Res., Spec. Publ. no. 9, p. 215, pl. 24, f. 14-16; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 46.

Clavulina eocaenica TERQUEM (not GÜMBEL), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 121, pl. 12, f. 35 (Lutetian; Paris basin).

Distribution. — Belgium : Sands of Brussels, Sands of Wemmél;
France : Lutetian.

Genus BIFARINA PARKER and JONES, 1872

Type species DIMORPHINA SAXIPARA EHRENBERG, 1854

Bifarina selseyensis (HERON-ALLEN and EARLAND)

Pl. X, fig. 8, 9, 10; 193

Bigenerina selseyensis HERON-ALLEN and EARLAND, 1909, Jour. Roy. Micr. Soc. London, p. 330, pl. 15, f. 15-17 (? Eocene; England).

Siphogenerina hexagona HALKYARD, 1918, Mem. Proc. Manchester Lit. Philos. Soc., vol. 62, pt. 2, p. 41, pl. 6, f. 5 (Eocene; Biarritz, France).

Remarks. — Most of our specimens of the Belgian and English Eocene show a very short triserial beginning of the test. In the English specimens the biserial part is followed by two or three irregularly uniserial chambers. In the Belgian material no specimens with a distinct uniserial part were found, but the last chambers of full-grown specimens show the tendency to become uniserial. In other respects the Belgian and English specimens are identical, and they resemble very well HERON-ALLEN and EARLAND's figures of *Bigenerina selseyensis*.

The aperture has a distinct collar-like lip, surrounding a very finely perforated plate, at the border of which a small slit is the only opening. The same type of aperture is indicated by CUSHMAN for *Bifarina reticulosa* CUSHMAN (1936, Cushm. Lab. Foram. Res., Spec. Publ. no. 6, p. 61, pl. 8, f. 17). The latter species also has about the same type of ornamentation as ours, but the reticulation of *B. reticulosa* is somewhat coarser than in our *B. selseyensis*.

BHATIA (1955, Jour. Pal., vol. 29, p. 680, pl. 66, f. 16) described specimens referable to our *Bifarina selseyensis* as *Bitubulogenerina reticulata* CUSHMAN (1936, Cushm. Lab. Foram. Res., Spec. Publ. no. 6, p. 62, pl. 8, f. 21). Probably both species are identical. Like *B. reticulata* our species sometimes shows a short and stout spine at the initial end, but mostly such a spine is absent.

The generally described differences between *Bifarina* and *Bitubulogenerina* seem to be more or less illusionary for our specimens.

Distribution. — Belgium : Sands of Lede, Sands of Wemmels, Clays of Asse;
England : Upper Bracklesham beds;
Netherlands (Woensdrecht) : Sands of Lede.

SUBFAMILY ROBERTININAE

Genus ROBERTINA D'ORBIGNY, 1846

Type species ROBERTINA ARCTICA D'ORBIGNY, 1846

Robertina germanica CUSHMAN and PARKER

Pl. X, fig. 11, 12; 210

Robertina germanica CUSHMAN and PARKER, 1938, Contr. Cushm. Lab. Foram. Res., vol. 14, p. 73, pl. 13, f. 2 (Oligocene; Germany); 1947, U. S. Geol. Survey, Prof. Paper 210-D, p. 73, pl. 18, f. 5.

Remarks. — Our specimens fairly well resemble the type figures, especially in the apertural characters.

The length of the test is variable. Some specimens are elongate like *Robertina mcguirti* HOWE (1939, Louisiana Dept. Cons., Geol. Bull. no. 14, p. 82, pl. 8, f. 23, 24). Just as in this species the earlier whorls of the test are hardly visible. In some specimens the narrow aperture lies in a groove.

Five to eight pairs of chambers are found in the final coil; the sutures are mostly slightly limbate and slightly, if at all, depressed. Specimens with more depressed sutures resemble *Robertina ovigera* CUSHMAN and PARKER (1936, Contr. Cushm. Lab. Foram. Res., vol. 12, p. 98, pl. 16, f. 15) from the Lutetian of the Paris basin, but they differ because of the flattened apertural face and the greater average number of chambers per coil.

Distribution. — Belgium : Sands of Lede, Sands of Wemmels, Clays of Asse;
England : Barton beds.

FAMILY CHILOSTOMELLIDAE

Genus PULLENIA PARKER and JONES, 1862

Type species NONIONINA BULLOIDES D'ORBIGNY, 1846

Pullenia quinqueloba (REUSS)

Pl. XI, fig. 1, 2; 59

Nonionina quinqueloba REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 71, pl. 5, f. 31 (Oligocene; Germany).
Pullenia quinqueloba (REUSS), CUSHMAN and TODD, 1943, Contr. Cushm. Lab. Foram. Res., vol. 19, p. 10, pl. 2, f. 5, pl. 3, f. 8; TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 128; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 139, pl. 6, f. 8.

Remarks. — Generally the periphery is slightly lobulate. Some specimens were noted with six chambers in the final coil.

A number of specimens have a slightly more compressed test than is typical for the species; they are perhaps referable to as *Pullenia quinqueloba* (REUSS) var. *angusta* CUSHMAN and TODD (1943, Contr. Cushm. Lab. Foram. Res., vol. 19, p. 10, pl. 2, f. 3, 4).

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle, Sands of Lede, Sands of Wemmél, Clays of Asse;
 England : London Clay, Upper Bracklesham beds, Barton beds;
 Netherlands (Woensdrecht) : Clays of Ieper.

Genus SEABROOKIA H. B. BRADY

Type species SEABROOKIA PELLUCIDA H. B. BRADY, 1890

Seabrookia lagenoides TEN DAM

Pl. X, fig. 13; 211

Seabrookia lagenoides TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 127, pl. 3, f. 18 (Eocene; Netherlands); CUSHMAN and TODD, 1949, Contr. Cushm. Lab. Foram. Res., vol. 25, p. 97, pl. 16, f. 21.

Distribution. — Belgium : Sands of Lede, Clays of Asse.

Genus ALLOMORPHINA REUSS, 1850

Type species ALLOMORPHINA TRIGONA REUSS, 1850

Allomorphina sp.

82

Remarks. — A small number of *Allomorphina* moulds was found. Specific determination appeared impossible.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels.

FAMILY NONIONIDAE

Genus NONION MONTFORT, 1808

Type species NAUTILUS INCRASSATUS FICHTEL and MOLL, 1798

Nonion affine (REUSS)

Pl. XI, fig. 3, 4; 23

Nonionina affinis REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 72, pl. 5, f. 32 (Oligocene; Germany).*Nonion affine* (REUSS), CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper no. 191, p. 9, pl. 2, f. 13; TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 108; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 140, pl. 6, f. 12.*Nonion umbilicatum* (WALKER and JACOB), BHATIA, 1955, Jour. Pal., vol. 29, p. 678, pl. 66, f. 2.

Remarks. — In our material the predominant type is that of *Nonion affine*, but it merges into others with an indistinctly developed central boss of hyaline shell material, which is more or less formed by thickenings along the umbilical opening. Such specimens mostly show limbate sutures, which are absent in typical forms. They resemble *N. chapapotense* COLE (1928, Bull. Am. Pal., vol. 14, no. 53, p. 210, pl. 1, f. 18, 19). CUSHMAN (1939, op. cit., p. 6) noticed the considerable variation of this species in the development of the central boss, which is present in typical forms, but completely absent in others.

Rather considerable variation we found in the degree of compression of the test. Forms resembling *Nonion soldanii* (D'ORBIGNY) (*Nonionina soldanii* D'ORBIGNY, 1846, Foram. foss. Vienne, p. 109, pl. 5, f. 15, 16) were met with, but their apertural face is not as broad as in typical specimens of that species from the Miocene of the Vienna basin. Y. LE CALVEZ (1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 53) recorded *N. soldanii* from the Lutetian of the Paris basin, but our specimens from the Lutetian of Grignon distinctly belong to *N. affine*.

Specimens in our collections from the Eocene of Biarritz, probably conspecific with *Nonion halkyardi* CUSHMAN (1936, Contr. Cushm. Lab. Foram. Res., vol. 12, p. 63, pl. 12, f. 1) from this locality, appeared to be broader and to have a lower apertural face than our *N. affine*. Some variants resembling *N. halkyardi* were found among our Lower and Middle Eocene material of Belgium. This proves that *N. halkyardi* may be another variant of the wide *N. affine* group.

Distribution. — Belgium: Clays of Ieper, Clays of Roubaix, Sand of Mons-en-Pévèle, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England: London Clay, Barton beds;

France: Lutetian;

Netherlands (Woensdrecht): Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter, Sands of Lede.

Nonion scaphum (FICHTEL and MOLL)

Pl. X, fig. 14, pl. XI, fig. 5; 78

- Nautilus scapha* FICHTEL and MOLL, 1798, Test. Micr., p. 105, pl. 19, f. d-f (recent; Adriatic, Italy).
Nonionina scapha (FICHTEL and MOLL), H. B. BRADY, 1884, Rep. Voy. Challenger, vol. 9, p. 730, pl. 109, f. 14, 15 (not 16).
Nonion scaphum (FICHTEL and MOLL), CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper no. 191, p. 20, pl. 5, f. 18-21; MARKS, 1951, Contr. Cushman Found. Foramin. Res., vol. 2, p. 49, pl. 5, f. 16.
Nonionina communis D'ORBIGNY, 1846, Foramin. foss. Vienne, p. 106, pl. 5, f. 7 (Miocene; Vienna basin); TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 42, pl. 2, f. 6.
Nonion commune (D'ORBIGNY), CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper no. 191, p. 10, pl. 3, f. 2; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 52.
Nonion acutidorsatum TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 108, pl. 3, f. 19 (Sands of Brussels, boring Woensdrecht, the Netherlands).

Remarks. — As MARKS pointed out it is very difficult to make any distinction between *Nonion commune* and *N. scaphum* in the material of the Vienna basin. He proposed to maintain the older name of FICHTEL and MOLL.

Nonion acutidorsatum lacks the granular filling of the umbilical region, but it is apparently only a variant of *N. scaphum*. Specimens with and without granules occur together throughout the Belgian material; the younger specimens mostly lack granules.

Some specimens, resembling *Nonion elongatum* (D'ORBIGNY) (*Nonionina elongata* D'ORBIGNY, 1852, Prodrôme Pal. Strat. Univ. An. Moll. Ray., vol. 3, p. 155) have been included.

Specimens from the Belgian Oligocene deposits described by BATJES as *Nonion boueanum* (D'ORBIGNY) (1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 143, pl. 7, f. 6, 7) appeared to comprise both *N. boueanum* (f. 7) and *N. scaphum* (f. 6). In the Lower Tongeren beds of the mine shaft Hendrik IV, Dutch Limburg, only *N. scaphum* was encountered.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
 England : London Clay;
 Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Lede.

Nonion graniferum (TERQUEM)

Pl. X, fig. 15; 72

- Nonionina granifera* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 42, pl. 2, f. 8, 9 (Lutetian; Paris basin).
Nonion graniferum (TERQUEM), CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper no. 191, p. 4, pl. 1, f. 9-11; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 53, pl. 4, f. 58, 59.

Remarks. — Sometimes the fine, granular umbilical filling extends more or less along the inner ends of the depressed sutures. Specimens with excessive development of these granules are sometimes inseparable from similar variants of *Elphidium laeve* (D'ORBIGNY).

Nonion graniferum resembles *N. granosum* (D'ORBIGNY) (*Nonionina granosa* D'ORBIGNY, 1846, Foramin. foss. Vienne, p. 110, pl. 5, f. 19, 20), but it differs by the fine pores in the wall and the smaller granules in the umbilicus.

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel;
 England : Barton beds;
 France : Sands of Cuise.

Genus NONIONELLA CUSHMAN, 1926

Type species NONIONELLA MIOCENICA CUSHMAN, 1926

Nonionella spissa CUSHMAN

Pl. XI, fig. 7, 8; 71

Nonionella hantkeni (CUSHMAN and APPLIN) var. *spissa* CUSHMAN, 1931, Contr. Cushman. Lab. Foram. Res., vol. 7, p. 58, pl. 7, f. 13 (Eocene; Carolina); CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper no. 191, p. 30, pl. 8, f. 5.

Nonionella spissa CUSHMAN, BANDY, 1949, Bull. Am. Pal., no. 131, p. 78, pl. 11, f. 2, 4.

Remarks. — The majority of our specimens agree fairly well with the figures given by BANDY. Thick variants, as figured by CUSHMAN, are scarce in our material. Some are still more compressed than those figured by BANDY.

Our specimens of the Lower Eocene are hardly distinguishable from *Nonion applinae* HOWE and WALLACE (1932, Louisiana Dept. Cons., Bull. no. 2, p. 51, pl. 9, f. 4). According to the figures this species is possibly a *Nonionella*.

Distribution. — Belgium: Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse.

Nonionella wemmelensis nov. sp.

Pl. XI, fig. 6; 206

Etymology. — Named after Wemmel, the type locality of the Sands of Wemmel.

Description. — Test small, about twice as long as broad, sides nearly parallel, ventral side involute with some papillae in the umbilicus, dorsal side evolute; periphery smooth, rounded; chambers eight to ten in the last whorl, distinct, increasing rapidly in length as added, the umbilical lobes very slight; sutures distinct, slightly depressed, slightly curved towards the periphery; surface smooth; wall very finely perforate; aperture a very low arch at the base of the septal face of the last chamber, extending slightly towards the involute side.

Dimensions of the holotype: length, 0,31 mm; breadth, 0,19 mm; thickness, 0,10 mm.

Remarks. — This rather flat species is characterized by the parallel sides and the very elongate chambers. It differs from *Nonionella longicamerata* BANDY (1949, Bull. Am. Pal., no. 131, p. 77, pl. 11, f. 8) by the few umbilical papillae and the absence of a far overlapping final chamber.

Nonionella wemmelensis also reminds of *Nonion grateloupi* (D'ORBIGNY) (*Nonionina grateloupi* D'ORBIGNY, 1839, in DE LA SAGRA, Hist. Phys. Pol. Nat. Cuba, Foram., p. 46, pl. 6, f. 6, 7), especially in the form of the chambers, but it distinctly belongs to the genus *Nonionella*.

Type locality. — Boring 48 near Wemmel; our sample Wemmel 48-22 m.

Type level. — The Sands of Wemmel. These deposits are commonly regarded as to be of Late Eocene age.

Distribution. — Belgium: Sands of Lede, Sands of Wemmel.

Depository. — The holotype and the paratypoids of this species are stored in the collections of the Geological Institute at Utrecht (S 10813, 10814).

FAMILY DISCORBIDAE

SUBFAMILY PATELLININAE

Genus PATELLINA WILLIAMSON, 1858

Type species PATELLINA CORRUGATA WILLIAMSON, 1858

Patellina nitida TERQUEM

130

Patellina nitida TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 123, pl. 12, f. 38 (Lutetian; Paris basin); Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 14, pl. 1, f. 11.

Remarks. — Only some single specimens, mostly ill-preserved.

Distribution. — Belgium: Sands of Brussels.

SUBFAMILY DISCORBININAE

Genus DISCORBIS LAMARCK, 1804

Type species DISCORBITES VESICULARIS LAMARCK, 1804

Discorbis vesicularis (LAMARCK)

Pl. XI, fig. 11-13; 136

Discorbites vesicularis LAMARCK, 1804, Ann. Mus. Hist. Nat., vol. 5, p. 183; vol. 8, pl. 62, f. 7 (Lutetian; Paris basin).

Discorbis vesicularis (LAMARCK), CUSHMAN, 1927, Contr. Cushman Lab. Foramin. Res., vol. 3, p. 123, pl. 24, f. 1; Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 16, pl. 3, f. 36-38.

Rotalina depressa TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 58, pl. 3, f. 17 (Lutetian; Paris basin).

Rotalina porosa TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 84, pl. 8, f. 15 (Lutetian; Paris basin).

Rosalina propinqua TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 99, pl. 10, f. 14 (Lutetian; Paris basin).

Discorbis propinqua (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 17, pl. 1, f. 12-14.

Rotalina coarctata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 76, pl. 7, f. 8 (Lutetian; Paris basin).

Rotalina semipunctata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 84, pl. 8, f. 15 (Lutetian; Paris basin).

Globigerina aequabilis TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 86, pl. 9, f. 5 (Lutetian; Paris basin).

Globigerina lamellosa TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 85, pl. 9, f. 1 (Lutetian; Paris basin).

Remarks. — YOLANDE LE CALVEZ concluded that several of TERQUEM's species are variants of *Discorbis vesicularis* and *D. propinqua*. On the basis of specimens from Grignon, the type locality of *D. vesicularis*, it appeared furthermore impossible to make a clear distinction between *D. vesicularis* and *D. propinqua*. The latter represents a younger stage of *D. vesicularis*.

cularis. Both types are characterized by narrow projections extending across the depressed central area of the ventral side, mostly fused together forming an imperforated calcareous plate that covers this central area. In young specimens this plate is star-like, as in *D. propinqua*, as it was figured by Y. LE CALVEZ. In bigger specimens more material is added to this structure which becomes less star-like, and forms a fairly irregular plate. Sometimes the extensions fuse incompletely. Such specimens are good in resemblance with the figures of *D. vesicularis* by Y. LE CALVEZ (pl. 3, f. 36-38).

Mostly there is a keeled periphery, but specimens without a keel and with a rounded periphery occur as well. The perforations of the dorsal sides are sometimes lacking, except along the sutures. Often the first formed chambers are not distinct.

The Belgian specimens all belong to the *Discorbis propinqua* group of young individuals.

Keeled variants resemble *Discorbis dimidiata* (PARKER and JONES) (*Discorbina dimidiata* PARKER and JONES, 1862, in CARPENTER, Introduction Study Foram., p. 201, tf. 32), type species of the genus *Lamellodiscorbis* BERMUDEZ, 1952.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel; France : Lutetian.

Discorbis limbata (TERQUEM)

Pl. X, fig. 16; 138

Rotalina limbata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 80, pl. 8, f. 6 (Lutetian; Paris basin).

Discorbis limbata (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 19, pl. 2, f. 30-32.

Remarks. — In the Belgian material some specimens with a stronger carina resemble the figures given by Y. LE CALVEZ for *Discorbis vitrea* (TERQUEM) (*Rotalina vitrea* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 79, pl. 8, f. 3).

Some of our specimens show swollen inner ends of the chambers at the ventral side. They resemble *Discorbis huneri* HOWE (1939, Louisiana Dept. Cons., Geol. Bull. no. 14, p. 74, pl. 9, f. 26, 27) and *D. mauricensis* HOWE and ROBERTS (1939, *ibid.*, p. 74, pl. 9, f. 28-30). They differ from *D. obvoluta* (TERQUEM) (*Rotalina obvoluta* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 81, pl. 8, f. 7) by the less curved sutures of the dorsal side, and by the absence of visible pores.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel; France : Lutetian; Netherlands (Woensdrecht) : Sands of Brussels.

Discorbis humilis Y. LE CALVEZ

126

Discorbis humilis Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 24, pl. 3, f. 48-50 (Lutetian; Paris basin).

Remarks. — This species differs from *Discorbis limbata* (TERQUEM) in the more strongly curved sutures of both sides and the greater number of chambers in the final coil, six to seven instead of four to five. *D. obvoluta* (TERQUEM) also shows strongly curved sutures on the dorsal side, but ventrally this feature is less distinct.

Distribution. — Belgium : Sands of Brussels.

Discorbis parisiensis (D'ORBIGNY)

Pl. XI, fig. 9, 10; 89

Rosalina parisiensis D'ORBIGNY, 1865, in PARKER, JONES and BRADY, Ann. Mag. Nat. Hist., vol. 16, ser. 3, pl. 2, f. 70 (Eocene; Paris basin); TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 99, pl. 10, f. 15-17.

Discorbis parisiensis (D'ORBIGNY), CUSHMAN, 1927, Contr. Cushm. Lab. Foram. Res., vol. 3, p. 142; Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 16.

Remarks. — The dorsal as well as the ventral side are usually coarsely perforated.

Most specimens of the Lutetian of Grignon are characterized by the peculiar ornamentation of the ventral side which consists of costae, broken up in the earlier part and running at right angles to the strongly curved sutures. Generally thicker specimens are less ornamented than thinner ones.

In the Belgian Eocene only a small number, of young individuals, was found. They mostly show the ornamentation, but lack the pores. Only flat representatives were met with. The ornamentation distinguishes these young specimens from those of *Discorbis humilis* Y. LE CALVEZ.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmél;

France : Lutetian;

Netherlands (Woensdrecht) : Sands of Brussels.

Discorbis perplexa Y. LE CALVEZ

87

Discorbis perplexa Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 21, pl. 2, f. 18-20 (Lutetian; Paris basin).

Rotalina elegans TERQUEM (not D'ORBIGNY), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 75, pl. 7, f. 6 (Lutetian; Paris basin).

Rotalina elegans TERQUEM (not D'ORBIGNY), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 80, pl. 8, f. 5 (Lutetian; Paris basin).

Remarks. — Our specimens from the Paris basin very well resemble the figures of Y. LE CALVEZ. Some ill-preserved, young specimens of the Belgian Eocene could be recognized by the characteristic umbilical knob.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Wemmél;

France : Lutetian.

Discorbis quadrata (TERQUEM)

Pl. X, fig. 17; 122

Rosalina quadrata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 98, pl. 10, f. 12 (Lutetian; Paris basin).

Discorbis quadrata (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 25, pl. 2, f. 21-23.

Remarks. — According to Y. LE CALVEZ this species has a smooth wall with very fine pores. Associated with such types we found very coarsely perforated individuals which are otherwise identical with those described by Y. LE CALVEZ. Mostly the ventral side is without pores, but some may be present along the periphery.

Possibly *Discorbis ubiqua* Y. LE CALVEZ (1949, op. cit., p. 23, pl. 2, f. 27-29) is a young stage of *D. quadrata*.

Distribution. — Belgium : Sands of Brussels;
France : Lutetian.

Discorbis sp. cf. *D. ferganensis* BYKOVA

Pl. X, fig. 18; 111

cf. *Discorbis ferganensis* BYKOVA, 1939, Neft. Geol. - Razv. Inst. Trudy, ser. A, vol. 121, pp. 28, 36, pl. 3, f. 7-9 (Eocene; Uzbek S. S. R., U. S. S. R.).

Remarks. — A number of small specimens, mostly single ones, resemble this Russian species best. They are characterized by the flat ventral side of the test. The chambers, seven to nine in the last whorl, leave a faint depression in the center of the ventral side. The chamber ends are mostly slightly raised. The aperture is ventral. Our specimens are less conical than those figured by BYKOVA.

They also resemble *Eponides minima* CUSHMAN (1933, Contr. Cushm. Lab. Foram. Res., vol. 9, p. 17, pl. 2, f. 8), but the latter species has a biconvex test, a slightly keeled periphery, and papillae at the ventral side.

Eponides dorji TOULMIN (1941, Jour. Pal., vol. 15, p. 601, pl. 81, f. 8, 9, tf. 4) has a more conical dorsal side, and the chambers are more inflated than in *Discorbis* sp. cf. *D. ferganensis*.

The generic place of our species is not clear. Secondary umbilical apertures seem to be present, which favours the assigning to *Discorbis*.

Distribution. — Belgium : Sands of Brussels, Sands of Ledeg;
Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels.

Discorbis spp.

76

Remarks. — In the samples of the French Lutetian a number of single individuals of some *Discorbis* species were found.

They belong to :

Discorbis turbinata (TERQUEM) (*Rotalina turbinata* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 75, pl. 7, f. 5),

Discorbis rotata (TERQUEM) (*Rotalina rotata* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 83, pl. 8, f. 13), and

Discorbis excavata (TERQUEM) (*Rosalina excavata* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 98, pl. 10, f. 11).

Undeterminable specimens were found in a number of samples of the Belgian Eocene.

Distribution. — Belgium : Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels;

France : Lutetian;

Netherlands (Woensdrecht) : Lower Panisel beds.

Genus EPONIDES MONTFORT, 1808

Type species NAUTILUS REPANDUS FICHTEL and MOLL, 1798

Eponides schreibersi (D'ORBIGNY)

Pl. XI, fig. 14, 15; 195

Rotalina schreibersi D'ORBIGNY, 1846, Foram. foss. Vienne, p. 154, pl. 8, f. 4-6 (Miocene; Vienna basin).*Rotalina karsteni* REUSS, 1855, Zschr. Deu. Geol. Ges., vol. 7, pt. 1, p. 273, pl. 9, f. 6 (Upper Eocene; Germany - see TRIEBEL, 1952, Notizbl. Hess. L. - Amt f. Bodenforschung, Wiesbaden, vol. 6, pt. 3, p. 29).

Remarks. — Our material showed that the illustration of *Eponides karsteni* (REUSS) represents a young individual of *E. schreibersi*.

The inner ends of the chambers of the ventral side are thickened to a number of hyaline knobs, which surround the narrow umbilical opening. Occasionally these knobs are absent (as in *Eponides karsteni*, as figured by REUSS). Sometimes the hyaline structures extend some way along the sutures. Those of adjoining chambers may have fused, forming limbate and raised instead of depressed sutures.

REUSS mentioned the absence of pores, but this seems to be due to the state of preservation. The walls are mostly finely perforated.

The aperture is a distinct slit at the base of the apertural face of the last chamber. Sometimes it continues into the umbilical depression.

Eponides schreibersi must be closely related to or conspecific with the American *E. mexicanus* (CUSHMAN) (*Pulvinulina mexicana* CUSHMAN, 1925, Bull. Am. Ass. Petr. Geol., vol. 9, p. 300, pl. 7, f. 7, 8) from the Eocene of Mexico.

Distribution. — Belgium : Sands of Lede, Sands of Wemmel, Clays of Asse; Netherlands (Woensdrecht) : Sands of Lede.

Eponides polygonus Y. LE CALVEZ

Pl. XII, fig. 1; 107

Eponides polygonus Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 28, pl. 5, f. 90-92 (Lutetian; Paris basin).

Remarks. — There is some variation in the distribution of the pores. Y. LE CALVEZ described the wall as finely perforate. In our Belgian specimens, as well as in individuals of the Lutetian of the Paris basin, the pores appeared to be rather coarse. They are distinctly absent on the apertural face of the last chamber. In very young individuals the pores are clearly fewer in number, and mostly only met with along the sutures.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel; France : Sands of Cuise, Lutetian; Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels.

Eponides toulmini BROTZEN

Pl. XII, fig. 2; 17

Eponides boueana TOULMIN (not *Rotalina boueana* D'ORBIGNY), 1941, Jour. Pal., vol. 15, p. 601, pl. 81, f. 6, 7 (Eocene; Alabama).

Eponides toulmini BROTZEN, 1948, Sver. Geol. Unders., Avh., ser. C, no. 493, p. 78, pl. 10, f. 16 (Paleocene; Sweden).

Remarks. — A number of small specimens closely resemble BROTZEN's species. Only the dorsal sutures are not raised or only faintly so.

Distribution. — Belgium: Clays of Ieper, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Clays of Asse;

France: Lutetian.

Eponides umbonatus (REUSS)

Pl. XIII, fig. 1; 226

Rotalina umbonata REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 75, pl. 5, f. 35 (Oligocene; Germany).

Pulvinulina umbonata (REUSS), H. B. BRADY, 1884, Rep. Voy. Challenger, vol. 9, p. 695, pl. 105, f. 2.

Eponides umbonatus (REUSS), TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 120; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 146, pl. 7, f. 10.

Remarks. — The variable curvature of the ventral sutures near the closed umbilicus is never as strongly developed as it is in *Eponides umbonatus* (REUSS) var. *ecuadorensis* (GALLOWAY and MURRAY) (*Rotalia ecuadorensis* GALLOWAY and MURRAY, 1929, Bull. Am. Pal., vol. 15, p. 26, pl. 3, f. 13).

The sutures of the dorsal side are at right angles to the periphery, but oblique and slightly curved sutures were found as well.

The aperture mostly shows a distinct lip, but this structure may be absent.

Distribution. — Belgium: Sands of Wemmél, Clays of Asse;

Netherlands (Woensdrecht): Sands of Wemmél.

Eponides plummerae CUSHMAN

Pl. XII, fig. 3; 9

Truncatulina tenera PLUMMER (not *Pulvinulina tenera* H. B. BRADY), 1927, Univ. Texas Bull., no. 2644, p. 146, pl. 9, f. 5 (Paleocene; Texas).

Eponides plummerae CUSHMAN, 1948, Contr. Cushm. Lab. Foram. Res., vol. 24, p. 44, pl. 8, f. 9 (Paleocene; Texas).

Eponides midwayensis HARRIS and JOBE, 1951, Microfauna basal Midway outcrops near Hope, Arkansas; Transcr. Press, Norman, Okl., p. 47, pl. 9, f. 3, 6 (Paleocene; Arkansas).

Remarks. — The number of chambers in the final coil varies from five to seven. Near the umbilical center the sutures of the ventral side are sometimes obscured by secondary material.

Our specimens resemble *Eponides lunata* BROTZEN (1948, Sver. Geol. Unders., Avh., ser. C, no. 493, p. 77, pl. 10, f. 17, 18) from the Lower Paleocene of Sweden. They differ by the lower conical test, and the less acute peripheral margin. Furthermore our specimens are dorsally less distinctly perforated than those of BROTZEN's figures.

Distribution. — Netherlands (Woensdrecht): Clays of Ieper.

Genus GYROIDINA D'ORBIGNY, 1826

Type species GYROIDINA ORBICULARIS D'ORBIGNY, 1826

Gyroidina octocamerata CUSHMAN and G. D. HANNA

Pl. XIII, fig. 2; 80

- Gyroidina soldanii* D'ORBIGNY var. *octocamerata* CUSHMAN and G. D. HANNA, 1927, California Acad. Sci. Proc., ser. 4, vol. 16, p. 223, pl. 14, f. 16-18 (Eocene; California); CUSHMAN, 1935, U. S. Geol. Survey, Prof. Paper 181, p. 45, pl. 18, f. 4; HOWE, 1939, Louisiana Dept. Conserv., Geol. Bull. no. 14, p. 75, pl. 9, f. 34-36; TOULMIN, 1941, Jour. Pal., vol. 15, p. 600, pl. 81, f. 3-5.
- Gyroidinoides soldanii* (D'ORBIGNY) var. *octocamerata* (CUSHMAN and G. D. HANNA), BROTZEN, 1948, Sver. Geol. Unders., Avh., ser. C, no. 493, p. 76, pl. 11, f. 3.
- Valvulineria octocamerata* (CUSHMAN and G. D. HANNA), BANDY, 1949, Bull. Am. Pal., vol. 32, no. 131, p. 84, pl. 13, f. 1.
- Valvulineria scrobiculata* CUSHMAN and PONTON, 1932, Contr. Cushm. Lab. Foram. Res., vol. 8, p. 70, pl. 9, f. 5 (Eocene; Alabama).
- Rotalina orbicularis* TERQUEM (not *Gyroidina orbicularis* D'ORBIGNY), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 60, pl. 4, f. 1-3 (Lutetian; Paris basin).
- Gyroidina orbicularis* Y. LE CALVEZ (not D'ORBIGNY), 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 27.
- Gyroidina cf. orbicularis* D'ORBIGNY, TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 118.

Remarks. — Our specimens from the Lutetian of Grignon, as well as the individuals from the Eocene of Belgium, resemble *Gyroidina octocamerata* much better than *G. orbicularis* D'ORBIGNY. The latter species seems to be characterized by an acute periphery, a closed umbilicus, and a more or less convex dorsal side with a distinctly protruding first part. Our specimens show a rounded periphery, an open umbilicus, and a flattened dorsal side. The elongate aperture extends from a point close to the periphery to the umbilicus, which is partly covered by a thin, valvular flap. This flap, which is mostly broken, is of variable size. Specimens with a flap as large as it is in the figures of TOULMIN are very scarce. Types, shown in the figures of BROTZEN and BANDY, are most common.

According to BANDY this flap, as well as the extending of the aperture into the umbilicus, are diagnostic features of *Valvulineria*. However, a definite statement about the generic position of the species is premature as long as no detailed description of *Gyroidina orbicularis*, the type species of *Gyroidina*, is available. The same holds true for the distinction between *Gyroidina* and *Gyroidinoides*, because the apertural features of *G. orbicularis* seem to be rather obscure. In material of our collections from Rimini, Italy, we failed to find distinct *G. orbicularis*.

Some variation is found in the depression of the sutures of both sides. Adult specimens mostly show a depressed spiral suture, as well as depressed ventral sutures near the umbilicus.

Distribution. — Belgium: Clays of Roubaix, Sands of Mons-en-Pévèle, Clays of Roncq, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmél, Clays of Asse; Netherlands (Woensdrecht): Lower Panisel beds, Sands of Aalter.

Gyroidina angustiumbilocata TEN DAM

Pl. XII, fig. 4; 31

- Gyroidina angustiumbilocata* TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 117, pl. 4, f. 7 (Lower Eocene; Netherlands).

Remarks. — Our individuals of *Gyroidina angustiumbilocata* differ from those of *G. octocamerata* by the less depressed umbilicus, closed or nearly closed, without flap and by the more evenly rounded periphery.

TEN DAM figured a specimen with seven chambers in the final coil, but in the description eight chambers are said to be typical. The last number appeared to be the most common among his paratypoids and also among our individuals.

Distribution. — England : London Clay;
Netherlands (Woensdrecht) : Clays of Ieper.

Gyroidina sp cf. *G. soldanii* (D'ORBIGNY)

Pl. XII, fig. 5; 229

cf. *Rotalina soldanii* D'ORBIGNY, 1846, Foram. foss. Vienne, p. 155, pl. 8, f. 10-12 (Miocene; Vienna basin).
cf. *Gyroidina soldanii* (D'ORBIGNY), MARKS, 1951, Contr. Cushm. Found. Foram. Res., vol. 2, p. 64; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 147, pl. 7, f. 12-15.

Remarks. — Our specimens are characterized by the distinctly limbate and raised sutures, the very convex ventral and flat dorsal side, and the valvular flap that covers part of the small umbilical opening.

Gyroidina girardana (REUSS) (*Rotalina girardana* REUSS, 1851, Zschr. Deu. Geol. Ges., vol. 3, p. 73, pl. 5, f. 34), interpreted by BATJES as a variety of *G. soldanii*, greatly resembles our individuals, but it has no limbate sutures, and furthermore an umbilical flap seems to be absent.

Distribution. — Belgium : Clays of Asse (only known from some samples of Oedelem, BRB).

SUBFAMILY CANCRININAE

Genus CANCRIS CUSHMAN, 1926

Type species NAUTILUS AURICULUS FICHEL and MOLL, 1803

Cancris subconicus (TERQUEM)

Pl. XII, fig. 6-8; 81

Rotalina subconica TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 61, pl. 4, f. 5 (Lutetian; Paris basin).

Valvulineria subconica (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 26, pl. 5, f. 87-89.

Cancris turgidus CUSHMAN and TODD, 1942, Contr. Cushm. Lab. Foram. Res., vol. 18, p. 92, pl. 24, f. 3, 4 (Oligocene; Germany); BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 149, pl. 10, f. 5.

Valvulineria ovalis TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 103, pl. 11, f. 10 (Lutetian; Paris basin).

Remarks. — Our specimens of the Lutetian of Grignon and BATJES' individuals of the Oligocene of Kassel, the type area of *Cancris turgidus*, appeared to belong to the same species.

Most Lower Eocene specimens of Belgium are young individuals, with six or seven chambers in the last whorl, and a distinct *Valvulineria*-like lip. They always show the clear area in the wall of the last-formed chamber, typical for *Cancris*. Specimens of the Upper Eocene sometimes show the same number of chambers, but individuals with five chambers are also frequent.

Some variation is found in the curvature of the sutures of the dorsal side. Specimens with most curved sutures commonly have a slightly lobulate periphery.

The lobe at the inner end of the last-formed chamber is variously developed, and hence the small rounded bosses around the umbilicus. They are almost absent in most of our individuals. Generally the lobes are best developed in young specimens, and gradually disappear in more adult ones.

There is some confusion about the generic place of our species, either in *Cancris* or in *Valvulineria*. We had better assign all forms characterized by a clear area of the last-formed chamber to *Cancris*, since in the description of the genotype of *Valvulineria* (*V. californica* CUSHMAN, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, p. 60, pl. 9, f. 1) no hyaline area was described. Such an area is also present in *Baggina*, but this genus is dorsally involute and *Cancris* evolute.

Distribution. — Belgium: Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmél, Clays of Asse;

France: Lutetian;

Netherlands (Woensdrecht): Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Brussels.

***Cancris auriculus* (FICHTEL and MOLL) var. *primitivus* CUSHMAN and TODD**

Pl. XII, fig. 9, 10; 213

Cancris auriculus (FICHTEL and MOLL) var. *primitivus* CUSHMAN and TODD, 1942, Contr. Cushman Lab. Foram. Res., vol. 18, p. 77, pl. 19, f. 1, 2 (Oligocene; Germany); BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 148.

Remarks. — The variety differs from *Cancris auriculus* (FICHTEL and MOLL) (*Nautilus auricula* FICHTEL and MOLL, 1803, Test. Micr., var. α , p. 108, pl. 20, f. a-c; var. β , p. 110, pl. 2, f. d-f) by the narrower test, the more depressed sutures, and in being more umbilicate and more convex on the ventral side, and in having a less acute periphery. The clear area above the aperture is mostly situated more towards the periphery than it is in *Cancris auriculus* s. str.

Specimens strongly resembling this *Cancris auriculus* type were sometimes found, but they have the less acute periphery and the more convex side of the variety.

Individuals with a more rounded periphery resemble *Cancris subconicus*, and it occasionally appeared difficult to distinguish both species.

Distribution. — Belgium: Sands of Lede, Sands of Wemmél, Clays of Asse.

Genus BAGGINA CUSHMAN, 1926

Type species BAGGINA CALIFORNICA CUSHMAN, 1926

***Baggina* sp. cf. *B. parisiensis* (D'ORBIGNY)**

Pl. XIII, fig. 3; 148

cf. *Globigerina parisiensis* D'ORBIGNY, 1850, Prodrome Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407 (Lutetian; Paris basin); FORNASINI, 1903, R. Accad. Sci. Ist. Bologna, vol. 7, p. 141, pl. 1, f. 5.

cf. *Baggina parisiensis* (D'ORBIGNY), CUSHMAN, 1944, Contr. Cushman Lab. Foram. Res., vol. 20, p. 97, pl. 15, f. 1, 2.

Remarks. — The original *Globigerina parisiensis* is possibly conspecific with *Cancris subconicus*. Therefore our distinct *Baggina* individuals are tentatively assigned to D'ORBIGNY's species.

Distribution. — France: Lutetian.

Genus NEOCRIBRELLA CUSHMAN, 1928

Type species DISCORBINA GLOBIGERINOIDES PARKER and JONES, 1864

Neocribrella globigerinoides (PARKER and JONES)

153

Discorbina globigerinoides PARKER and JONES, 1864, Phil. Trans. Roy. Soc. London, vol. 155, pt. 1, p. 325 (Lutetian; Paris basin).

Neocribrella globigerinoides (PARKER and JONES), CUSHMAN, 1928, Contr. Cushm. Lab. Foram. Res., vol. 4, p. 6, pl. 1, f. 6, 7.

Discorbina megasphaerica GÜMBEL, 1868, Abh. K. Bayer. Akad. Wiss., II Cl., vol. 10, pt. 2, p. 655, pl. 2, f. 96 (Eocene; Bavaria).

Rotalina megasphaerica (GÜMBEL), TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 59, pl. 3, f. 21.

Distribution. — France : Lutetian.

FAMILY ANOMALINIDAE

Representatives of the genera *Anomalina*, *Cibicides* and *Planulina* are very numerous throughout our material. Some types could always be distinguished as distinct species, but most of them show various ways of intergradation. For possible stratigraphic subdivision of the column many types have been given specific rank, notwithstanding the fact that morphologically they are not clearly distinguishable from others. The clusters are but partly illustrated by our figures.

Genus ANOMALINA D'ORBIGNY, 1826

Type species ANOMALINA PUNCTULATA D'ORBIGNY, 1826

Anomalina auris Y. LE CALVEZ

Pl. XII, fig. 11; 64

Anomalina auris Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 43, pl. 4, f. 66-68 (Lutetian; Paris basin).

Remarks. — The species resembles *Anomalina bundensis* VAN BELLEN (1946, Meded. Geol. Stichting, ser. C, vol. 5, no. 4, p. 73, pl. 11, f. 1-3), from which it differs by the keeled periphery and the less depressed sutures.

Distribution. — Belgium : Clays of Ieper, Sands of Brussels, Sands of Lede, Sands of Wemmel;

France : Lutetian;

Netherlands (Woensdrecht) : Sands of Brussels, Sands of Lede.

Anomalina acuta PLUMMER

Pl. XII, fig. 12, 13, pl. XIII, fig. 4; 47 and 48

Anomalina ammonoides (REUSS) var. *acuta* PLUMMER, 1926, Univ. Texas Bull., no. 2644, p. 149, pl. 10, f. 2 (Paleocene; Texas).*Anomalina acuta* PLUMMER, TOULMIN, 1941, Jour. Pal., vol. 15, p. 608, pl. 82, f. 9, 10; TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 129.*Anomalinoides acuta* (PLUMMER), BROTZEN, 1948, Avh. Sver. Geol. Unders., ser. C, no. 493, p. 87, pl. 14, f. 2.

Remarks. — TEN DAM reported *Anomalina acuta* from the Lower and Middle Eocene of the Netherlands, and *Cibicides anomalinoides* TEN DAM (1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 132, pl. 5, f. 7) from the Upper Eocene. However, the latter species seems to be only a larger, flatter variant of the other, with fainter dorsal and ventral knobs. This variant, frequent in the Belgian Upper Eocene, was also met with in samples from older strata.

The numerous specimens found in the Ieper Clays of the boring Woensdrecht (pl. XII, fig. 12, 13) are all small and less distinctly compressed than those of PLUMMER's figures. They belong to *Anomalina acuta* var. *ypresiensis* (TEN DAM) (*Cibicides ypresiensis* TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 136, pl. f. 2). Mostly the sutures are limbate but not raised; the bead-like umbilical ends of the sutures of the dorsal side, characteristic of *A. acuta*, are not present. Mostly the chambers of the last whorl form a rim around the central knob, which is slightly raised if at all. The individuals of this variety are smaller than those of *A. acuta* s. str.; perhaps this explains their lower number of chambers, eight to ten instead of ten to twelve.

Anomalina acuta var. *ypresiensis* resembles *A. nobilis* (BROTZEN) (*Anomalinoides nobilis* BROTZEN, 1948, Sver. Geol. Unders., Avh., ser. C, no. 493, p. 89, pl. 19, f. 5), but it differs by the smooth, apparently not perforated ventral side of the test, and the less broadly rounded periphery. However, the last two or three chambers of some of our specimens show umbilical lips. This feature occurs in *A. nobilis*, but it was not reported by TEN DAM for *Cibicides ypresiensis*.

Distribution. — *Anomalina acuta*. Belgium: Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Clays of Roncq, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England: London Clay;

Netherlands (Woensdrecht): Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Wemmel.

Anomalina acuta var. *ypresiensis*. Belgium: Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle;

England: London Clay;

Netherlands (Woensdrecht): Clays of Ieper.

Anomalina sp. cf. **A. danica** (BROTZEN)

Pl. XIII, fig. 5; 2

cf. *Cibicides danica* BROTZEN, 1940, Sver. Geol. Unders., Avh., ser. C, no. 42, p. 31, tf. 2 (Upper Cretaceous; Sweden).

cf. *Anomalinoides danica* (BROTZEN), BROTZEN, 1948, Avh. Sver. Geol. Unders., ser. C, no. 493, p. 87, pl. 14, f. 1, tf. 22.

Remarks. — Our few small specimens somewhat resemble the original figures of BROTZEN's species. They are more involute, and are furthermore different by the distinct coarse perforation of the dorsal side and the virtual absence of pores ventrally. The dorsal pores are accentuated by a thickened rim around them. Most specimens lack a distinct angle in the dorsal part of the broadly rounded periphery as is typical for *Anomalina danica*.

Distribution. — Netherlands (Woensdrecht) : Clays of Ieper.

***Anomalina grosserugosa* (GÜMBEL)**

Pl. XII, fig. 14; 86

Truncatulina grosserugosa GÜMBEL, 1868, Abh. Bay. Ak. Wiss., vol. 10, p. 660, pl. 2, f. 104 (Eocene; Bavaria).

Anomalina grosserugosa (GÜMBEL), TEN DAM (part), 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 130.

Truncatulina granosa HANTKEN, 1875, Mitt. Jahrb. Ung. Geol. Anst., vol. 4, pt. 1, p. 74, pl. 10, f. 2 (Eocene; Hungary).

Anomalina granosa (HANTKEN), LEROY, 1953, Mem. Geol. Soc. Am., no. 54, p. 17, pl. 6, f. 1-3.

Remarks. — Specimens from material of the Bavarian Eocene showed this species to be characterized by its coarse perforations, inflated chambers, and broadly rounded, more or less lobulate periphery. Often only the last-formed chambers are inflated.

The aperture extends to the dorsal side, often but slightly, but specimens with the aperture along the last two chambers were met with as well. The aperture is usually bordered by a slight lip.

Sometimes the dorsal sutures are somewhat limbate, and the umbilical region shows a more or less rounded and irregular knob. In the samples of the lowermost Panisel beds in the Woensdrecht boring this knob is distinct and limbate sutures between the early chambers are common. These variants resemble *Anomalina grandis* LEROY (1953, op. cit., p. 18, pl. 9, f. 6-8). They form an intergrading series with the more frequent type of the accompanying *A. grosserugosa* s. str.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Clays of Roncq, Sands of Vlierzele, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel;

Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Aalter, Sands of Brussels.

***Anomalina claustrata* (TERQUEM)**

146

Rotalina claustrata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 78, pl. 7, f. 15 (Lutetian; Paris basin).

Anomalina claustrata (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 43, pl. 4, f. 63-65.

Boldia claustrata (TERQUEM), Y. LE CALVEZ, 1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 50.

Remarks. — As long as the character of the genus *Boldia* is not clear (see our remarks concerning *Globotruncana*), it seems preferable to maintain this species in *Anomalina*.

Distribution. — France : Lutetian.

Genus CIBICIDES MONTFORT, 1808

Type species CIBICIDES REFULGENS MONTFORT, 1808

Cibicides westi HOWE

Pl. XIII, fig. 6, 7; 44

Cibicides westi HOWE, 1939, Louisiana Dept. Cons., Geol. Bull. no. 14, p. 88, pl. 13, f. 20-22 (Eocene; Louisiana); BANDY, 1949, Bull. Am. Pal., vol. 32, no. 131, p. 112, pl. 20, f. 7.

Remarks. — The specimens of the Belgian Eocene appeared to be rather variable, including variants as those figured by HOWE and BANDY. A deep umbilicus, as in the figured type of HOWE, is absent in most of our specimens, but distinctly present in others. Lobulation of the periphery is mostly slight, but some very lobulate specimens were met with. The latter individuals resemble variants of *Cibicides lobatulus*, but they differ from the general type of this species by the more widely evolute character of the dorsal side. In the apertural face perforations are mostly absent.

Probably *Cibicides vortex* DORREEN (1948, Jour. Pal., vol. 22, p. 299, pl. 41, f. 5) from the Eocene of New Zealand is very close to our *C. westi*. Both species belong to the group of *C. refulgens*, but, unfortunately, MONTFORT's species has never been accurately described and figured.

Distribution. — Belgium: Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Aalter, Sands of Lede, Sands of Wemmél; Netherlands (Woensdrecht): Sands of Aalter, Sands of Brussels.

Cibicides dutemplei (D'ORBIGNY)

Pl. XII, fig. 15; 198

Rotalina dutemplei D'ORBIGNY, 1846, Foram. foss. Vienne, p. 157, pl. 8, f. 19-21 (Miocene; Vienna basin). *Cibicides dutemplei* (D'ORBIGNY), MARKS, 1951, Contr. Cushman Found. Foram. Res., vol. 2, p. 72; KAASSCHIETER, 1955, Verh. Kon. Ned. Ak. Wet., afd. Nat., ser. 1, vol. 21, no. 2, p. 94, pl. 11, f. 3; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 150, pl. 9, f. 9-11. *Cibicides pygmeus* TEN DAM (not *Pulvinulina pygmea* HANTKEN), 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 135, pl. 5, f. 3.

Remarks. — Just as in the Belgian Oligocene, *Cibicides dutemplei* and its allies are very common in the Upper Eocene. They show about the same variation as BATJES described for the group in the Lower Tongeren beds.

Distinct *Cibicides dutemplei*, with a more or less biconvex test, coarsely perforated walls, and mostly eight to ten chambers, has the sutures ventrally slightly depressed and dorsally flush and limbate. It is most common in the Asse Clays. In these deposits there is a fairly sharp boundary between *C. dutemplei* and *C. sp. cf. C. tenellus* which is more finely perforated. The *praecinctus*-type (see BATJES), with limbate and raised dorsal sutures, is only represented by a few individuals.

In the Lede Sands and in the Wemmél Sands it appeared difficult to recognize any boundary in the group of *Cibicides dutemplei*, *C. sp. cf. C. tenellus*, *C. proprius* var. *acutimargo*, and *C. lobatulus*, especially because most individuals are young ones. The determination of intermediate specimens is a matter of personal opinion. The *C. dutemplei* type is the most distinct.

Cibicides dutemplei, as found in the Belgian and Dutch Upper Eocene, differs from *C. pygmeus* (HANTKEN) by the greater dimensions, the curved sutures of the ventral side instead of nearly straight ones and the more prominent spiral portion of the test.

Distribution. — Belgium : Sands of Lede, Sands of Wemmél, Clays of Asse;
 England : Upper Bracklesham beds, Barton beds;
 Netherlands (Woensdrecht) : Sands of Lede, Sands of Wemmél.

***Cibicides pygmeus* (HANTKEN)**

Pl. XIV, fig. 1; 215

Pulvinulina pygmea HANTKEN, 1875, Mitt. Jahrb. K. Ungar. Geol. Anstalt, vol. 4, pt. 1, p. 78, pl. 10, f. 8 (Eocene; Hungary).

Eponides pygmeus (HANTKEN), BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 146, pl. 7, f. 11.

Eponides cf. pygmeus (HANTKEN), BHATIA, 1955, Jour. Pal., vol. 29, p. 683, pl. 67, f. 7.

Remarks. — In adult specimens of *Cibicides pygmeus* the aperture clearly extends to the dorsal side of the test, but most younger individuals show an *Eponides*-like aperture, situated completely ventrally and near the periphery.

Specimens from the Upper Bracklesham beds and Barton beds of Wight are more distinct than the Belgian ones.

Distribution. — Belgium : Sands of Wemmél, Clays of Asse;
 England : Upper Bracklesham beds, Barton beds.

***Cibicides* sp. cf. *C. tenellus* (REUSS)**

Pl. XIV, fig. 2; 197

cf. *Truncatulina tenellus* REUSS, 1865, Sitz. ber. K. Akad. Wiss. Wien, vol. 50, p. 477, pl. 5, f. 6 Oligocene; Germany).

cf. *Cibicides tenellus* (REUSS), TEN DAM and REINHOLD, 1942, Meded. Geol. Stichting, ser. C, vol. 5, no. 2, p. 99, pl. 8, f. 6, pl. 10, f. 2; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 151, pl. 9, f. 3, 4.

Remarks. — According to BATJES *Cibicides tenellus* is characterized by the glassy knob that fills the umbilicus, the great number of chambers, and the curvation of the sutures near the periphery. The same author found in the Lower Tongeren beds of Dutch South Limburg a number of specimens closely resembling *C. tenellus*, except for the knob that is mostly wanting.

In the Asse formation such specimens were found in great numbers, accompanied by a few with a more or less distinct knob. The majority shows smooth ventral sides with a restricted number of pores (not in our figured full-grown specimen).

The number of chambers is variable, in general between seven and eleven. The form of the test varies also. There is not always a clear difference with *Cibicides lobatulus*. Small individuals are sometimes hard to distinguish from young individuals of *C. sp. cf. C. ungerianus*.

In the Lede Sands typical specimens of *Cibicides* sp. cf. *tenellus* are scarce. Possibly a number of this type was included in *C. lobatulus*.

Distribution. — Belgium : Sands of Lede, Sands of Wemmél, Clays of Asse;
 England : Upper Bracklesham beds, Barton beds;
 Netherlands (Woensdrecht) : Sands of Lede, Sands of Wemmél.

Cibicides sp. cf. **C. ungerianus** (D'ORBIGNY)

Pl. XIV, fig. 3; 55

cf. *Rotalina ungeriana* D'ORBIGNY, 1846, Foram. foss. Vienne, p. 157, pl. 8, f. 16-18 (Miocene; Vienna basin).

cf. *Cibicides ungerianus* (D'ORBIGNY), MARKS, 1951, Contr. Cushm. Found. Foram. Res., vol. 2, p. 73, pl. 8, f. 2; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 152, pl. 9, f. 6.

Remarks. — Typical *Cibicides ungerianus* has coarsely perforated walls, numerous chambers, strong curvature of the ventral sutures near the periphery, and a granular covering of the earlier whorls of the dorsal side. It is rare in our material. Especially specimens without coarse perforations and without dorsal granules form the majority of our group. These specimens, nearly all of them juvenile ones, differ from our *C. sp. cf. C. tenellus* by the greater number of chambers, and the more convex dorsal side, but a distinct boundary between both types is absent among these young individuals. Some specimens with dorsal granules, but without the characteristic perforation are intermediate to *C. sp. cf. C. tenellus*.

From the Ieper formation TEN DAM (1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 136) described a number of specimens as *C. aff. ungerianus*. In the Ieper Clays of the boring Woensdrecht individuals of the same group were found. They show the granular ornamentation of the dorsal umbilical region, but sometimes the granules seem to have fused and to form an irregular umbilical knob. Furthermore these individuals show fewer chambers than typical *C. ungerianus* and they lack the peculiarly curved sutures of the ventral side.

Distribution. — Belgium : Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wommel, Clays of Asse;

England : Upper Bracklesham beds, Barton beds;

Netherlands (Woensdrecht) : Clays of Ieper, Lower Panisel beds, Sands of Brussels.

Cibicides sp. cf. **C. dutemplei** (D'ORBIGNY)

Pl. XIV, fig. 4; 3

cf. *Rotalina dutemplei* D'ORBIGNY, 1846, Foram. foss. Vienne, p. 157, pl. 8, f. 19-21 (Miocene; Vienna basin).

Remarks. — This type only occurs in the lower Ieper Clays of the boring Woensdrecht. Its dorsal side reminds of *Cibicides dutemplei*, but the specimens are smaller, ventrally without visible pores and mostly with a distinct glassy ventral knob.

Distribution. — Netherlands (Woensdrecht) : Clays of Ieper.

Cibicides vialovi БУКОВА

Pl. XIII, fig. 8; 216

Cibicides vialovi БУКОВА, 1939, Trudy Naft. Geol. - Razv. Inst., ser. A, vol. 121, pp. 31, 37, pl. 4, f. 13-15 (Eocene; Uzbek S. S. R.).

Remarks. — The characteristic ornamentation of the umbilical region of the dorsal side of *Cibicides vialovi* with the spirally situated small knobs of hyaline shell material is distinct in all our specimens. Most of them are slightly smaller than the type, and they show about eight to ten chambers in the final whorl. The periphery is mostly narrowly rounded, occasionally somewhat more acute.

Distribution. — England : Upper Bracklesham beds, Barton beds.

Cibicides lobatulus (WALKER and JACOB)

Pl. XIV, fig. 5; 54

Nautilus lobatulus WALKER and JACOB, 1798, Adam's Essays, Kanm. Ed., p. 642, pl. 14, f. 36 (recent; England).

Truncatulina lobatula (WALKER and JACOB), CUSHMAN, 1918, U. S. Nat. Mus., Bull. 676, p. 16, pl. 1, f. 10, p. 60, pl. 17, f. 1-3.

Cibicides lobatulus (WALKER and JACOB), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 46; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 153, pl. 9, f. 7, 8.

Remarks. — It is considered questionable whether all specimens united here as *Cibicides lobatulus*, form a single species. We included all individuals with a more or less distinctly lobulate periphery and flattened dorsal side.

Samples with only *Cibicides lobatulus* are very rare. Mostly the specimens occur together with individuals of other types, with intermediates in between. One of the adjoining distinct types is described here as *C. carinatus*, which is of stratigraphic importance for the Sands of Lede. All others have been included in *C. lobatulus*.

BATJES' remark that his *Cibicides lobatulus* grades into *C. dutemplei* is also valid for our Upper Eocene specimens, but they are also sometimes hardly separable from *C. proprius*, *C. sp. cf. C. ungerianus*, and *C. sp. cf. C. tenellus*, especially in groups of smaller individuals.

Distribution. — Belgium: Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Clays of Roncq, Sandy Clays of Anderlecht, Sands of Vlierzele, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England: London Clay, Barton beds;

France: Sands of Cuise, Lutetian;

Netherlands (Woensdrecht): Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter, Sands of Brussels, Sands of Lede.

Cibicides carinatus (TERQUEM)

Pl. XIV, fig. 6; 95

Truncatulina carinata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 94, pl. 10, f. 1, 2 (Lutetian; Paris basin).

Cibicides carinatus (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 45, pl. 4, f. 72-74.

Truncatulina disjunctis TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 95, pl. 10, f. 3 (Lutetian; Paris basin).

Truncatulina orbicularis TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 95, pl. 10, f. 4, 5 (Lutetian; Paris basin).

Cibicides orbicularis (TERQUEM), TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 134, pl. 5, f. 10.

Truncatulina boueana TERQUEM (not D'ORBIGNY), 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 94, pl. 9, f. 28 (Lutetian; Paris basin).

Remarks. — This *Cibicides* type is characterized by the planoconvex test, the wide keel, the low number of usually six chambers, and the coarsely perforated wall.

It differs from *Cibicides lobatulus* by the usually more flattened aspect of the test, and the hyaline carina. However, complete intergradation between both types was found. *C. carinatus* is considered to be a variant of our *C. lobatulus* group.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
 France : Lutetian;
 Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels, Sands of Lede.

***Cibicides proprius* (BROTZEN)**

Pl. XIII, fig. 9, 10, pl. XIV, fig. 7; 43 and 45

- Cibicidoides proprius* BROTZEN, 1948, Avh. Sver. Geol. Unders., ser. C, no. 493, p. 78, pl. 12, f. 3, 4 (Paleocene; Sweden).
Cibicides proprius (BROTZEN), HAYNES, 1957, Contr. Cushman Found. Foramin. Res., vol. 8, p. 46, pl. 5, f. 1, 2.
Cibicides praecursorius TOULMIN (not *Discorbina praecursoria* SCHWAGER), 1941, Jour. Pal., vol. 15, p. 610, pl. 81, f. 19, 20 (Eocene; Alabama).
Cibicides cryptomphalus TEN DAM (not *Rotalina cryptomphala* REUSS), 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 132, pl. 1, f. 4 (Eocene; Netherlands).

Remarks. — Our specimens agree fairly well with the type description of the species. Mostly the test is planoconvex with the dorsal side flat and the ventral side more or less elevated. Individuals with a convex spiral side occur as well. Young specimens have a rounded keel; in adult ones the periphery is more acute, and the keel of the younger stages remains visible as a distinct, thickened spiral suture. Some specimens lack the central filling of the ventral side. Coarse pores of the ventral side are restricted in number to absent.

Part of the specimens resemble *Cibicides crassus* TEN DAM (1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 133, pl. 6, f. 1).

Cibicides proprius differs from our *C. pygmeus* by the curved sutures, the greater number of chambers, and the not protruding early part.

Part of our material of *Cibicides proprius* is referable to the variety *acutimargo* TEN DAM [*Cibicides cryptomphalus* (REUSS) var. *acutimargo* TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 133, pl. 5, f. 4] from the Eocene of the Netherlands (see our pl. XIII, fig. 10; pl. XIV, fig. 7). This variety differs from typical *C. proprius* by the more rounded periphery and the finer perforation of the dorsal side. The periphery of the last chambers of adult specimens is more or less lobulate, with considerable overlap of the chambers on the previous whorl. According to the description and the figures *C. pygmeus* (HANTKEN) var. *almaensis* SAMOILOVA (1947, Bull. Soc. Nat. Moscou, New Series, vol. 52, no. 4, pp. 94, 101, tf. 31-33) is probably identical with our variety *acutimargo*.

Distribution. — *Cibicides proprius*-Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sandy Clays of Anderlecht;
 England : London Clay;
 France : Sands of Cuise;
 Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds.

Cibicides proprius var. *acutimargo*-Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
 England : London Clay;
 Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter, Sands of Brussels, Sands of Lede.

Cibicides sulzensis (HERRMANN)

Pl. XIII, fig. 11; 19

Discorbina sulzensis HERRMANN, 1917, Mitt. Geol. L. Anst. Els. - Loth., vol. 10, pt. 3, p. 290, pl. 3, f. 2 (Oligocene; Germany).

Cibicides sulzensis (HERRMANN), BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 149, pl. 9, f. 5.

Cibicides baileyi BECK, 1943, Jour. Pal., vol. 17, p. 611, pl. 109, f. 7-9 (Eocene; State of Washington, U. S. A.).

Remarks. — *Cibicides sulzensis* has a compressed test, a more or less prominent keel, frequently a hyaline umbilical filling at the ventral side, a very evolute dorsal spiral, and five to nine, mostly seven or eight, chambers in the final coil.

Throughout the Eocene *Cibicides sulzensis* shows but little variation. The umbilical filling may be absent.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Lede, Sands of Wemmél, Clays of Asse;

England : London Clay, Barton beds;

Netherlands (Woensdrecht) : Clays of Ieper, Lower Panisel beds, Sands of Lede, Sands of Wemmél, Clays of Asse.

Cibicides sp. cf. *C. mauricensis* HOWE and ROBERTS

Pl. XIV, fig. 8; 42

cf. *Cibicides mauricensis* HOWE and ROBERTS, 1939, Louisiana Dept. Cons., Geol. Bull. no. 14, p. 87, pl. 13, f. 4, 5 (Eocene; Louisiana).

cf. *Cibicidina mauricensis* (HOWE and ROBERTS), BANDY, 1949, Bull. Am. Pal., vol. 32, no. 131, p. 93, pl. 15, f. 3.

Remarks. — Our specimens belong to the group of species referred to by BANDY as *Cibicidina*. They are characterized by the involute dorsal side with a small umbo, surrounded by a furrow with reentrants between the chambers.

Our specimens differ from *Cibicides mauricensis*, as figured by BANDY, in the depressed dorsal sutures, and the absence of papillae. The figures of HOWE and ROBERTS are still more different, also from those of BANDY.

The test of our individuals is variably convex ventrally, the periphery is subacute to rounded. Some specimens without a ventral umbilical filling were found.

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle, Sands of Brussels;

France : Sands of Cuise;

Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels, Sands of Lede.

Cibicides sp. cf. *C. tallahatensis* BANDY

Pl. XIII, fig. 12; 125

cf. *Cibicides tallahatensis* BANDY, 1949, Bull. Am. Pal., vol. 32, no. 131, p. 110, pl. 20, f. 5 (Eocene; Alabama).

Remarks. — No better name could be found for a number of *Cibicides* individuals of the Brussels Sands. In general appearance they might be intermediate between *C. tallahatensis* and *C. mimulus* BANDY (1949, op. cit., p. 106, pl. 19, f. 1).

Adult specimens often show a more or less developed ventral umbo, but specimens without it, such as *Cibicides mimulus*, were found as well. Dorsally the wall of the earlier whorls is much thickened, mostly forming an umbilical knob.

Distribution. — Belgium : Sands of Brussels.

Genus PLANULINA D'ORBIGNY, 1826

Type species PLANULINA ARIMINENSIS D'ORBIGNY, 1826

Planulina burlingtonensis (JENNINGS)

Pl. XIV, fig. 9, 10; 98

Cibicides burlingtonensis JENNINGS, 1936, Bull. Am. Pal., vol. 23, no. 78, p. 39, pl. 5, f. 5 (Eocene; New Jersey); TOULMIN, 1941, Jour. Pal., vol. 15, p. 609, pl. 82, f. 14, 15.

Anomalina grosserugosa TEN DAM (not GÜMBEL) (part), 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 130 (Eocene; the Netherlands).

Remarks. — Our specimens are in good accordance with JENNINGS' figures, but most of the adult specimens are ventrally distinctly evolute, which feature justifies our placing them in the genus *Planulina*. Often this species is assigned to *Anomalina*, but the aperture is a *Planulina*-like, arched slit at the periphery extending to the dorsal side along one or more chambers.

Considerable variation is found in the ventral side, with in part of our individuals a distinctly evolute chamber series. Dorsally the chambers are mostly completely embracing. The periphery is asymmetrically rounded.

Our species somewhat resembles *Cibicides robustus* Y. LE CALVEZ (1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 47, pl. 4, f. 57-59) from the Lutetian of the Paris basin, but the latter has about twelve chambers in the final convolution; in our species there are only five to seven.

Rosalina kochi REUSS (1855, Zschr. Deu. Geol. Ges., vol. 7, p. 274, pl. 9, f. 8) as described from the Upper Eocene of Mecklenburg, Germany, resembles our species in general outline, but it differs by the granular ornamentation of the central dorsal part. Perhaps REUSS' species is conspecific with our *Cibicides* sp. cf. *C. ungerianus*.

In the Lower Eocene of Belgium, the typical form was found to intergrade with *Planulina burlingtonensis* var. *neelyi*, which is characterized by a dorsal ornamentation of strongly limbate and raised sutures.

There is no intergradation with *Anomalina grosserugosa* (GÜMBEL) with which our species has often been confused.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sandy Clays of Anderlecht, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

Netherlands (Woensdrecht) : Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Lede.

Planulina burlingtonensis (JENNINGS) var. neelyi (JENNINGS)

Pl. XIV, fig. 11; 63

Cibicides neelyi JENNINGS, 1936, Bull. Am. Pal., vol. 23, no. 78, p. 39, pl. 5, f. 4 (Eocene; New Jersey).

Remarks. — In samples of the Lower Eocene typical *Planulina burlingtonensis* appeared to intergrade with a more heavily ornamented type, which corresponds to JENNINGS' figures of *Cibicides neelyi*.

There is no distinct boundary with *Planulina burlingtonensis* var. *tendami*. The latter variety is different by a more compressed test, some more chambers, and a more evolute character of the test.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sandy Clays of Anderlecht, Sands of Aalter, Sands of Brussels;

Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter.

***Planulina burlingtonensis* (JENNINGS) var. *tendami* nov. var.**

Pl. XIV, fig. 12; 109

Planulina osnabrugensis TEN DAM (not ROEMER), 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 131, pl. 5, f. 3 (Eocene; the Netherlands).

Etymology. — Named after the Dutch micropaleontologist Dr. A. TEN DAM, Turkey.

Description. — Variety differing from the type of the species by the more compressed and more evolute test with about seven to nine chambers in the final whorl instead of five to seven, and by the raised and limbate sutures.

Dimensions of the holotype : length, 0,65 mm; breadth, 0,58 mm; thickness, 0,20 mm.

Remarks. — As indicated already *Planulina burlingtonensis*, *P. burlingtonensis* var. *neelyi*, and *P. burlingtonensis* var. *tendami* form an intergrading series. The varieties differ in the limbate and raised character of the sutures, and in the greater compression of the test. Furthermore some variation is found in the number of chambers, with five to seven in the type of the species, six to eight in the variety *neelyi*, and seven to nine in the variety *tendami*.

In the material of the Panisel beds, for which this variety seems to be a characteristic form, a complete intergradation was found between the varieties *neelyi* and *tendami*, but in adult specimens the latter variety is distinct by its still more compressed test and the more evolute whorls.

Some variation is found in the limbation of the sutures; in some specimens it is almost absent, and these individuals differ from the type of the species only in the more compressed test with more chambers.

Type locality. — The boring Woensdrecht, in the Dutch province Noord Brabant; our sample Woensdrecht 385 m.

Type level. — Sands of Aalter; these deposits are probably of Middle Eocene age.

Distribution. — Belgium : Sandy Clays of Anderlecht;
Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Aalter.

Depository. — The holotype and the paratypoids of this variety are stored in the collections of the Geological Institute of Utrecht (S 11769, 11770).

***Planulina stelligera* MARIE**

Planulina stelligera MARIE, 1941, Mém. Mus. Nat. Hist. Nat. Paris, New Series, vol. 12, pt. 1, p. 245, pl. 37, f. 344 (Cretaceous; Paris basin).

Remarks. — Many specimens assignable to this Cretaceous species were found in a number of samples of the Roubaix Clays and the Sands of Mons-en-Pévèle. These individuals occur together with a number of *Globotruncana* specimens. They are more or less worn. Probably they were derived from Cretaceous sediments of the area of the Axis of Artois in northern France.

Genus HANZAWAIA ASANO, 1944

Type species HANZAWAIA NIPPONICA ASANO, 1944

Hanzawaia producta (TERQUEM)

Pl. XIII, fig. 13; 18

Truncatulina producta TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 92, pl. 9, f. 20, 21 (Lutetian; Paris basin).*Cibicides productus* (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 47, pl. 4, f. 69-71.

Remarks. — Our specimens from the Lutetian of the Paris basin, as well as those from the Belgian Eocene, clearly belong to the *Hanzawaia boueana* group. They differ from *H. boueana* (D'ORBIGNY) (*Truncatulina boueana* D'ORBIGNY, 1846, Foram. foss. Vienne, p. 169, pl. 9, f. 24-26) in the number of chambers: six to eight instead of nine to eleven. A hyaline keel is usually absent, but especially specimens of the Upper Eocene show this feature distinctly. At both sides of the test, the sutures are mostly curved, depressed and not limbate. The pores are of variable size, but always medium to coarse. Usually there are dorsally hyaline areas above the aperture. Specimens with a fully perforated dorsal side, thus resembling the figures of YOLANDE LE CALVEZ, are extremely rare in our material. The dorsal, imperforate flaps covering the aperture, are often broken.

The specimens of *Hanzawaia producta* of the Upper Eocene resemble *H. boueana* better than do the stratigraphically older ones. However, only small individuals were found in the Upper Eocene, which fact hampers a reliable comparison. The specimens of the Upper Eocene generally have more chambers (up to eight) than those of the Lower or Middle Eocene (six to seven). The Eocene individuals probably form a completely intergrading series, which shows the development from *H. producta* towards *H. boueana*. The latter type is dominant in Upper Oligocene and younger strata.

Distribution. — Belgium: Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sandy Clays of Anderlecht, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England: Upper Bracklesham beds;

France: Lutetian;

Netherlands (Woensdrecht): Lower Panisel beds, Sands of Brussels, Sands of Lede.

FAMILY EPISTOMINIDAE

Genus EPISTOMINA TERQUEM, 1883

Type species EPISTOMINA REGULARIS TERQUEM, 1883

Epistomina elegans (D'ORBIGNY)

221

Rotalia elegans D'ORBIGNY, 1871, in PARKER, JONES and BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, pl. 12, f. 142 (Pliocene; Italy).

Epistomina elegans (D'ORBIGNY), MARKS, 1951, Contr. Cushman Found. Foramin. Res., vol. 2, p. 65; TROELSEN, 1954, Medd. Dansk Geol. For., vol. 12, p. 460; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 155, pl. 10, f. 2.

Distribution. — Belgium : Sands of Wemmel.

Genus ALABAMINA TOULMIN, 1941

Type species ALABAMINA WILCOXENSIS TOULMIN, 1941

Alabamina obtusa (BURROWS and HOLLAND)

Pl. XIII, fig. 15; 30

Pulvinulina exigua (BRADY) var. *obtusa* BURROWS and HOLLAND, 1897, Proc. Geol. Assoc., vol. 15, p. 49, pl. 2, f. 25 (Paleocene; England); PLUMMER, 1926, Texas Univ. Bull., no. 2644, p. 151, pl. 11, fig. 2.

Alabamina obtusa (BURROWS and HOLLAND), HAYNES, 1956, Contr. Cushman Found. Foramin. Res., vol. 7, p. 89, pl. 17, f. 3-3 l.

Remarks. — Our specimens of *Alabamina obtusa* are characterized by a rounded periphery and five to six chambers in the last whorl. The test is mostly biconvex, ventrally more convex than dorsally.

In the redescription of the species, HAYNES mentioned the apertural face to be infolded into a deep « infundibulum » parallel to the periphery. This infolding, characteristic for the genus, is usually not as well developed in our material as it is in specimens from the Thanet Sands of England (according to HAYNES' descriptions).

A number of specimens were noted with a more narrowly rounded periphery.

BOWEN (1954, Proc. Geol. Assoc., vol. 65, p. 165) reported *Alabamina scitula* BANDY (1949, Bull. Am. Pal., vol. 32, no. 131, p. 89, pl. 14, f. 6) from the London Clay of the London basin and of Alum Bay. Our specimens from the latter locality are closer to *A. obtusa* than to *A. scitula*. They seem to form only variants of *A. obtusa*, different by the relatively greater height of the last two chambers.

Distribution. — England : London Clay;
Netherlands (Woensdrecht) : Clays of Ieper.

Alabamina wilcoxensis TOULMIN

Pl. XIII, fig. 14; 60

Alabamina wilcoxensis TOULMIN, 1941, Jour. Pal., vol. 15, p. 603, pl. 81, f. 10-14, tf. 4 A-C (Eocene; Alabama).

Remarks. — Our specimens, mainly small, show some variation in the periphery. It is blunt in most specimens, but more acute in some others, which resemble *Alabamina amchitkaensis* TODD (1953, Contr. Cushm. Found. Foram. Res., vol. 4, p. 5, pl. 2, f. 7).

As noted by BROTZEN (1948, Sver. Geol. Unders., Avh., ser. C, no. 493, p. 99) it is difficult to distinguish these small, apparently young individuals of *Alabamina wilcoxensis* from his *A. midwayensis*. This latter species was established for forms intermediate between *A. wilcoxensis* and *A. obtusa*. However, HAYNES (1956, Contr. Cushm. Found. Foram. Res., vol. 7, p. 89) concluded that *A. midwayensis* is no more than a variety of *A. obtusa*, but, in between our *A. wilcoxensis* and *A. obtusa* there is no group referable to as *A. midwayensis*. This may be due to the small size of all our individuals, however.

Distribution. — England : London Clay;
Netherlands (Woensdrecht) : Clays of Ieper.

Alabamina wolterstorffi (FRANKE)

Pl. XIV, fig. 13; 143

Rotalia wolterstorffi FRANKE, 1925, Abh. Ber. Mus. Nat. Heimatk. Naturw. Ver. Magdeburg, vol. 4, pt. 2, p. 186, pl. 6, f. 66 (Oligocene; Germany).

Alabamina wolterstorffi (FRANKE), BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 156, pl. 8, f. 11.

Remarks. — The ventral side of our specimens is of variable convexity. Some specimens resemble *Alabamina scitula* BANDY (1949, Bull. Am. Pal., vol. 32, no. 131, p. 89, pl. 14, f. 6), especially in the apertural features.

Specimens with a bluntly rounded periphery resemble *Alabamina obtusa*. In general, the dorsal side of *A. wolterstorffi* specimens is somewhat flatter, the periphery sharper, and the aperture is a slightly higher arched opening.

As BATJES has remarked already, the specimen from the Belgian coast, figured by CUSHMAN (1949, Mém. Inst. R. Sc. Nat. Belg., no. 111, p. 47, pl. 9, f. 3) probably belongs to *Alabamina wolterstorffi*, reworked from Eocene strata.

Distribution. — Belgium : Clays of Roubaix, Sands of Mons-en-Pévèle, Sandy Clays of Anderlecht, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
Netherlands (Woensdrecht) : Sands of Aalter.

Genus *EPISTOMINELLA* HUSEZIMA and MARUHASI, 1944

Type species *EPISTOMINELLA PULCHELLA* HUSEZIMA and MARUHASI, 1944

***Epistominella oveyi* (BHATIA)**

Pl. XV, fig. 1; 101

Pseudoparella oveyi BHATIA, 1955, Jour. Pal., vol. 29, p. 684, pl. 66, f. 29, tf. 7 (Oligocene; Wight); BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 158, pl. 8, f. 10.

Remarks. — As in the Oligocene material of Wight and Belgium considerable variation was met with in the convexity of the dorsal side. Distinctly conical specimens are scarce, most are more or less biconvex. A subacute periphery occurs frequently, but specimens with a more rounded periphery were encountered as well. As in the type material the conical specimens appeared to be microspheric with up to four visible whorls. The more numerous megalospheric specimens show about three whorls.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Aalter, Sands of Ledde, Sands of Wemmel;
England : Upper Bracklesham beds;
Netherlands (Woensdrecht) : Lower Panisel beds.

***Epistominella acutimargo* (HALKYARD)**

Pl. XIV, fig. 14; 194

Pulvinulina acutimargo HALKYARD, 1919, Mem. Proc. Manchester Lit. Philos. Soc., vol. 62, pt. 6, p. 120, pl. 7, f. 4, (Eocene; Biarritz, France).

Remarks. — HALKYARD figured a specimen with five chambers in the last whorl, but both in our samples from the Upper Eocene of Biarritz and in those from the Belgian Eocene most specimens have five to six chambers in the final coil.

At the ventral side our specimens show a closed umbilicus, sometimes ornamented with knobs. The length of the aperture is variable, sometimes it is as long as the apertural face. Occasionally it is bordered by a slight lip.

Distribution. — Belgium : Sands of Ledde, Sands of Wemmel, Clays of Asse;
England : Barton beds.

***Epistominella gyrata* (TERQUEM)**

150

Rotalina gyrata TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 70, pl. 6, f. 6 (Lutetian; Paris basin).

Pulvinulinella gyrata (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 38, pl. 6, f. 106-108.

Remarks. — As far as could be observed the aperture of *Epistominella gyrata* is ventral at the base of the last chamber, and extending over a short distance into the apertural face, parallel to the periphery.

Our observations are too few for a definite decision about the generic place of this species.

Distribution. — France : Lutetian.

Genus SIPHONINA REUSS, 1850

Type species SIPHONINA FIMBRIATA REUSS, 1850

Siphonina prima PLUMMER

Pl. XV, fig. 2; 15

Siphonina prima PLUMMER, 1927, Bull. Texas Univ., no. 2644, p. 148, pl. 12, f. 4 (Paleocene; Texas); TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 122.*Pulsiphonina prima* (PLUMMER), HAYNES, 1956, Contr. Cushman Found. Form. Res., vol. 7, p. 96, pl. 17, f. 9-9b.

Remarks. — Most of our specimens show about four chambers instead of five as indicated by PLUMMER, but individuals with five chambers in the last whorl were found as well. The ventral perforations are very minute, with some scattered coarse ones. The pores of the keel are clearly visible.

The form of the test is mostly equally biconvex and strongly compressed, but some specimens have a flatter dorsal side.

The aperture, without a neck, is distinctly that of the subgenus *Pulsiphonina*. BROTZEN suggested that a primitive neck might be seen in the peripheral keel combined with the lip below the apertural slit. This lip is more or less variable, but in our material it is somewhat more distinct in the stratigraphically younger individuals.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels (basal strata);

England : London Clay;

Netherlands (Woensdrecht) : Clays of Ieper.

Siphonina lamarckana CUSHMAN

Pl. XIV, fig. 15; 108

Siphonina lamarckana CUSHMAN, 1927, Proc. U. S. Nat. Mus., vol. 72, no. 2716, art. 20, p. 3, pl. 3, f. 3 (Lutetian; Paris basin); Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 34.

Remarks. — *Siphonina lamarckana* is an intermediate type between *S. prima* and younger, more typical *Siphonina* species, such as *S. reticulata* (CZJZEK) (*Rotalina reticulata* CZJZEK, 1848, Haidinger's Nat. Abh., vol. 2, p. 145, pl. 13, f. 7, 8).

The apertural slit is situated on a very short neck, which is formed by the peripheral margin and the lip below this slit. This lip and correspondingly the neck is somewhat variable in development. Further variability is as in our *Siphonina prima*. Pores are distinct on the dorsal side. The ventral wall is very finely perforate, with occasionally some coarse pores.

In the original description CUSHMAN mentioned a number of four chambers in the last whorl. In our Belgian material four or five chambers are present, in the samples of the Upper Eocene there are mostly five.

Distribution. — Belgium : Sands of Brussels, Sands of Ledde, Sands of Weimel, Clays of Asse;

France : Sands of Cuise, Lutetian.

Genus KARRERIA RHEZAK, 1891

Type species KARRERIA FALLAX RHEZAK, 1891

Karrereria fallax RHEZAK

Pl. XIV, fig. 16; 43

Karrereria fallax RHEZAK, 1891, Ann. Naturh. Hofmus. Wien, vol. 6, p. 4; 1895, *ibid.*, vol. 10, p. 40, pl. 7, f. 7, 8 (Eocene; Austria); BROTZEN, 1948, Sver. Geol. Unders., Avh., ser. C, no. 493, p. 115, pl. 18, f. 3, *tf.* 34-37.

Remarks. — Most of our specimens show spiral tests without a rectilinear series of chambers; specimens with such a rectilinear part show as many as three uniserial chambers.

The variable form of the test is clearly connected with the original attachment. The various positions of the aperture in spiral specimens, as indicated by BROTZEN (*tf.* 35), were also found in our material, but specimens with the aperture at the base of the apertural face of the last-formed chamber are relatively rare.

Some specimens show a position in between *Karrereria fallax* and *K. cubensis* (CUSHMAN and BERMUDEZ) (*Stichocibicides cubensis* CUSHMAN and BERMUDEZ, 1936, Contr. Cushman Lab. Foram. Res., vol. 12, p. 33, pl. 5, f. 19-21) in showing a more or less keeled periphery.

In our opinion *Ammocibicides pontoni* EARLAND (1935, Discovery Rep., Foraminifera, pt. 3, vol. 10, p. 107, pl. 4, f. 8-12) from the Wilcox Eocene of Alabama, is a synonym of *Karrereria fallax*.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Lede; Netherlands (Woensdrecht) : Clays of Ieper.

FAMILY CERATOBULIMINIDAE

Genus LAMARCKINA BERTHELIN, 1881

Type species PULVINULINA ERINACEA KARRER, 1868

Lamarckina cristellaroides (TERQUEM)

Pl. XV, fig. 3, 4; 97

Rotalina cristellaroides TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 57, pl. 3, f. 15 (Lutetian; Paris basin).

Lamarckina cristellaroides (TERQUEM), CUSHMAN, 1926, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, p. 10; Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 25.

Remarks. — TERQUEM's figures of this species are either those of a young specimen, somewhat damaged near the aperture, or they give a simplified idea of the species. Specimens of the Lutetian of the Paris basin (see fig. 3) are characterized by limbate dorsal sutures, that are curved backward. The early part of the dorsal side is flattened, sometimes slightly concave. The periphery of the early stages is often slightly keeled, that of later chambers more rounded. Ventrally a large, semicircular plate covers the apertural area. About seven to eight chambers are found in the last coil.

Specimens with about the same features were found in the Belgian Upper Eocene. In these strata the tests of larger specimens are less elongate than those of the French Lutetian.

The surface of the dorsal part of the chambers is mostly smooth, but specimens with short, blunt spines near the periphery were found as well. The latter resemble *Lamarckina halkyardi* CUSHMAN (1926, Contr. Cushm. Lab. Foram. Res., vol. 2, p. 11), in which species the spines are coarser and cover the whole dorsal surface between the ridges of the sutures.

Lamarckina naheolensis CUSHMAN and TODD (1942, Contr. Cushm. Lab. Foram. Res., vol. 18, p. 39, pl. 7, f. 5-7) from the Midway formation of Alabama, resembles *L. cristellaroides* in the ventral aspect of the test, but differs by the more coarsely perforated dorsal side.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
France : Sands of Cuise, Lutetian.

Genus ASTERIGERINA D'ORBIGNY, 1839

Type species ASTERIGERINA CARINATA D'ORBIGNY, 1839

Asterigerina bartoniana (TEN DAM)

Pl. XVI, fig. 2, 3; 52

Rotalia granulosa TEN DAM (not *Rosalina granulosa* KARRER), 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 121, pl. 4, f. 2 (Eocene; the Netherlands).

Rotalia bartoniana TEN DAM, 1947, Jour. Pal., vol. 21, p. 186.

Asterigerina bartoniana (TEN DAM), BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 158, pl. 10, f. 1, 8.

Remarks. — Our specimens of *Asterigerina bartoniana* show considerable variation, perhaps including *A. tatumi* HUSSEY (1951, Contr. Cushm. Found. Foram. Res., vol. 2, p. 19, pl. 3, f. 1-3).

The ventral side of the test varies between strongly convex to flat. The young stages mostly have a flat dorsal side, as it is also shown in TERQUEM's figures of *Asterigerina campanella* (GÜMBEL) [see *Rotalina campanella* (GÜMBEL), TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 74, pl. 7, f. 1-4]. Such young individuals are often the only representatives of the species in the Brussels Sands, in which strata adult specimens are very rare.

The peripheral keel is variably developed. Mostly it forms a broad rim around the test, while it varies but slightly in thickness. In the Upper Eocene, specimens with crenulations of the keel are rare, in the Lower Eocene deposits they occur more often. Specimens with the keel almost wanting, as figured by BATJES, were found as well, but always in low numbers. Sometimes there are distinct spines on the keel.

The papillae of the ventral side vary in coarseness. Specimens with a granulation as fine as indicated by BATJES occur together with individuals with papillae of somewhat greater size, as figured by TEN DAM. This granulation covers the whole test of the type specimen of the species, but often it is only found in front of the aperture.

The number of chambers varies between seven and twelve, the secondary chambers vary in relative size. In the Upper Eocene they mostly reach half way to the periphery. In the Lower Eocene specimens with smaller secondary chambers are more numerous. Usually the stellate pattern of these secondary chambers is distinct, but it may be obscured by a cover of

papillae or shell material of the central boss. This central knob is not found in all specimens, especially in small individuals it may be absent.

Often the chambers are ventrally slightly inflated. The dorsal sutures are generally curved, sometimes they are oblique and straight. The ventral sutures are often more or less radial; curved sutures were largely found in younger specimens.

In the Barton beds of Barton, England, a number of small specimens was found resembling our *Asterigerina bartoniana*. They lack a distinct keel as it is present in most of the Belgian young individuals. Furthermore their papillae are restricted to the apertural area.

Distribution. — Belgium : Clays of Roubaix, Sands of Mons-en-Pévèle, Clays of Roncq, Sandy Clays of Anderlecht, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

France : Sands of Cuise, Lutetian;

England : Barton beds;

Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse.

***Asterigerina wilcoxensis* CUSHMAN and GARRETT**

Pl. XVI, fig. 4; 35

Asterigerina wilcoxensis CUSHMAN and GARRETT, 1939, Contr. Cushman Lab. Foramin. Res., vol. 15, p. 86, pl. 15, f. 10 (Eocene; Alabama).

Asterigerina lutetiana TEN DAM, 1947, Jour. Pal., vol. 21, p. 586, tfs. 1-4 (Middle Eocene; the Netherlands).

Remarks. — *Asterigerina wilcoxensis*, as well as *A. lutetiana*, are characterized by the large secondary chambers, which form almost the whole ventral surface, so that the chambers of the dorsal series are ventrally only visible as small triangles along the periphery. In some samples of the Ieper Clays there are specimens with smaller secondary chambers.

The dorsal side of the test as well as the supplementary chambers are coarsely perforated, the ventral parts of the dorsal chamber series are hyaline, and lack visible pores.

Distribution. — Belgium : Clays of Roubaix, Sands of Mons-en-Pévèle, Clays of Asse;

Netherlands (Woensdrecht) : Clays of Ieper.

***Asterigerina* sp. cf. *A. guerrai* (BERMUDEZ)**

Pl. XVI, fig. 1; 62

cf. *Asterigerinata guerrai* BERMUDEZ, 1952, Mem. Soc. Cien. Nat. La Salle, vol. 12, no. 32, p. 204, pl. 1, f. 4-6 (Eocene; Mexico).

Remarks. — Our specimens resemble the Mexican species fairly well. Generally, the small supplementary chambers are less inflated. In BERMUDEZ's figures the sutures of the dorsal side are more limbate than in our specimens. The apertural arch of our individuals often reaches the peripheral margin, instead of it being confined to the central portion of the inner margin of the final chamber.

Some similarity is apparent with *Asterigerina primaria* PLUMMER (1926, Univ. Texas Bull., no. 2644, p. 157, pl. 12, f. 8), which differs by the greater supplementary chambers, and the limbate and less curved sutures of the dorsal side.

Our specimens furthermore resemble *Asterigerina hadleyi* HOWE and ROBERTS (1939, Louis. Dept. Cons., Geol. Bull. no. 14, p. 79, pl. 10, f. 13, 14), which species differs by the coarsely perforated dorsal side, the limbate dorsal sutures, the not-inflated chambers, and the small apertural opening near the umbilicus.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Brussels;
France : Sands of Cuise.

***Asterigerina* sp. cf. *A. glabra* (BERMUDEZ)**

Pl. XV, fig. 5; 192

cf. *Asterigerinata globulospinosa* (CUSHMAN) var. *glabra* BERMUDEZ, 1952, Mem. Soc. Cien. Nat. La Salle, vol. 12, no. 32, p. 209, pl. 3, f. 4-6 (Eocene; Mexico).

Remarks. — Most of our specimens show greater secondary chambers than BERMUDEZ's figures. Sometimes the apertures as well as the supplementary chambers reach the peripheral margin, but in general they are well removed from the periphery. The secondary chambers may be slightly inflated.

Distribution. — Belgium : Sands of Lede, Sands of Wemmel, Clays of Asse.

***Asterigerina* sp.**

Pl. XV, fig. 6; 94

Remarks. — Especially in the Upper Eocene we found a great number of single specimens of a small *Asterigerina* species. They are characterized by a more or less semiglobular test, a concave ventral side, a rounded periphery, three to five chambers in the last whorl, which are more or less inflated, and small and often indistinct supplementary chambers.

In general form they resemble *Discorbis lauriei* (HERON-ALLEN and EARLAND) (*Discorbina lauriei* HERON-ALLEN and EARLAND, 1924, Jour. Linn. Soc. London, Zool., vol. 35, p. 633, pl. 36, f. 50-52, pl. 37, f. 53-55).

Probably our specimens are variants of *Asterigerina* sp. cf. *A. glabra*, but intermediate types were not found.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Lede, Sands of Wemmel, Clays of Asse;

England : Upper Bracklesham beds, Barton beds.

Genus EPISTOMARIA GALLOWAY, 1933

Type species DISCORBINA RIMOSA PARKER and JONES, 1862

***Epistomaria semimarginata* (D'ORBIGNY)**

149

Rotalia semi-marginata D'ORBIGNY, 1850, Prodrôme Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407 (Lutetian; Paris basin).

Rotalina semi-marginata (D'ORBIGNY), TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 56, pl. 3, f. 12-14.

Epistomaria semi-marginata (D'ORBIGNY), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pl. 2, p. 33.

Distribution. — France : Lutetian.

FAMILY GLOBIGERINIDAE

Genus HASTIGERINA THOMSON, 1876

Type species HASTIGERINA MURRAYI THOMSON, 1876

Hastigerina micra (COLE)

Pl. XVI, fig. 5, 6; 117

Nonion micrus COLE, 1927, Bull. Am. Pal., vol. 14, no. 51, p. 22, pl. 5, f. 12 (Eocene; Mexico).

Globigerinella (?) *micra* (COLE), GRIMSDALE, 1951, Proc. 3rd World Petrol. Congr., section 1, p. 468.

Globigerinella micra (COLE), SUBBOTINA, 1953, Trudy Vses. Neft. Naukno.-Issledov., Geol.-Razv. Inst., New Series, no. 76, pl. 13, f. 16, 17; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 162, pl. 11, f. 6.

Hastigerina micra (COLE), BOLLI, 1957, U. S. Nat. Mus., Bull. 215, p. 161, pl. 35, f. 2.

Globigerinella pseudovoluta BANDY, 1949, Bull. Am. Pal., vol. 32, no. 131, p. 123, pl. 24, f. 4 (Eocene; Alabama).

Remarks. — Most specimens show a high, arched basal opening. Others possess a lower aperture in which the septal face touches the previous whorl, thus dividing the aperture into two openings. The coarseness of the pores is somewhat variable, mostly they are fine.

GRIMSDALE recognized that *Globigerinella micra* and *G. pseudovoluta* belong to one species. Some variants in our material, identical with BANDY's species, show a slightly evolute test, but in others the previous whorls are hardly visible.

Distribution. — Belgium : Sands of Lede, Sands of Wemmél, Clays of Asse; Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Lede, Sands of Wemmél.

Genus GLOBIGERINA D'ORBIGNY, 1826

Type species GLOBIGERINA BULLOIDES D'ORBIGNY, 1826

Globigerina triloculinoides PLUMMER

Pl. XVI, fig. 7; 39

Globigerina triloculinoides PLUMMER, 1926, Univ. Texas Bull., no. 2644, p. 134, pl. 8, f. 10 (Paleocene; Texas); SUBBOTINA, 1953, Trudy Vses. Neft. Naukno.-Issledov., Geol.-Razv. Inst., New Series, no. 76, pl. 11, f. 15, pl. 12, f. 1, 2; BOLLI, 1957, U. S. Nat. Mus., Bull. 215, p. 70, pl. 15, f. 18-20; TROELSEN, 1957, U. S. Nat. Mus., Bull. 215, p. 129, pl. 30, f. 4.

Remarks. — Our specimens of the Lower Eocene are all characterized by the reticulate surface, and the globular chambers. The fairly low apertural slit is often provided with a lip. In most specimens the chambers are rapidly enlarging, others show a more gradual increase in chamber size.

Distribution. — LOEBLICH and TAPPAN (1957, U. S. Nat. Mus., Bull. 215, p. 175) recorded this species from the whole Paleocene of the Gulf and Coastal Plains of the U. S. A. SUBBOTINA (1953) found *Globigerina triloculinoides* in deposits from Paleocene to Middle Eocene age, as did GRIMSDALE (1951, Proc. 3rd World Petrol. Congr., sect. 1, p. 466).

Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle;
Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds.

Globigerina sp. cf. *G. angustumbricata* BOLLI

Pl. XV, fig. 7, 8; 214

cf. *Globigerina ciproensis angustumbricata* BOLLI, 1957, U. S. Nat. Mus., Bull. 215, p. 109, pl. 22, f. 12, 13, p. 164, pl. 36, f. 6 (Oligocene; Trinidad).

Remarks. — Our specimens tentatively described as *Globigerina angustumbricata* more or less resemble BOLLI's figures. Some individuals show more depressed ventral sutures than is indicated by BOLLI, but these sutures never become as distinctly depressed and U-shaped as in *G. ciproensis angulisuturalis* BOLLI (1957, op. cit., p. 109, pl. 22, f. 11). Some specimens show a somewhat coarser perforation of the test than seems to be typical for *G. angustumbricata*.

The aperture is a low, arched slit, often bordered by a thin lip, and opening into the small umbilicus. A few individuals show a greater umbilicus. The aperture of these specimens is somewhat higher than is found in *Globigerina angustumbricata*. They better resemble the figures of *G. ciproensis ciproensis* BOLLI (1957, op. cit., pl. 22, f. 10) (see our figure 7).

Distribution. — Belgium : Sands of Ledde, Sands of Wemmel, Clays of Asse;
England : Barton beds;
Netherlands (Woensdrecht) : Sands of Ledde.

Globigerina sp. cf. *G. varianta* SUBBOTINA

Pl. XV, fig. 9, 10; 38

cf. *Globigerina varianta* SUBBOTINA, 1953, Trudy Vses. Neft. Naukno-Issledov., Geol.-Razv. Inst., New Series, vol. 76, pl. 3, f. 5-12, pl. 4, f. 1-3, pl. 15, f. 1-3 (Eocene; U. S. S. R.).

cf. *Globorotalia varianta* (SUBBOTINA), LOEBLICH and TAPPAN, 1957, U. S. Nat. Mus., Bull. 215, p. 196, pl. 44, f. 1, 2, pl. 45, f. 4.

Remarks. — Specimens of this species, the most numerous *Globigerina* type in the Belgian Lower Eocene, are in fairly good accordance with SUBBOTINA's figures. The height of the coils is somewhat variable. Some specimens resemble *G. pseudobulloides* PLIMMER (1926, Univ. Texas Bull., no. 2644, p. 133, pl. 8, f. 9) in which species the spiral side is flattened and the initial whorl depressed to slightly convex. They differ from *G. pseudobulloides* by the spinose surface. The number of chambers varies between four and five, specimens with six chambers in the final coil are very scarce. Often the early chambers are somewhat more spinose than the later ones, which may be entirely smooth. The aperture is a high, arched opening, bordered by a distinct lip. In a number of specimens this lip has a more or less triangular form, widest in the middle.

Our specimens also resemble *Globigerina prolata* BOLLI (1957, U. S. Nat. Mus., Bull. 215, p. 72, pl. 15, f. 24-26), but they differ by the more spinose surface.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle;
Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds.

Globigerina spp.

128

Remarks. — The few ill-preserved *Globigerinae* of the Sands of Brussels could not be determined specifically.

Distribution. — Belgium : Sands of Brussels.

Genus **GLOBIGERINOIDES** CUSHMAN, 1927

Type species **GLOBIGERINA RUBRA** D'ORBIGNY, 1839

Globigerinoides sp. cf. **G. daubjergensis** (BRÖNNIMANN)

Pl. XV, fig. 11: 40

- cf. *Globigerina daubjergensis* BRÖNNIMANN, 1953, *Eclog. Geol. Helv.*, vol. 45, no. 2, p. 340, f. 1 (Paleocene; Denmark); TROELSEN, 1957, *U. S. Nat. Mus., Bull.* 215, p. 128, pl. 30, f. 1, 2; BOLLI, 1957, *U. S. Nat. Mus., Bull.* 215, p. 70, pl. 16, f. 13-15.
cf. *Globigerinoides daubjergensis* (BRÖNNIMANN), LOEBLICH and TAPPAN, 1957, *U. S. Nat. Mus., Bull.* 215, p. 184, pl. 40, f. 1, 8, pl. 41, f. 9, pl. 42, f. 6, 7, pl. 43, f. 1, pl. 44, f. 7, 8.

Remarks. — Our small specimens are always high-spired. Specimens with four chambers in the final coil are the most numerous, but individuals with five chambers occur as well. The low aperture opens into the small umbilicus. The finely perforated surface is usually spinose; some specimens with a smooth surface were noted. The latter resemble *Globigerina spiralis* BOLLI (1957, *U. S. Nat. Mus., Bull.* 215, p. 70, pl. 16, f. 16-18).

Secondary apertures, typical for *Globigerinoides*, could often not be observed, but this may be due to the state of preservation.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle;
Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds.

FAMILY GLOBOROTALIIDAE

Genus **GLOBOROTALIA** CUSHMAN, 1927

Type species **PULVINULINA MENARDII** (D'ORBIGNY) var. **TUMIDA** H. B. BRADY, 1877

Globorotalia spp.

85

Remarks. — Some scattered young specimens of *Globorotalia* were found. The specimens of the Sands of Mons-en-Pévèle resemble *G. lensiformis* SUBBOTINA (1953, *Trudy Vses. Neft. Naukno-Issledov., Geol.-Razv. Inst., New Series*, vol. 76, pl. 18, f. 4, 5), but they may as well be young specimens of other similar *Globorotalia* species.

Distribution. — Belgium : Sands of Mons-en-Pévèle, Sands of Lede.

Genus CYCLOLOCULINA HERON-ALLEN and EARLAND, 1908

Type species CYCLOLOCULINA ANNULATA HERON-ALLEN and EARLAND, 1908

Cycloloculina sp. cf. **C. punctata** (TERQUEM)

132

cf. *Planorbulina punctata* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 91, pl. 9, f. 18 (Lutetian; Paris basin).cf. *Cycloloculina punctata* (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 41, pl. 6, f. 93, 94.

Remarks. — Some specimens were found resembling this Lutetian species. A single individual with bridges across the sutures of the last circular chambers, met with in the Brussels Sands, resembles the figure of Y. LE CALVEZ of *Cycloloculina eocenica* (TERQUEM) (*Planorbulina eocenica* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 90, pl. 9, f. 15; *Cycloloculina eocenica* (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 42, pl. 6, f. 96).

Distribution. — Belgium : Sands of Brussels, Sands of Lede;
France : Lutetian.

Genus GLOBOTRUNCANA CUSHMAN, 1927

Type species PULVINULINA ARCA CUSHMAN, 1926

Globotruncana spp.

Remarks. — Reworked specimens of *Globotruncana* were found in a number of samples of the Belgian Eocene, often together with other Cretaceous foraminifera, such as *Buliminella* sp., *Planulina stelligera* and *Gümbelina* spp.

Especially in dorsal view, our specimens of the Lutetian of the Paris basin resemble the figures of TERQUEM of *Rotalina lobata* TERQUEM (1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 63, pl. 4, f. 11) redescribed by Y. LE CALVEZ (1952, Mém. Expl. Carte Géol. dét. France, pt. 4, p. 50, pl. 4, f. 40, 41) as *Boldia lobata*.

In 1946 VAN BELLEN described the genus *Boldia* with *Rotalina lobata* TERQUEM as type species. The value of this generic name may be doubted as long as the exact nature of the type specimen is not clarified. If the type specimen of *Rotalina lobata* does belong to *Globotruncana*, the name *Boldia* is a synonym.

FAMILY GÜMBELINIDAE

Genus GÜMBELINA EGGER, 1899

Type species TEXTULARIA GLOBULOSA EHRENBERG, 1840

Gümbelina spp.

Pl. XV, fig. 12

Remarks. — In some samples a few, mostly broken and silicified specimens of *Gümbelina* were found. Probably they have been reworked from Cretaceous strata; they occur together with *Globotruncana* specimens.

FAMILY ELPHIDIIDAE

Genus ELPHIDIUM MONTFORT, 1808

Type species NAUTILUS MACELLUS FICHTEL and MOLL, 1798

Elphidium laeve (D'ORBIGNY)

Pl. XVI, fig. 15, 16; 68

Nonionina laevis D'ORBIGNY, 1865, in PARKER, JONES, and BRADY, Ann. Mag. Nat. Hist., vol. 16, ser. 3, pl. 3, f. 97 (Eocene; Paris basin); TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 44, pl. 2, f. 12-14.

Nonion laeve (D'ORBIGNY), CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper no. 191, p. 3, pl. 1, f. 6, 7; TEN DAM, 1944, Meded. Geol. Stichting, ser. C, vol. 5, no. 3, p. 108; Y. LE CALVEZ, 1950, Mém. Expl. Carte Géol. dét. France, pt. 3, p. 52.

Remarks. — Some of our specimens of the Lutetian of the Paris basin as well as of those of the Belgian Eocene showed small sutural openings and hence, the distinct belonging of the species to *Elphidium*.

CUSHMAN (1939) described the aperture as a low opening at the base of the last chamber, but specimens from Grignon showed a row of pores at the inner margin of the last chamber.

The species resembles *Elphidium cryptostomum* (EGGER) (*Polystomella cryptostoma* EGGER, 1857, Neues Jahrb. Min., etc., p. 301, pl. 9, f. 19, 20) which is possibly identical.

Small specimens of *Elphidium laeve* and *E. subnodosum* are sometimes difficult to separate from each other. The umbilical knob is occasionally developed as a mass of granules, resembling the ornamentation of our *Nonion graniferum* (TERQUEM).

Distribution. — Belgium: Clays of Ieper, Sands of Mons-en-Pévèle, Clays of Roncq, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
 England: London Clay, Barton beds;
 France: Sands of Cuise, Lutetian;
 Netherlands (Woensdrecht): Lower Panisel beds, Sands of Brussels, Sands of Lede.

Elphidium subnodosum (ROEMER)

Pl. XVI, fig. 17, 18; 53

Robulina subnodosa ROEMER, 1838, Neues Jahrb. Min., etc., p. 391, pl. 3, f. 61 (Miocene; Germany).
Elphidium subnodosum (ROEMER), CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper no. 191, p. 40, pl. 11, f. 2; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 163, pl. 8, f. 12, 13.

Remarks. — Our specimens, scattered throughout the whole column, are regarded to be conspecific with the forms described by BATJES from the Oligocene. Distinct specimens as figured by BATJES in figure 12 were not encountered in our material. Sometimes individuals resembling the one of his figure 13 were met with, but they have somewhat more indistinct sutural openings.

The majority of our material is formed by young specimens. They are identical with the small specimens, which in BATJES' material were found together with distinct larger individuals. They differ from our *Elphidium laeve* in having no depression around the umbo.

Distribution. — Belgium : Clays of Ieper, Sands of Mons-en-Pévèle, Sandy Clays of Anderlecht, Sands of Aalter, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England : London Clay, Barton beds;

Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Aalter, Sands of Brussels, Sands of Lede.

***Elphidium hiltermanni* HAGN**

112

Elphidium hiltermanni HAGN, 1952, Geol. Bav., no. 10, p. 163, pl. 1, f. 6, pl. 2, f. 14 (Miocene; Germany);
BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 165, pl. 12, f. 4.

Remarks. — Our few specimens have more in common with those of BATJES than those of HAGN.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel;

England : Upper Bracklesham beds;

Netherlands (Woensdrecht) : Lower Panisel beds.

***Elphidium latidorsatum* (REUSS)**

Pl. XV, fig. 13, 14; 65

Polystomella latidorsata REUSS, 1864, Denkschr. K. Akad. Wiss. Wien, vol. 23, p. 10, pl. 1, f. 6 (Oligocene; Germany).

Elphidium latidorsatum (REUSS), CUSHMAN, 1939, U. S. Geol. Survey, Prof. Paper no. 191, p. 39, pl. 10, f. 16.

Remarks. — Small specimens referable to *Elphidium latidorsatum* occur throughout the Belgian Eocene. They have a rounded periphery, six to eight chambers, and small retral processes, up to twenty in the last formed chambers. The umbilicus is usually small and depressed, some specimens show an umbilical filling; the degree of compression of test is variable.

Specimens with inflated chambers resemble *Elphidium rischtanicum* БУКОВА var. *ferganensis* БУКОВА (1939, Trudy Neft. Geol.-Razv. Inst., ser. A, vol. 121, pp. 27, 36, pl. 3, f. 13, 14), which is different by an inflated umbo.

A number of specimens have fine, longitudinal striae on the early part of the last whorl. Often the striae are also present on the apertural face.

Elphidium minutum (REUSS) (*Polystomella minuta* REUSS, 1865, Sitz. Ber. K. Akad. Wiss. Wien, vol. 50, p. 478, pl. 4, f. 6) resembles our *E. latidorsatum*, but it has more chambers (ten to fourteen) in the last coil, and more distinct retral processes.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Lower Panisel beds, Sands of Brussels, Sands of Lede, Sands of Wemmel;

England : London Clay, Barton beds;

Netherlands (Woensdrecht) : Clays of Ieper, Sands of Mons-en-Pévèle, Lower Panisel beds.

FAMILY ROTALIIDAE

Genus ROTALIA LAMARCK, 1804

Type species ROTALIA TROCHIDIFORMIS LAMARCK, 1804

Rotalia audouini D'ORBIGNY

Pl. XVI, fig. 8-10; 24

- Rotalia audouini* D'ORBIGNY, 1850, Prodrôme Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407 (Lutetian; Paris basin); FORNASINI, 1906, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 3, p. 65, pl. 2, f. 9, 10; Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 29; KAASSCHIETER, 1955, Verh. Kon. Ned. Akad. Wetensch., afd. Nat., ser. 1, vol. 21, no. 2, p. 84, pl. 9, f. 3.
- Rotalina audouini* (D'ORBIGNY), TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 72, pl. 6, f. 11.
- Rotalia armata* D'ORBIGNY, 1850, Prodrôme Pal. Strat. Univ. Anim. Moll. Ray., vol. 3, p. 157 (Miocene; France and recent; West Indies); Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 29.
- Rotalina armata* (D'ORBIGNY), TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 67, pl. 5, f. 14, 15.
- Pararotalia armata* (D'ORBIGNY), LOEBLICH and TAPPAN, 1957, Smiths. Misc. Coll., vol. 135, no. 2, p. 9, pl. 5, f. 2.
- Rotalina inermis* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 68, pl. 6, f. 1 (Lutetian; Paris basin).
- Pararotalia inermis* (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 32, pl. 3, f. 54-56; LOEBLICH and TAPPAN, 1957, Smiths. Misc. Coll., vol. 135, no. 2, p. 14, pl. 1, f. 2, 3.
- Rosalina spinigera* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 97, pl. 10, f. 10 (Lutetian; Paris basin).
- Globorotalia spinigera* (TERQUEM), Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 39, pl. 6, f. 97-99.
- Rotalia spinigera* (TERQUEM), GULLENTOPS, 1956, Mém. Inst. Géol. Univ. Louvain, vol. 20, p. 17, pl. 1, f. 15, 16.
- Pararotalia spinigera* (TERQUEM), LOEBLICH and TAPPAN, 1957, Smiths. Misc. Coll., vol. 135, no. 2, p. 18, pl. 4, f. 1-3.
- Rotalia canui* CUSHMAN, 1928, Bull. Soc. Sci. Seine-et-Oise, ser. 2, vol. 8, p. 55, pl. 3, f. 2 (Oligocene; Paris basin); BHATIA, 1955, Jour. Pal., vol. 29, p. 684, pl. 66, f. 32; BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 168, pl. 12, f. 5-7.
- Pararotalia subinermis* BHATIA, Jour. Pal., vol. 29, p. 683, pl. 67, f. 3 (Oligocene; Wight).

Remarks. — *Rotalia audouini* s. str. is characterized by depressed sutures on the ventral side of the test, a more or less elevated plug surrounded by a distinct furrow, and a keeled, lobulate periphery, often ornamented with spines.

The *armata*-variant has a stellate outline, and around the umbo there is a series of nodes, which correspond to the inner parts of the chambers. Intermediates between the *audouini* and the *armata* types are much more numerous than the types themselves. They were referred to by LOEBLICH and TAPPAN as *Pararotalia inermis*, which is not exactly the same as the type of TERQUEM's species.

The *spinigera* type lacks the umbilical plug, and it has a *Globorotalia*-like aperture in the last-formed chamber. However, specimens with such an aperture in the last chamber and with a distinct umbilical plug are more common. The *spinigera* variant is furthermore connected with the *armata* type by a series of specimens with small umbilical knobs. Broken specimens of this *spinigera* variant showed that penultimate chambers never possess a *Globorotalia*-like aperture, which opens into the umbilicus.

Most variation is found among juvenile specimens. The adult specimens of a sample mostly belong to only one of the mentioned varieties. The presence of spines along the keel is common in young individuals, adult ones generally show a lobulate periphery. Commonly there is only one spine per chamber. A peripheral keel is nearly always present, but some specimens show a more or less rounded periphery. They resemble *Rotalia canui*. This type appeared to be common in the Oligocene (BATJES, 1958, p. 168).

The plug is variable. In distinct *armata* forms it is large, rounded and well elevated, in others it is frequently smaller, and it is completely absent in the *spinigera* variants.

The aperture varies between a large opening along the entire inner margin and a narrow, elliptical opening in the apertural face, more or less removed from the base, and provided with lips below and above the slit. This apertural type was considered typical for the genus *Pararotalia* by Y. LE CALVEZ and by LOEBLICH and TAPPAN. In our material it was found more often in penultimate chambers than in final ones. LOEBLICH and TAPPAN described this apertural type to be due to the development of a plate, which covers the umbilical portion of the aperture. Mostly this plate overlies the whole basal part of the aperture along the inner margin, leaving a slit-like opening roughly parallel to the base of the apertural face. Sometimes, however, the plate extends less far to the peripheral margin, and the slit still reaches the base of the chamber margin.

This *Pararotalia* type of aperture was also found in our *audouini* specimens, though LOEBLICH and TAPPAN described the aperture of *Rotalia audouini* to be always completely basal and without umbilical plate.

Distribution. — Belgium : Clays of Ieper, Clays of Roubaix, Sands of Mons-en-Pévèle, Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;
 England : Upper Bracklesham beds, Barton beds;
 France : Lutetian;
 Netherlands (Woensdrecht) : Lower Panisel beds, Sands of Brussels.

***Rotalia* sp. cf. *R. calvezae* (LOEBLICH and TAPPAN)**

Pl. XVI, fig. 11; 114

cf. *Pararotalia calvezae* LOEBLICH and TAPPAN, 1957, Smithsonian Misc. Coll., vol. 135, no. 2, p. 12, pl. 2, f. 3-7 (Eocene; France).

Remarks. — Some scattered, small and juvenile specimens resemble *Rotalia calvezae*. Spines on the periphery are but faint, a furrow around the plug is indistinct. The periphery is rounded, but some specimens with a slight keel were found as well. The aperture is commonly an arched opening at the inner margin of the last-formed chamber. A number of specimens showed the features of *Pararotalia* Y. LE CALVEZ with an aperture removed from the base of the chamber. Some specimens without an umbilical plug were noted.

The specimens are often ill-preserved. Thus a more certain determination is impossible.

Distribution. — Belgium : Sandy Clays of Anderlecht, Sands of Brussels, Sands of Lede;
 Netherlands (Woensdrecht) : Lower Panisel beds.

Rotalia propingua REUSS

Pl. XVI, fig. 12; 145

Rotalia propingua REUSS, 1856, Sitz. ber. K. Akad. Wiss. Wien, vol. 18, p. 241, pl. 4, f. 53 (Oligocene; Germany); BATJES, 1958, Mém. Inst. R. Sc. Nat. Belg., no. 143, p. 167, pl. 12, f. 11.

Remarks. — Our specimens better resemble BATJES' figures than those of REUSS. They often show deep grooves in the sutures near the umbilicus. This feature was also met with in BATJES' specimens from the German Upper Oligocene.

Some variation is found in the convexity of the dorsal and ventral sides. In typical specimens the dorsal side is convex and the ventral side nearly flat, but sometimes the test is about equally biconvex.

Rotalia papillosa D'ORBIGNY (1850, Prodrôme Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407; FORNASINI, 1906, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 3, p. 64, pl. 2, f. 6) has more chambers and a more distinctly granular umbilical filling. No indications of sutural grooves are to be found in FORNASINI's figures.

Distribution. — Belgium : Sands of Brussels, Sands of Lede, Sands of Wemmel, Clays of Asse;

England : Upper Bracklesham beds, Barton beds;

France : Lutetian;

Netherlands (Woensdrecht) : Sands of Lede.

Rotalia spp.

51

Remarks. — In the Belgian Eocene, as well as in the Lutetian of the Paris Basin, some other *Rotalia* species were recognized. The Belgian material is rather ill-preserved, and the different species mostly occur in very low numbers.

Three types could be distinguished :

Rotalia thouini D'ORBIGNY (1850, Prodrôme Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407; FORNASINI, 1906, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 3, p. 64, pl. 2, f. 7) - plate XVI, fig. 13.

Single specimens in MMV 1201 (Sands of Mons-en-Pévèle) and CO 1240 (basal strata of the Sands of Brussels).

Rotalia guerini D'ORBIGNY (1850, Prodrôme Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407; FORNASINI, 1906, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 3, p. 65, pl. 2, f. 8).

Some specimens in three samples of the Brussels Sands of the Woensdrecht boring.

Rotalia perovalis (TERQUEM) (*Rotalina perovalis* TERQUEM, 1882, Mém. Soc. Géol. France, ser. 3, vol. 2, p. 70, pl. 6, f. 5).

Single specimens in NX 91 and 95 (Clays of Ieper and Sands of Mons-en-Pévèle, respectively), in CM 51 and Woensdrecht 364 m (Sands of Brussels).

The individuals of other samples are too ill-preserved and fragmentary for specific determination.

In our samples of Grignon (CAB) we found in association with *Rotalia guerini* and *R. perovalis* some other species, such as :

Rotalia trochidiformis LAMARCK (1804, Ann. Mus., vol. 5, p. 184; vol. 8, pl. 14, f. 8),
Rotalia complanata D'ORBIGNY (1850, Prodrome Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 407; FORNASINI, 1906, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 3, p. 67, pl. 3, f. 9), and
Rotalia suessonensis D'ORBIGNY (1850, Prodrome Pal. Strat. Univ. Anim. Moll. Ray., vol. 2, p. 336; FORNASINI, 1906, Mem. R. Accad. Sci. Ist. Bologna, ser. 6, vol. 3, p. 66, pl. 3, f. 2).

FAMILY VICTORIELLIDAE

Genus GYROIDINELLA Y. LE CALVEZ, 1949

Type species GYROIDINELLA MAGNA Y. LE CALVEZ, 1949

Gyroidinella magna Y. LE CALVEZ

Pl. XVI, fig. 14; 129

Gyroidinella magna Y. LE CALVEZ, 1949, Mém. Expl. Carte Géol. dét. France, pt. 2, p. 27, pl. 6, f. 103-105 (Lutetian; Paris basin).

Remarks. — Specimens of *Gyroidinella magna* were found only in section THB (Nalinnes) of the Belgian Eocene.

HAGN (1955, Pal. Zeitschr., vol. 29, pt. 1/2, p. 66) described the features of *Gyroidinella* and *Eorupertia*. Pillars, characterizing the chamber walls of *Eorupertia*, are completely absent in our specimens.

Distribution. — Belgium : Sands of Brussels.

SUMMARY

A systematic study of the foraminifera from the Belgian Eocene has been carried out. The examined material has been collected from more than 450 surface samples. For a more complete knowledge of the foraminiferal assemblages a number of well samples of the Geological Survey of Belgium were at our disposal. Furthermore the Eocene core samples from the Woensdrecht-well (the Netherlands) have been investigated. To compare the faunas of the Belgian and Dutch Eocene formations a number of samples from the type localities of the most important formations of the Paris and the Hampshire basins were available.

Altogether some 225 species and varieties were recognized, of which 13 are new. Furthermore 2 existing species had to be renamed.

The ostracods of most of our samples have been described by KEIJ (1957).

Some remarks about the studied foraminiferal assemblages have been added, as well as some conclusions about the Belgian Eocene stratigraphy. It is suggested that the Brussels formation and part of the Lower Panisel beds are of the same age and both belong to the Lutetian. Serious doubt is expressed about the existence of Ledian and Bartonian as separate stages in the Late Eocene, and both may have to be united as Bartonian. Some more facts supporting a time-equivalence of the Late Bartonian and the Early Tongrian have been given.

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On the occasion of the writer taking his degree at the State University of Utrecht in April 1959, a summary of the present paper was published in Dutch under the same title. Except for one note about the Sands of Oostende the manuscript of the present paper has not been modified since its presentation in April 1959.

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