

FORAMINIFERA FROM THE BAY OF JAKARTA, JAVA

by

J. HOFKER Sr.

INTRODUCTION

Foraminifera from the North coast of Java have been described by MILLET (1898-1904); by KEIJZER (1935). The Siboga Expedition did not sample on the Java coast; most of the species described by Millet were also collected elsewhere in the Indonesian Archipelago. Keijzer did not have the intention to describe the faunas he gathered, but he mentions the occurrence of many species at the coast at Rembang, East of Soerabaia and the Strait of Madoera. The list of species described by him is as follows:

Cornuspira involvens (Reuss); not found in the Bay of Jakarta.
Biloculina vespertilio Schlumberger; idem.
Triloculina tricarinata d'Orbigny; found in the Bay of Jakarta.
Triloculina trigonula (Lamarck); not found in the B. of J.
Triloculina rupertiana (Brady); found in the B. of J.
Triloculina fichteliana d'Orbigny; found in the B. of J.; now known as *Flintina bradyana* Cushman.
Spiroloculina planissima (Lamarck); not found in B. of J.
Spiroloculina depressa d'Orbigny; not found in B. of J.
Spiroloculina grateloupi d'Orbigny; found in B. of J.; given here as *S. communis*
Spiroloculina nitida d'Orbigny; not found in B. of J.
Quinqueloculina venusta Karrer; not found in B. of J.
Quinqueloculina kerimbatica (Heron-Allen and Earland); found in B. of J.
Quinqueloculina seminulum (Linné); found in B. of J.; it is in reality *Quinqueloculina bicostata* d'Orbigny.
Massilina agglutinans Keijzer; not found in B. of J.; this was not a new species, as Keijzer believed, but *Pseudomassilina australis* Cushman, 1932, as the inner structure proves.
Discorbis globularis (d'Orbigny); not found in B. of J.
Operculina complanata (Defrance); found in the B. of J.

Textularia gramen d'Orbigny; found in the B. of J.; this is *Textularia kerimbaensis* Said.

Textularia agglutinans d'Orbigny; found in the B. of J.; this is *Valvotextularia foliacea* (Heron-Allen and Earland).

Rotalia papillosa Brady; found in B. of J.; this is *Rotalidium concinnum* (Millet).

Rotalia schroeteriana Parker and Jones; found in B. of J.; now known as *Pseudorotalia*.

The material studied here was originally collected by the Laboratory for Investigation of the Sea at Batavia, in 1937 and later years (textfig. 1). It was gathered for the study of the molluscs, but the finer residues contained many Foraminifera. As will be seen from the chart, Foraminifera were found mainly in the western part of the Bay of Jakarta; from the Eastern and coastal stations no Foraminifera were collected; this may be a consequence of the low salinity of these parts. The richer faunas were found in the north-western part; the direction of the current is from west to east, so in this part the salinity will have been high, as well as the concentration of O₂. In the eastern part, the salinity must have been low, and much detritus must have been found there from rivers and sewage. From north-west to south-east the samples contain less and less species of Foraminifera, till in the Stations H 4, F 3, G 3, E 2 the samples mainly contain many specimens of *Pseudorotalia schroeteriana*, *Asterorotalia pulchella* and *Elphidium batavum*.

On the shell-fragments in the, obviously, not so muddy north-western part of the bay many attached species of Foraminifera were found; this will mean that when collecting would have been carried out between the corals of the islands in that part many more of these Foraminifera would have been found. On the debris found in the muddy stations no attached Foraminifera were discovered.

Miliolids are common in many of the samples, but become rare towards the southern and eastern part of

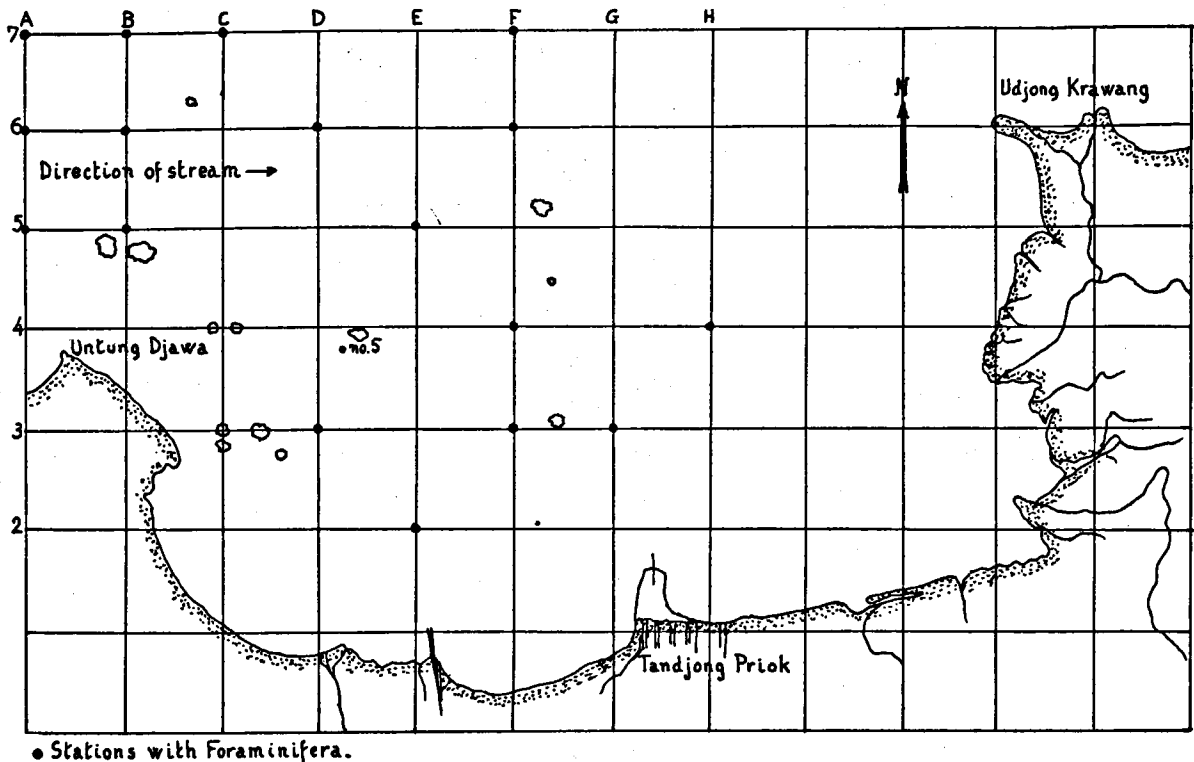


Fig. 1. Bay of Jakarta.

the bay; *Baculogypsinoidea spinosus* was very common in the Stations A 7, B 7, C 7, B 6 and A 5; somewhat less common is *Calcarina spengleri* in these samples; these are the samples which are in contact with the western stream. Very abundant was *Nummulites complanatus* in St. A 5, B 5, E 5 and No.5. It was absent in the St. F 4, H 4, F 3 and E 2. *Elphidium batavum* was found in all samples but A 7 and B 7. *Pseudorotalia schroeteriana* was not found in the St. A 7, B 7, C 7, A 6, B 6, D 6, A 5; it seems to prefer muddy, less aerated habitats.

Some smaller and uncommon species have not been mentioned; the author believes that they do not belong to the real fauna of the bay.

The distribution of the fauna in the stations is to be found in text fig. 2.

The study of this distribution chart shows that there are species which prefer aerated bottom, viz.

Bigenerina nodosaria
Textularia kerimbaensis
Valvotextularia foliacea
Spiroloculina communis
Flintina bradyana
Dendritina striatopunctata

Miniacina miniacea
Calcarina spengleri
Baculogypsinoidea spinosus
Parrellina hispidula
Heterostegina curva
Amphistegina sp.

There are also ubiquitous, with preference for aerated water, such as *Nummulites complanatus*; others even prefer the silty mud, badly aerated, such as *Asterorotalia pulchella* and *Pseudorotalia schroeteriana*. These species form the bulk of the Foraminifera found in such stations, in which the fauna consists of very few species and becomes very monotonous. No species were found which only occur in these unfavorable environments; only ubiquitous can settle here, obviously. Remarkable is that the total number of species rapidly decreases from 21 to 3 when the aeration of the bottom decreases; it is possible that the salinity also is a cause here; but obviously the well aerated bottom with much chalky debris in the north-west is preferred to the muddy bottom in the south-east. It is remarkable that no samples from the southern and eastern part were available yielding Foraminifera. Ubiquitous, not showing preference, is the new species

Station indications (From NW to SE)	A7	B7	C7	A6	B6	A5	B5	D6	F7	F6	5	E5	F4	D3	F3	G3	E2	H4
<i>Sagenina frondescens</i>	•	•		•														
<i>Placopsilina bradyi</i>	•	•																
<i>Reophax scorpiurus</i>						•		•	•		•							
<i>Bdelloidina aggregata</i>	⊙																	
<i>Bigenerina nodosaria</i>		•	•			•	•	•	•		•					•		
<i>Textularia kerimbaensis</i>	•	•			•	•		•										
<i>Valvotextularia foliacea</i>	•	•		•		•			•		•	•				•		
<i>Valvotextularia rugulosa</i>	•					•												
<i>Clavulina pacifica</i>						•												
<i>Spiroloculina communis</i>	•		•	•	•	•	•	•	•	•					•	•		
<i>Quinqueloculina kerimbatica</i>		•	•	•	•	•	•	•	•	•	•		•		•	•		•
<i>Quinqueloculina bicarinata</i>		•	•		•		•	•	•	•	•	•	•		•	•	•	•
<i>Quinqueloculina curta</i>		•						•	•		•							
<i>Quinqueloculina bidentata</i>		•	•	•	•	•					•				•			
<i>Flintina bradyana</i>	•		•		•	•		•	•									
<i>Triloculina tricarinata</i>	•					•			•									
<i>Triloculina rupertiana</i>	•																	
<i>Schlumbergerina areniphora</i>				•		•		•										
<i>Dendritina striatopunctata</i>		•	•	⊙		•	•	•	•	•	•	•						
<i>Discogypsina vesicularis</i>	•								•									
<i>Sphaerogypsina globulus</i>	•																	
<i>Gypsina plana</i>	•																	
<i>Miniacina miniacea</i>	•	•		•														
<i>Planorbulinella larvata</i>	•				•													
<i>Biarritzina proteiformis</i>	•																	
<i>Carpenteria utricularis</i>	•																	
<i>Calcarina spengleri</i>		•	•	•	•	•	•											
<i>Baculogypsinooides spinosus</i>	⊙	⊙	•	•	•	•	•	•	•									
<i>Asterorotalia pulchella</i>		•	•		•	•	•	•	•	•	•	•	•		•	•	⊙	
<i>Rotalidium concinnum</i>		•			•	•	•	•			•	•				⊙		•
<i>Pseudorotalia schroeteriana</i>			•	•		•	•	•	•	•	•	•	•	⊙	•	⊙	•	⊙
<i>Parrellina hispidula</i>		•	•		•	•		•	•		•	•						
<i>Elphidium batavum</i>		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Nummulites complanatus</i>		•	⊙	•	⊙	•	•	•	•	•	•	•	•	•		•		•
<i>Heterostegina curva</i>	•																	
<i>Amphistegina</i> sp.	•	•		•	•													
Number of species p. Stat.	20	19	14	13	15	22	12	17	17	8	14	9	6	3	7	10	4	6

Fig. 2. Occurrences of species in the stations in which Foraminifera were observed.

• = the species occurs.

⊙ = the species is very abundant.

The genus *Amphistegina* is also given; yet the specimens were rare in the stations and all specimens were much eroded so that it is not certain that they belong to the faunae. No description in the text is given for this reason.

Elphidium batavum which shows an equal abundance in all the samples but A 7 and B 7.

Some remarkable facts yielded this study of the Foraminifera of the Bay of Jakarta. In many species the structure of the toothplate was analysed; several species of *Textularia* showed pores in their walls and had to be removed to other genera. The megalospheric generation of *Quinqueloculina kerimbatica* showed a kind of agglutination which was not found in the microspheric generation. It is stated that the genus *Ammoassilina* is synonym of *Schlumbergerina*. In many genera, such as *Gypsina*, *Sphaerogypsina* and *Discogypsina*, and also in *Planorbulinella* and *Miniacina* the microstructure of the wall is not bilamellar, but a granular primary wall is secondarily thickened by outer, often also inner lamellae of more hyaline substance. *Carpenteria utricularis* has simple granular walls, whereas *Biarritzina* has double walls and septa. *Calcarina spengleri* may be called bilamellar, but does not have any traces of toothplates. *Baculogypsinoidea spinosus* cannot be distinguished generically from *Siderolites calcitrapoides*. The spines of *Asterorotalia pulchella* are formed by the toothplates and the tube within these spines, opening at their ends, must be looked at as a toothplate-foramen. *Rotalia concinna* Millet belongs to the genus *Rotalidium* and the so-called secondary chamberlets are built up by the toothplates. In both *Rotalidium concinnum* and *Pseudorotalia schroeteriana* the microspheric specimens coil to the right, whereas the megalospheric specimens coil to the left. In the latter species trimorphism was noted. *Elphidium hispidulum* belongs to the genus *Parrellina*. In *Nummulites complanatus* trimorphism is described, and the spiral of this species has been analysed, with the conclusion that especially in the microspheric form and the A₁-form this spiral is that which was called by Goethe "Spirale des Lebens" and is subjected to the rule of the sectio divina. *Heterostegina curva* Möbius is a distinct species, differing from *H. suborbicularis* in the number of undivided chambers in the A-generation.

The material has been stored in the Zoological Museum of the University of Amsterdam.

SYSTEMATICAL PART

Sagenina frondescens (Brady). Pl. 1, fig. 1-5.

Sagenella frondescens Brady, 1879, Quart. Journ. Micr. Sci., N.S. 19, p. 41.

Sagenina frondescens (Brady), Chapman, 1900, Linn. Soc. London, Journ. Zool. 28, p. 4.

Sagenina frondescens (Brady), Loeblich and Tappan, 1964, Treatise Foraminifera, p. 205, Fig. 117, 4.

This species forms yellowish low depressed tubes, often branching dichotomously or irregularly, with very fine muddy agglutination; the apertures consist of the open ends of the tubes. On section the tubes surround the lumen wholly, forming a flat base over the substrate and are much compressed; the hollows in the tubes are very narrow, also compressed. The agglutination is extremely fine, without traces of coarser grains. The species is known from the Eocene to Recent and is common in the Pacific. Loeblich and Tappan place it in the Textulariina, however without reason, since the test does not show any indication of chambering.

Placopsilina bradyi Cushman and McCulloch. Pl. 1, fig. 6-12.

Placopsilina cenomana d'Orbigny, Hofker, 1930, Siboga Rept., VIa, pt. 2, p. 124, pl. 40, fig. 9; pl. 49, fig. 1-8, 10, 11.

Placopsilina bradyi Cushman and McCulloch, 1939, South Calif. Univ. Publ., Allan Hancock Pacific Exp., 6, No. 1, p. 112, pl. 12, fig. 14, 15.

In their description Cushman and McCulloch also mention Brady's fig. pl. 36, fig. 3, Challenger Rep., 1884; but Cushman had already given this atlantic species a name: *P. confusa* Cushman, 1920, U.S. Nat. Mus. Bull. 104, p. 71, pl. 14, fig. 6. So this reference is not correct. Yet the present author believes that the atlantic species differs from the pacific one since the atlantic form has a much coarser agglutination. So the name *P. bradyi* may stand. The name, given by HOFKER (1930) is based on the name given by Brady to the atlantic species; yet the species from the Cenomanian is, as far as can be seen from the figures given by LOEBLICH and TAPPAN (1964, fig. 159, 1, 2) a more primitive form.

The test begins with a short spiral, followed by a long series of chambers which are broader than long. The whole tests are attached to shells with flat attached sides. The aperture consists of a horizontal somewhat areal slit near the base of the last formed chamber; the septal foramina are likewise. The test wall is very finely agglutinated and pierced by relatively fine pores, not only at the dorsal, but also in larger parts of the ventral flat side. The chambers increase in breadth as added. Most individuals are twisted.

The specimens found in the Bay of Jakarta are somewhat smaller than those described by the author from Ambon in 1930.

Bdelloidina aggregata Carter. Pl. 1, fig. 13-20.

Bdelloidina aggregata Carter, 1877, Ann. Mag. Nat. Hist., ser. 4, 19, p. 201.

Bdelloidina aggregata Brady, 1884, Challenger Rep., p. 316, pl. 36, fig. 4-6.

This species occurred in many, often broken specimens in sample A 7. Many specimens are attached to pieces of corals and shells. Some specimens were complete. It could be shown that the specimens greatly vary in total form, due to the form of the substratum; in the case that it is small, the specimen when growing creeps reverly to its original direction, filling up the whole substratum. One specimen begins with a short spiral, with several short outgrowths; than a long narrow chamber is formed, followed by the usual row of broad chambers. Often specimens bifurcate.

The last formed chamber may open with a single row of rounded foramina or, when it is more bulky, with several rows of them or with more scattered openings.

The inner lumen of a chamber is partly filled with columns, many of which are attached at one side to the proximal or distal wall of the chamber; moreover, at the dorsal as well as at the ventral side the inner wall is complicated by many small holes which end into canals or pores running to the outer surface. The ventral side of the chambers is mostly smooth and shows the impressions formed by the substratum. The dorsal walls show the depressed sutures between the broad, somewhat irregular chambers. The wall itself consists of irregular sand grains, often consisting of calcite, but also of quartz, smoothly cemented together; sponge spicules also may be added. Toward the lumen of the chamber the calcitic cement augments so that the inner side of the wall is very smooth, but for the labyrinthic structure.

LOEBLICH and TAPPAN (1964, p. 250) place the species together with *Coscinophragma* in a subfamily Coscinophragmatinae. But the study of *Coscinophragma* Thalmann (formerly *Polyphragma* Reuss), as I have given it in 1928 (pp. 105-108, figs. 1-8), does show the labyrinthic chambers, while the pores in the walls are missing in *Coscinophragma*. Formerly LOEBLICH and TAPPAN (1955, p. 22) were inclined to place *Bdelloidina* in the Placopsilinidae, in which

Cushman also placed it. I have shown (1930, p. 124-125, pl. 40, fig. 9; pl. 49, fig. 1-8, 10, 11) that *Placopsilina bradyi* Cushman (there described as *Placopsilina cenomana*) has simple walls, but pierced by the same coarse pores as found now in *Bdelloidina*. It may be that *Bdelloidina* is a genus which shows a higher developed structure of the test wall, but otherwise is very closely allied to *Placopsilina*.

Textularia kerimbaensis Said. Pl. 1, fig. 21, 22, 23-25.

Textularia conica d'Orbigny var. *corrugata* Heron-Allen and Earland, 1915, Trans. Zool. Soc. London 20, p. 629, pl. 47, fig. 24-27.

Textularia corrugata Heron-Allen and Earland, Cushman, 1932, U.S. Nat. Mus. Bull. 161, pt. 1, p. 12, pl. 3, fig. 2, 4.

Textularia kerimbaensis Said, 1949, Cushman Lab. For. Res., Spec. Publ. no. 26, p. 6, pl. 1, fig. 8.

Textularia gramen d'Orbigny, Keijzer, 1935, p. 127, text-fig. 24.

This species, only common in A 7, is characterised by its triangular shape, horizontal sutures which mostly are distinctly depressed, consequently flat apertural side, slit-like aperture and smooth surface resulting from a very fine agglutination. The chambers are numerous and low. Large, elongate specimens seem to be microspheric. No specimens with a spiral initial part could be found, not even among the specimens with very small proloculus. Keijzer described this species, under a different name, from Rembang. It is wide-spread, mentioned from the Kerimba Archipelago, the Red Sea, the Indonesian Archipelago and the Philippines. Graham and Militante mention it also from the Gulf of California.

Reophax scorpiurus Montfort. Pl. 1, fig. 22a.

Reophax scorpiurus Montfort, 1808, Coch. Syst. 1, p. 239, pl. 162, fig. k.

The present author described the different forms or generations of this species in 1932, Pubbl. Staz. Zool. Napoli, vol. 12, p. 77-80, fig. 9-11.

In the Bay of Jakarta the species is not common. It is similar in all the samples in which it was found. It consists of a short series of rapidly increasing chambers the walls of which are very roughly agglutinated. The chambers are pyriform, and the last formed chamber shows the rounded open aperture on a short neck. Especially the individuals figured by BRADY (1884, pl. 30, fig. 16, 17) from Torres Street resemble most

the specimens found in the Bay of Jakarta. It is not at all certain that the figure given by GRAHAM and MILITANTE (1959, pl. 1, fig. 9) is this species; it looks more like the microspheric form of *Bigenerina nodosaria* with its strongly overlapping chambers. Characteristic for the specimens from the Bay of Jakarta is the very irregular and extremely rough agglutination, consisting mainly of shell fragments. It occurred in the stations A 5, D 6, No. 5, F 7.

Bigenerina nodosaria d'Orbigny. Pl. 1, fig. 26-29; Pl. 2, fig. 1-6.

Bigenerina nodosaria d'Orbigny, 1826, Ann. Sci. Nat. 7, p. 261, pl. 11, fig. 9-11, modèles no. 57.
Bigenerina nodosaria d'Orbigny, Hofker, 1933, Vidensk. Medd. Dansk naturh. Foren. 93, p. 85-87, pl. 11, fig. 3, 4, 15, 16; textfig. 8, 9.

This species is characterised by an elongate test with numerous uniserial chambers which in reality are pyriform but overlapping each other so that, due to the rough agglutination, often consisting in shell fragments and small Foraminifera, the sutures are diffuse. There are three generations; the microspheric one begins with a biserial part which mostly stands obliquely to the axis of the main test and easily may break off, followed in adult specimens by up to 12 uniserial chambers. The biserial part consists of about 11 chambers. The A₁-generation has a short biserial part with its axis in that of the uniserial part; the biserial part consists of about 6 chambers, followed by about 6 chambers in the uniserial part. The A₂-generation shows two biserial chambers, often less, followed by about 4-5 uniserial chambers. These three generations, already described by the present author in 1933 from the Key-Islands, were refound in the material of the Bay of Jakarta, where the species is common in several of the north-western stations. The aperture consists of a simple opening, or may have a more triangular form. This opening is found on a protruding part of the chamber. It may be that the microspheric form has been described by other authors as *Reophax scorpiurus* Montfort, when the fragile biserial initial part is broken off (cf. GRAHAM and MILITANTE, 1959, p. 23, pl. 1, fig. 9).

Valvotextularia foliacea (Heron-Allen and Earland). Pl. 2, fig. 7-14.

Textularia foliacea Heron-Allen and Earland, 1915, Trans. Zool. Soc. London 20, p. 628, pl. 47, fig. 17-20. See for further literature: Graham and Militante, 1959, Stanford Univ. Publ., geol. Sci. 6, No. 2, p. 28.

Textularia foliacea Heron-Allen and Earland, var. *oceanica* Cushman, 1932, U.S. Nat. Mus. Bull. 161, pt. 1, p. 8, pl. 1, fig. 11-12. See for further literature also Graham and Militante, l.c., p. 28.

Textularia agglutinans (non d'Orbigny), Möbius, 1880, Beitr. Meeresfauna Mauritius etc., p. 93, pl. 9, fig. 1-8.

This species was found in many stations in the Bay of Jakarta, in the western and northern part. There are two forms, often occurring together, the one with elongated test with in the later part nearly parallel sides, the other with a triangular shape and with in the end strongly inflated chambers. The first mentioned form always is megalospheric and is identical with *T. foliacea*, the second one is *T. foliacea* var. *oceanica*. The two forms often are mentioned by authors to be found together; Möbius also mentions them from Mauritius, though under a different name. The triangular form always is microspheric. Especially in the megalospheric form it can be observed from the outside already that the test begins with a short spiral; in the microspheric test this spiral only is evident in sections. Moreover, the walls of the chambers, especially their outer walls, are pierced by pores which can be seen in very thin sections. These pores avoid the rather coarse agglutination. This agglutination can be very coarse and mostly consists of shell-fragments and small Foraminifera; particles of volcanic ashes or glauconite can be added, but are rare. It was Möbius who described the pores in the test walls. For such textularid species the present author founded the genus *Valvotextularia*, with *Text. catenata* Cushman as genotype. The present species only shows the spiral initial part in the microspheric generation, whereas in the megalospheric one only a slight indication of a spiral remains. But the pores in the walls form another characteristic mentioned in the diagnosis of the genus. Möbius also figures the confused initial end in a section (fig. 7); his specimens show a more regular and not so coarse agglutination; but such specimens also occur in the Bay of Jakarta and in the Philippines. It is obvious, that *Textularia agglutinans* as described by KEIJZER (1935, pp. 128, 132, fig. 25 a-g) also is this species; but he did not reach the real proloculus in the microspheric triangular form (fig. g). The present author mentioned it as *Textularia agglutinans* from the Key Islands; I had it also from off Sorong, New Guinea (1933, p. 85). The species is a widespread one in the Indian and West Pacific Oceans.

Valvotextularia rugulosa (Cushman). Pl. 2, fig. 15-20.

Gaudryina (*Siphogaudryina*) *rugulosa* Cushman, 1937,

Cushman Lab. For. Res., Spec. Publ. No. 7, p. 84, pl. 12, fig. 11, 12.

In 1933 (pp. 82-84, textfig. 6, 7) the present author described a species from Banda which shows much resemblance with *Textularia rugosa* Brady (not *Plecanium rugosum* Reuss 1869), which is characterized by distinct and regular hollows at the proximal sutures of the chambers and by a slender form and a labyrinthic inner chamber wall in the chambers, so that he brought it to the genus *Textulariella*. This species does not show any traces of pores in the wall. Cushman's species, however, shows a broader form and has the hollows at the sutures much more irregular, whereas the wall is distinctly porous. Cushman brings his species, which he identifies with *Textularia rugosa* Brady, to the genus *Gaudryina* (*Siphogaudryina*), a subgenus which does not show pores in the walls of its genotype, *Siphogaudryina stephensoni* Cushman and of its other fossil species, as the present author could show (1957, p. 73-98). Moreover Cushman says about his *G. (S.) rugulosa* "early triserial portion usually confined to the earliest stages"; in reality the specimens observed in the Bay of Jakarta (only two specimens found in St. A7) do not show any trace of a triserial initial part, but begin directly biserially after the proloculus. The inner structure of the test of the specimens of the Bay of Jakarta is not labyrinthic, but the pores in the outer walls are evident. The septal and apertural walls miss them and are agglutinated with many globular chalk particles, whereas the outer walls show a much finer agglutination between the coarse pores. In the case where in some individuals a triserial part also occurs, as described by Cushman, the species should be transferred to *Valvoreussella* Hofker, though the genotype of that species, *V. bronni* (Reuss), does not show the characteristic hollows at the chamber sutures.

The species is a large one, length of the two specimens found about 3 mm.

Clavulina pacifica Cushman. Pl. 2, fig. 21-26.

Clavulina angularis (non d'Orbigny), Millet, 1900, Journ. Roy. Micr. Soc., p. 13.

Clavulina pacifica Cushman, 1924, Publ. 342, Carnegie Inst. Wash., p. 22, pl. 6, fig. 7-11.

Several specimens only consisting of the triangular part, some with one chamber which shows the tendency to belong to the uniserial chambers, with areal aperture with distinct tooth, seem to belong to this species. They occurred only in St. A 5. They show

that this species, which can become very long with a series of uniserial chambers, did not have here its optimal conditions. It is not the species which the present author described from the Key Islands as *Clavulina tricarinata* (Reuss); that species shows an aperture with neck without a tooth, and must belong to the genus *Clavulinoides* (HOFKER, 1933, p. 87-90).

Spiroloculina communis Cushman and Todd. Pl. 2, fig. 27-33.

Spiroloculina excavata Brady (non d'Orbigny), 1884, Challenger Rep., Zool. 9, p. 151, pl. 9, fig. 5-6.

Spiroloculina grateloupi Cushman (non d'Orbigny), 1917, U.S. Nat. Mus. Bull. 71, pt. 6, p. 31, pl. 4, fig. 4, 5.

Spiroloculina communis Cushman and Todd, 1944, Cushman Lab. For. Res., Spec. Publ. no. 11, p. 63, pl. 9, fig. 4, 5, 7, 8.

It is this species which has been described by KEIJZER (1935, p. 111, textfig. 12). It is the only *Spiroloculina* in the Bay of Jakarta, where it is found in most of the north-western Stations. The robust species is more or less elongate, with slight apertural neck and strongly thickening later chambers. The outer margin always is somewhat rounded in apertural view. The rounded open aperture has a simple tooth. The initial part is more or less quinqueloculine, the chamber walls do not surround the lumen of the chamber axially. Mostly at the periphery there are two distinct carinae at each chamber which, together with the rounded margin, give a peculiar feature to the test seen from the broad side.

West-Indian species, such as *Spiroloculina antillarum* d'Orbigny and *S. ornata* d'Orbigny, of which the author described transverse sections (1964, fig. 7, 8) show in the megalospheric form no trace of a quinqueloculine embryonic stage; according to LOEBLICH and TAPPAN (1964) they should belong to *Spiroloculina*, whereas those species, such as *S. communis* from the Pacific, invariably show a more or less developed quinqueloculine young stage; such forms according to the Treatise should belong to the genus *Massilina*; however, in the monograph on the genus *Spiroloculina* by Cushman and Todd, 1944, l.c., *S. communis* belongs to *Spiroloculina*; Cushman and Todd describe the genus *Spiroloculina* as having in the megalospheric form a reduced quinqueloculine stage or not at all. The present author believes that only in those species in which the quinqueloculine stage is well-developed and only very few chambers are added in a single plane, the species should belong to *Massilina*, whereas in the case that the initial

quineloculine stage forms a minor part of the total test, with many chambers added in a single plane, the species should be referred to *Quinqueloculina*. The two genera, however, are not sharply distinguishable, since in species with only one proloculus followed by the chambers in a single plane, often in the microspheric form the initial stage is quineloculine.

Quinqueloculina bidentata d'Orbigny. Pl. 3, fig. 1-4.

Quinqueloculina bidentata d'Orbigny, 1839, in: de la Sagra, Hist. fis., pol., nat. Isla de Cuba, p. 197, pl. 12, fig. 18-20.

Quinqueloculina sclerotica Karrer, 1868, Sitz. Ber. Akad. Wiss. Wien 43, Abth. 1, p. 152, pl. 3, fig. 5.

Quinqueloculina agglutinans (non d'Orbigny), Cushman, 1921, U.S. Nat. Mus. Bull. 100, vol. 4, p. 441, pl. 91, fig. 1.

Quinqueloculina bidentata d'Orbigny, Hofker, 1964, Studies Fauna Curaçao etc. 21, p. 23, fig. 14-17; Graham and Militante, 1959, Stanford Univ. Publ., Geol. Sci. 6, no. 2, p. 42, pl. 5, fig. 1, 2.

This species occurs, always in small specimens, in several Stations of the Bay of Jakarta; it is characterized by its compact form and relatively coarse and irregular agglutination. The test is oval, with a slight neck to the aperture which neck is not agglutinated. The aperture is rounded, with a small tooth which, in outgrown specimens, may become more plate-like.

On transverse section the species is quineloculine throughout with often coarse sandgrains only at the outer surface of the chamber walls. The walls do not surround the chambers totally.

Whether this species is identical with Karrer's species is not at all certain. The specimens figured by Graham and Militante certainly belong to the same species as those found in the Bay of Jakarta. *Q. agglutinans*, originally described from the coast of Cuba, and fully described by the present author in 1964 (p. 24, fig. 27-30), always has a much finer agglutination and more inflated and rounded chambers in transverse section.

Quinqueloculina curta Cushman. Pl. 3, fig. 5-7.

Quinqueloculina disparalis var. *curta* Cushman, 1917, U.S. Nat. Mus. Bull. 71, pt. 6, p. 49, pl. 14, fig. 2; textfig. 30.

Quinqueloculina curta Cushman, 1921, U.S. Nat. Mus. Bull. 100, vol. 4, p. 426, pl. 100, fig. 1, 2.

Cribrolinoides curta (Cushman), Cushman and LeRoy, 1939, Cushman Lab. For. Res., Contr., 15, pt. 1, p. 15-19, pl. 3, 4.

The present author described this species very accurately (1933, pp. 98-102, pl. 3, fig. 13-25, textfig. 19, 20). He showed that the megalospheric generations A_1 and A_2 of this species have relatively simple teeth but that only the microspheric specimens show the complicated teeth which lead to a more or less cribrate aperture. Though only one generation of this species shows this characteristic, Cushman and LeRoy took this feature as the characteristic on which they based their new genus, *Cribrolinoides*. This would lead to the absurdity, that of a species one generation was belonging to another genus than the two other generations. It will have been therefore that GRAHAM and MILITANTE (1959, p. 44) have given *Cribrolinoides curta* as synonym of *Quinqueloculina curta*; yet LOEBLICH and TAPPAN (1964, p. 453) have maintained this dubious genus and, moreover, placed it in the Nubeculariidae, since they observed that in the megalospheric initial coil the species is "cyclogyrine". This, however, is not so, or otherwise all megalospheric species of *Quinqueloculina* with large proloculus (A_2) would have to be placed in the Nubeculariidae; the present author gives a transverse section here, showing that the large proloculus is followed by the large neck-chamber and then by the third chamber which, together with the neck chamber and the 4th and 5th chambers form a good quineloculine structure, as in all other species of *Quinqueloculina*; due to the enormous proloculus the chamber arrangement of the "first coil" seems to be "cyclogyrine".

The species is not uncommon in some of the stations of the north-western part of the Bay of Jakarta; microspheric specimens as described in 1933 also occur; but the species is always found in small numbers, and never so abundantly as in St. 78, Sunda Street, of the Key-Expedition.

Quinqueloculina (Miliola) kerimbatica (Heron-Allen and Earland). Pl. 3, fig. 8-23.

Miliolina parkeri Brady, Millet, 1898, Journ. Micr. Soc. London, pt. 2, p. 507, pl. 12, fig. 4.

Miliolina kerimbatica Heron-Allen and Earland, 1915, Trans. Roy. Soc. London 20, p. 574, pl. 43, fig. 13-23.

Quinqueloculina kerimbatica (Heron-Allen and Earland), Cushman, 1921, U.S. Nat. Mus. Bull. 100, vol. 4, p. 437.

Quinqueloculina kerimbatica (Heron-Allen and Earland), var. *reticulostriata* Cushman, 1921, U.S. Nat. Mus. Bull. 100, p. 437, pl. 89, fig. 1.

Quinqueloculina kerimbatica (Heron-Allen and Earland), var. *philippinensis* Cushman, 1921, U.S. Nat. Mus. Bull. 100, p. 438, pl. 89, fig. 2, 3.

Quinqueloculina reticulata d'Orbigny?, Hofker, 1933,

Vidensk. Medd. Dansk naturh. Foren., pp. 95-97, pl. 3, fig. 5-7; textfig. 17.

Quinqueloculina reticulo-striata Cushman, Hofker, 1933, *ibid.*, pl. 2, fig. 17-19; pl. 3, fig. 1-4; textfig. 16.

Triloculina kerimbatica (Heron-Allen and Earland), Cushman, Todd and Post, 1954, U.S. Geol. Surv., Prof. Paper 260-H, p. 339, pl. 85, fig. 10, 11.

Triloculina kerimbatica (Heron-Allen and Earland), var. *philippinensis* (Cushman), Graham and Militante, 1959, Stanford Univ. Publ., Geol. Sci., vol. 6, No. 2, p. 55, pl. 8, fig. 1-4.

Triloculina kerimbatica (Heron-Allen and Earland), var. *reticulostriata* (Cushman), Graham and Militante, 1959, *l.c.*, p. 55, pl. 8, fig. 5, 6.

This variable species is a *Quinqueloculina* throughout. In the Bay of Jakarta, where it is common in most of the stations, it is found in two forms which are equally common. Typical forms of the *philippinensis*-form all showed to be microspheric, whereas specimens with the characteristics of *reticulostriata* all showed to be megalospheric; the latter "variety" also differs from the former one in having sand grains incorporated into the hollows formed by the ornamentation, so that often all chambers in transverse section show these foreign grains at their outer surfaces. KEIJZER seems to be right when he says (1935, p. 114) "It seems to be an extra weight on nomenclature, and not at all necessary, where CUSHMAN (1921) introduces a few new names for varieties such as var. *reticulostriata* and var. *philippinensis*." Typical is the large number of microspheric specimens in the samples; they even are more abundant than the megalospheric form. The smooth variety described by KEIJZER (*l.c.*, p. 115, fig. 15, e.f) must have been caused by erosion of tests laying on the beach; such forms are seldom in the material at hand.

The typical elongate form, described by Heron-Allen and Earland and by Graham and Militante was not observed in the Bay of Jakarta; all specimens with strong ornamentation and without sand grains attached, show the form of "*philippinensis*" and are microspheric; more elongate are most of the specimens with only few ornamentation and only more distinct longitudinal costae and with sand grains attached at the sutures; they thus have the form of "*reticulostriata*" and are all megalospheric.

In *Quinqueloculina kerimbatica* we have a species in which the microspheric and the megalospheric forms show distinct outer characteristics.

Quinqueloculina kerimbatica shows a typical primitive characteristic in the total surrounding of the hollow of the chambers by the walls; this characteristic also was found in *Quinqueloculina tricarinata* d'Or-

bigny from the Caribbean, so that the present author believed it to belong to the genus *Miliola*, which also shows this feature and, moreover, in many species also the peculiar ornamentation of the test wall. However, in fossil *Miliola* the aperture not only shows a dent, but often is closed by a porous plate in connection with this dent (see: HOFKER, 1964, p. 17, fig. 2-4). In the paper mentioned the author even believes that *Q. kerimbatica* and *Q. tricarinata* are synonyms; GRAHAM and MILITANTE (*l.c.*, pl. 7, fig. 14) figure a specimen which they contribute to *Q. kerimbatica*, but which shows all the characteristics (elongate form, long apertural neck) of *Q. carinata*; yet it was found in the Philippines; in the Pacific the variation breadth of *Q. kerimbatica* obviously encloses the form known as *Q. tricarinata* from the Caribbean region. This means that, consequently, this ancient species, closely allied to *Miliola*, a genus common in the Eocene, has a very large geographic distribution.

Quinqueloculina bicarinata d'Orbigny. Pl. 3, fig. 24-34.

Quinqueloculina bicarinata d'Orbigny, 1826, Ann. Sci., Nat., ser. 1, 7, p. 302.

The specimens found abundantly in many stations of the Bay of Jakarta may be best compared with this Mediterranean species; only they are lacking longitudinal striae as figured by several authors; these striae only occur between the two larger carinae at the margin of each chamber.

The species distinctly is that which has been described by CUSHMAN (1921, p. 428) where he states: "It is always short and broad, the central part especially bicarinate, but the carinae often coalescing toward either end. It is occasionally slightly striate, but it is not the same as *Q. cuvieriana*." Cushman not only found it in the Philippine Archipelago, but also southward, in the Sulu Sea and the coast of Borneo. It has been described, without any doubt, as *Quinqueloculina seminulum* (Linné) by KEIJZER (1935, p. 116-120), who got many eroded specimens at Rembang, north-coast of Java. It is the commonest species in the Bay of Jakarta. Transverse sections show that the chamber walls do not surround completely the chamber lumen, contrarily to the figures given by Keijzer. He may have been wrong in his interpretation of his sections, which may not have been thin enough; however, his transverse section fig. 16 d is nearly that given here of megalospheric specimen.

Flintina bradyana Cushman. Pl. 4, fig. 1-6.

Miliolina fichteliana Brady (non d'Orbigny), 1884, Rept. Challenger, Zool. 9, p. 169, pl. 4, fig. 9.

Triloculina fichteliana d'Orbigny, Keijzer, 1935, Thesis, Leiden, p. 106, fig. 9.

Flintina bradyana Cushman, 1921, U.S. Nat. Mus. Bull. 100, vol. 4, p. 467, pl. 94, fig. 2, textfig. 38-44; Graham and Militante, 1959, Stanford Univ. Publ., geol. Sci. no. 2, p. 34, pl. 3, fig. 7; Loeblich and Tappan, Treatise, 1964, p. 461, fig. 349, 7-9.

Smaller megalospheric specimens do not differ from a *Quinqueloculina*; very large ones show the last formed chambers not covering the whole side of the test so that 3 chambers seem to form a coil. In how far such a characteristic, obviously more due to the voluminous later chambers than to a real generic feature, can be the base of a distinct genus, is far from certain; yet this species is the genotype of *Flintina*. Very peculiar is the tooth of the last formed chambers, surrounded by the peculiar key-hole shaped aperture. This tooth has been very adequately described by Keijzer: a somewhat bifid tooth running inward into the chamber, strengthened by a kind of outer pillar with an opening between these two structures. Former chambers only show the bifid tooth. The whole test is finely striated. Transverse sections show that the inner structure in reality is quinqueloculine and not triloculine. To my regret I could not find a microspheric specimen. The species is found in the most north-western part of the Bay of Jakarta; it is known from the Philippines.

Triloculina tricarinata d'Orbigny. Pl. 4, fig. 7-10.

Triloculina tricarinata d'Orbigny, 1826, Ann-Sci. Nat., ser. 1, vol. 7, p. 299; Keijzer, Thesis, Leiden, 1935, p. 103, fig. 6.

Miliolina tricarinata (d'Orbigny), Brady, 1884, Challenger Rep., Zool. 9, p. 165, pl. 3, fig. 17.

This species is present in some of the stations, but always in very small specimens. The sides are slightly rounded, and the carinae distinct. The transverse section of a megalospheric specimen showed it to be trilocular throughout. Microspheric specimens in the North Atlantic reach a large diameter, but such specimens were not found in the Bay of Jakarta.

Triloculina rupertiana (Brady). Pl. 4, fig. 11-15.

Miliolina rupertiana Brady, 1884, Challenger Rep., Zool. 9, p. 178, pl. 7, fig. 7-12.

Triloculina rupertiana (Brady), Cushman, 1921, U.S. Nat. Mus. Bull. 100, p. 464, pl. 93, Fig. 2; Keijzer, 1935, Thesis Leiden, p. 104-106, textfig. 8, a-g.

This species was found in St. A 7 in several specimens; the much compressed, elongate test is characterised by fine elongate striae in which are found rows of fine hollows, and by a narrow aperture with two parallel sides without a tooth. The aperture is directed in the direction of depression and is areal. The description by Keijzer is very accurate, only the specimens found in the Bay of Jakarta show a distinct carina as has been figured by Cushman. The typical small hollows in the walls are found only in the outer three chambers. The species is triloculine throughout. It is remarkable that according to literature the species only is common in the Red Sea and at Mauritius, but that more to the east it becomes rare in the samples. Keijzer found it at the north coast of Java in only a few specimens. GRAHAM and MILITANTE (1959, p. 56) found it, however, to be common in one station in the Philippines. The present author had it from off Sorong, New Guinea.

Schlumbergerina areniphora Munier-Chalmas. Pl. 4, fig. 16-24.

Schlumbergerina areniphora Munier-Chalmas, 1882, Soc. géol. France, Bull., ser. 3, 10, pt. 6, p. 424.

Miliolina alveoliniformis Brady, 1879, Quart. Journ. Micr. Soc., n. ser., 19, p. 268; Brady, 1884, Challenger Rep., Zool. 9, p. 181, pl. 18, fig. 15-20.

Quinqueloculina alveoliniformis (Brady), Cushman, 1917, U.S. Nat. Mus. Bull. 71, pt. 6, p. 43; 1921, U.S. Nat. Mus. Bull. 100, vol. 4, p. 443.

Massilina alveoliniformis (Brady), Millet, 1898, Journ. Roy. Micr. Soc., pt. 3, p. 609, pl. 13, fig. 5-7.

Massilina alveoliniformis Millet, Hofker, 1933, Vidensk. Medd. Dansk naturh. Foren. 93, pp. 102-105, textfig. 21, 22.

Ammomassilina alveoliniformis (Millet), Cushman, 1933, Contr. Cushman Lab. For. Res., 9, pt. 2, p. 32, pl. 3, fig. 5.

There are two forms known, both from the Pacific. The one begins with a small megalospheric proloculus surrounded by about 6 chambers, then later chambers are added till at last about 10 chambers form the outer test; the other one begins in quite the same way, till about 9 chambers surround a test equal to that of the first one; then chambers are added in a single plane, or rather in a sigmoid way. Young specimens of the second form do not differ in any way from those of the first form. The typical agglutination, fine and diffuse, is the same in both forms. So Millet already mentions

the fact that his species is very closely allied to *Schlumbergerina*: "It may be regarded as a dimorphous form of *Miliolina alveoliniformis*, the earlier chambers, as shown by fig. 6, having all the characteristics of that species." In 1933, p. 104, the present author added: "So I am inclined to believe that *Schlumbergerina alveoliniformis* and *Massilina alveoliniformis* are so closely related to one another, that they belong to the same genus, *Schlumbergerina*, if not to the same species."

In the Bay of Jakarta the flat form was mostly found; in the neighbourhood of Sorong, most of the specimens showed the fusiform characteristic; it may be that only differing circumstances are the cause of the two forms. In the Philippines, GRAHAM and MILITANTE (1959, l.c., pp. 33 and 49) found both forms in Puerta Galera Bay, even in the same stations (see distribution chart).

It is difficult to give the specific name of this species; Loeblich and Tappan believe it to be *S. areniphora*; it may be that the rules of nomenclature would incline to the name *Schlumbergerina alveoliniformis*. Whether the two forms are generations or only forms which differ due to environmental conditions, is not yet clear.

Remarkable is the somewhat alveolar structure of the test wall; this may indicate that the agglutination is not caused by sand grains but by grains formed by the animal itself.

Dendritina striatopunctata Hofker. Pl. 4, fig. 24a-30.

Dendritina striato-punctata Hofker, 1951, Journ. Roy. Micr. Soc. 71, p. 233, textfig. 10, 11.

Test compressed, chambers strongly involute, reaching the centre, mostly oval in shape, in very large tests later chambers have a tendency to uncoil. Sutures slightly rounded, bending backward. In adult tests margin rounded to sub-acute. Sutures distinct and often slightly elevated. Apertural face sharply triangular, in younger tests with triangular basal but areal aperture with axial lip, in later chambers elongate with crenulate sides, dendritical. Wall ornamented with transverse rows of elongate pits, which are directed slightly obliquely to the sutures.

On horizontal sections the walls of the last formed whorl with simple primary walls; more axial whorls thickened externally. On transverse sections chambers of the next whorl overlapping those of the former whorl at the centre; the outer lamellum of each chamber seems to be formed by the chamber itself

and not by the chamber of the next whorl, when we observe the way in which each chamber wall with its outer thickening overlaps the wall of a former whorl.

The proloculus is followed in the megalospheric test by a long and narrow neck chamber, surrounding more than half of the proloculus. Peculiar is the test figured here which shows a sudden change in the direction of coiling.

The species is rather common in the north-western part of the Bay of Jakarta. It was first described from the eastern part of the Archipelago.

Discogypsina vesicularis (Goës). Pl. 5, fig. 1-9.

Tinoporos vesicularis (Parker and Jones), Goës, 1882, K. Svens. Vetenskapakad. Handl. 19, No. 4, p. 104.

Discogypsina vesicularis (Goës), Silvestri, 1937, Paleont. Italica 32, Suppl. 2, p. 155.

Gypsina discus Goës, Bursch, 1947, Schweiz. Pal. Abh. 65, p. 40, pl. 3, fig. 2, 4, 13, 17, 21; pl. 5, fig. 6, 7; textfig. 15, 20.

Test lenticular, with rounded edges, convex on both sides, large (about 2.5-3 mm). At the outside irregular lateral chambers visible without any trace of pillars. In transverse section a somewhat irregular but distinct layer of median chambers, surrounding a flat spiral of chambers in the centre, with megalospheric proloculus, surrounded by about 5 chambers and some adjacent chambers. This set of initial chambers is surrounded at both sides by small chambers forming a more compact mass. From this mass and from the median layer of chambers rows of lateral chambers are built perpendicularly to the surface. The median chambers show only pores in the dorsal walls, whereas the ventral walls are poreless; moreover, the margins of these chambers are poreless, so that a horizontal section shows the walls of these chambers without a trace of pores; these walls are distinctly double, contrarily to those of *Sphaerogypsina globulus* (Reuss). But the walls of the initial chambers are simple, granular, and this also can be said of the inner lamellum of the later chambers. In this respect *Discogypsina* resembles *Orbitoides*. The lateral chambers in transverse section show poreless thickened side walls, whereas the distal wall shows the distinct pores; here also the walls are double.

Discogypsina is known from the Eocene up to Recent; it is found in the Pacific as well as in the Caribbean Sea; in the Bay of Jakarta it is found in sample A 7, not common. The geologic appearance of this genus may suggest that it has some connection with *Lepidocyclina*, of which it has much in common

and with the Orbitoid Foraminifera. It differs from *Gypsina plana* (Carter), *Gypsina mastelensis* Bursch and *Sphaerogypsina* in the double walls of the later chambers which are found only indistinctly in the species just mentioned. *Gypsina cretae* Marsson from the Maestrichtian shows the double walls in the later chambers, but no lateral chambers.

Sphaerogypsina globulus (Reuss). Pl. 5, fig. 10-21.

Ceritoporus globulus Reuss, 1848, Nat. Abh. (Haidinger) 2, p. 33, pl. 5, fig. 7.

Tinoporus pilaris Brady, 1876, Ann. Soc. malac. Belgique 11, p. 103.

Gypsina globulus (Reuss), Brady, 1884, Chall. Rep., Zool. 9, p. 117, pl. 101, fig. 8.

Sphaerogypsina globulus (Reuss), Galloway, 1933, Manual Foram., p. 108, 109, pl. 28, fig. 13, 14.

This species was found in several specimens in A 7. Some specimens are nearly globular, others have a flattened side, and one of them was pyriform. The totally globular specimens often, but not always, have the proloculus in the centre; the specimens with a flattened side have always the proloculus near to the flat side; the pyriform specimen had the proloculus in the narrow part; some pyriform specimens from the Mediterranean had also the proloculus in the narrow part. The megalospheric proloculus is followed by two other chambers which together have a secondarily thickened hyaline wall at the outside, but are separated from each other only by the granular primary wall, as is found in primitive *Orbitoides*. Then a symmetric chamber follows which has the primary wall at the inside and the hyaline, fibrous calcareous thickening lamellum at the outside. From this chamber two spirals of primitive chambers originate, and these chambers also form a cluster all around the embryonic apparatus. These primitive chambers form a globular mass around the centre, with all chambers only showing the two lamellae mentioned. From this globular mass series of chambers run towards the outer walls, mostly in straight series, but in the pyriform specimens more fanning. In these chambers the walls towards the periphery often show the distinct pores, whereas the side walls, often partly also formed by the side walls of adjacent chambers, are poreless. Basally several rounded openings pierce through the side walls communicating the chamber with adjacent chambers. In these later chambers the walls more and more get three lamellae, the primary wall in the middle, and an inner and outer thickening of hyaline fibrous calcareous material. At the outside of the test the latest

formed chambers have only the primary wall, which gets broken very easily. Comparison with sections of individuals from the Leitha Chalk of the Basin of Vienna (type-locality of the genotype) revealed that in these specimens all walls have only the outer hyaline thickening, so that they are more primitive than the specimens found in the Recent Pacific. Since no columns are formed as in *Schlumbergerella* (former *Tinoporus*) it is obvious that between the rows of chambers running perpendicularly to the surface other rows can be intercalated; these secondary rows are in some way comparable with the columns.

In the eocene species, found at Little Stave Creek (Jackson-Formation) in California the chambers are larger and the walls mostly consist of the primary wall only.

Gypsina plana (Carter). Pl. 5, fig. 22-27.

Polytrema planum Carter, 1876, Ann. Mag. Nat. Hist., ser. 4, 17, p. 211.

A single flat specimen was found, obviously growing on both sides of some weed. At one side the specimen consisted of the usual series of chamber rows perpendicular to the surface; on the other side, which obviously was connected with the first since at one side of the totally vanished weed (except for some traces) the rows of chambers continued to the other side, part of the individual consisted of very large and irregular chambers, possibly brood chambers. Especially these chambers closely resemble those figured by Lindsey and reproduced by LOEBLICH and TAPPAN (1964, p. 697, fig. 2).

The transverse chamberwalls of the chambers are thickened and at the outside protrude slightly, so that on the surface the chambers are seen surrounded by slightly elevated hyaline walls. In these side walls, here and there the stolons between the chambers can be seen, mostly at their base. The walls parallel to the surface are pierced by coarse pores. Very thin sections reveal that the walls consist of an inner granular (or finely agglutinated) primary wall and that the walls are thickened at the outside by a hyaline, fibrous crystalline wall. That this outer thickening is secondary can be seen at the junction of two walls: here the wall of a next chamber is sunken into the wall of a former chamber.

This species is found rarely in the samples, mostly covering corals; it was found in several specimens in A 7. It is known from Mauritius as well as from the Caribbean Sea.

Miniacina miniacea (Pallas). Pl. 6, fig. 1-8.

Millepora miniacea Pallas, 1766, Elenchus Zoophytorum (the Hague), p. 251.

Polytrema miniacea Carpenter, Parker and Jones, 1862, Introd. Foram., p. 228, 235, pl. 13, fig. 18-20; Hofker, 1927, Siboga Rept. IVa, pt. 1, p. 27-31, pl. 12; pl. 13, fig. 1-7; pl. 14, fig. 1-11 (here older literature).

Miniacina miniacea (Pallas), Galloway, 1933, Manual Foram., p. 305.

This species is not very abundant in the material, and mostly in small specimens, incrustated on pieces of coral and fragments of Echinids. It has been exhaustively analysed by the present author in 1927, but some of the characteristics which in recent time are believed to be of value, have been overseen then. On transverse section it is found that the main opening of the test is formed nearly above the initial part; elongate chambers are running directly from the initial chambers up to the main opening, where they have large foramina opening into the outer world. It was possible to get a good horizontal section of a specimen built on a flat piece of echinid chalk and it was found that the megalospheric embryo consists of four chambers: the proloculus, a second chamber with nearly equal size, and a third chamber opening with one foramen; these three chambers are separated by a thin granular wall which can be seen as the inner lamellum of the outer walls of these chambers; this granular lamellum thus is the primary wall; this wall is thickened at the outside by a hyaline radial calcareous lamellum; the next chamber rests on the proloculus and the third chamber; these four chambers form the "raspberry" of the embryo. Then several larger chambers are added, obviously arranged in two spirals beginning at the fourth chamber. The author could find such an embryo just attached to its substrate, and consisting of about 11 chambers, the outer ones forming small protuberances attaching themselves to the substratum. Several other specimens on transverse section revealed that in the case that the specimen is attached to a rough surface, the embryos are found in holes of the substratum.

Later chambers have a slightly different structure compared with those found in the young specimen; they show the granular primary wall in the middle of the wall on transverse section, and the hyaline thickening is found as well at the outside as on the inside of the primary wall which always can be detected by the fine granules. With small magnification the wall of the later chambers thus seems to be bilamellar.

Quite the same finer structure of the walls (two

lamellae in the embryonic walls and the inner one of them granular; three lamellae in the later walls, the middle one being the granular primary wall) as well as the structure of the embryo (a proloculus, a second chamber and the third one giving rise to a chamber which forms at both sides a spiral of chambers) is also found in *Orbitoides* in the older stages of evolution, and in several other related genera. It may be that *Miniacina* has to be placed in this group of forms.

That the granular lamellum is the primary wall could be ascertained in the so-called hollow pillars at the outside of the test. These pillars, formed by the walls of adjacent chambers, must be closed later when next layers of chambers are added; this closing begins with a thin wall at the surface where the pillar opens, and this wall, pierced by pores, consists of the granular lamellum only; then the next chamber is laid down over it and forms at its inner side a second, now hyaline lamellum.

Planorbulinella larvata (Parker and Jones). Pl. 6, fig. 9-15.

Planorbulina larvata Parker and Jones, 1865, Roy. Soc. London, Philos. Trans. 155, p. 379, pl. 19, fig. 3.

Planorbulinella larvata (Parker and Jones), Cushman, 1927, Contr. Cushman Lab. For. Res. 3, pt. 1, p. 96, pl. 20, fig. 9.

This species has already been described by the present author (1927, p. 6, pl. 1, 2). The two sides are slightly different, one side mostly shows more tubercules in the central part than the other side; the side with tubercules seems to be the attached side, since one specimen, attached to a mollusc shell-part shows this side without distinct tubercules; most specimens seem to have been attached to plants.

Larger magnified horizontal sections reveal that the embryonic part consists of three chambers, which are surrounded together by a secondarily thickened wall. Apart from that thickening, the three chambers are surrounded and separated from each other by a thin granular primary wall. The proloculus has an areal foramen toward the second chamber which shows one basal opening towards the third chamber; the third chamber continues the short spiral and also has one distal foramen. This foramen leads to an auxiliary chamber with two foramina, from which two spirals of chambers start, surrounding the embryo; both spirals consist of four chambers and at their meeting point a symmetrical chamber is found. Most later chambers are symmetrical and gradually increase

in volume, till in the end, at the periphery of the test, large, often protruding chambers are formed.

The inner chambers mostly show the primary granular lamellum at the inner side and the more hyaline secondary thickening at the outside; in later chambers the primary wall can also be seen as a median lamellum. The walls of the latest formed chambers may have an inner hyaline lamellum and a thick granular outer one.

In general it can be said that the embryonic chambers have inner primary walls and only the outer walls of them are thickened secondarily. Real bilamellarity does not occur in *Planorbulinella*, and the peculiar megalospheric embryo with only one auxiliary (or symmetric) chamber does not show much resemblance with the embryonic part of *Planorbulina*; however, in some specimens from off Sorong, Papua, the embryonic megalospheric apparatus consists of a single spiral and a small proloculus (A₁-generation). LOEBLICH and TAPPAN (1964, p. 694) describe the wall of *Planorbulinella* as "calcareous, coarsely perforate, radial in structure, bilamellar"; this description has to be corrected: the wall is calcareous, coarsely perforate, for the larger part granular, with granular primary lamellum, often thickened at the outside, in some parts also at the inside, by more hyaline, fibrous radial, thickenings.

The species is common in the eastern part of the Archipelago, and also common in the Philippines (GRAHAM and MILITANTE, 1959, p. 118, pl. 19, fig. 17; here also the references to this species). In the Bay of Jakarta it was found in A 7 and B 6.

Carpenteria utricularis (Carter). Pl. 6, fig. 16-21.

Polytrema utricularis Carter, 1876, Ann. Mag. Nat. Hist., ser. 4, 17, p. 211, pl. 13, fig. 11-17.
Carpenteria utricularis Carter, 1877, Ibid., 20, p. 176; Brady, 1884, Rep. Voy. Challenger, Zool. 9, p. 678, pl. 99, fig. 6, 7; pl. 100, fig. 1-4; Cushman, 1921, U.S. Nat. Mus. Bull. 100, vol. 4, p. 360, pl. 73, fig. 4, 5; Hofker, 1930, Siboga Rep., vol. 4a, pt. 2, p. 126, pl. 50; pl. 52, fig. 1-5, 8, 9.

This species is rare in the samples; only one specimen of the *Carpenteria*-type was found, showing the typical ornamentation of the wall; whether the other forms mentioned in the Siboga-paper (*C. monticularis* Carter, *Ramulina herdmanni* Dakin, *Annomalina polymorpha* Costa) belong to the species could not be checked.

The specimen found has the form of a barnacle, with 7 chambers visible on the outside. The aperture

of the last formed chamber is found on top of the little mountain, in a slight groove; the apertural face (the later septum) is truncate to the upper wall of the last formed chamber and poreless. The walls of the chambers are covered by a network of honeycomb ridges as is typical for *C. utricularis*. The whole test does not differ from the neotype of *Carpenteria balaniformis* Gray, as figured by LOEBLICH and TAPPAN (1964, p. 709, fig. 580, 1a-c). The pores open into the hollows formed by the ridges and are of medium size.

A transverse section reveals a relatively large proloculus followed by a set of trochoidal spiral chambers. This set is followed by chambers overgrowing the primary set and all opening at their top. The outer wall of them is relatively thick, but does not show any trace of bilamellar structure; the pores remain simple. The honeycomb structure consists of secondary material laid down on this primary wall; it does not show any trace of pores and the ridges mainly are formed by folds in this secondary thickening. Since the chambers are curving at their tops, some of the poreless septa also can be seen in the section; they do not show any trace of lamination. The microstructure of the whole test is granular or, possibly, in some parts faintly fibrous.

Since the specimen figured here does not differ from the type-specimen of *Carpenteria*, but for the secondary ornamentation, it is obvious that the genus *Carpenteria* cannot belong to the bilamellar family (Subfamily) Victoriellinae in which LOEBLICH and TAPPAN placed it (1964). Toothplates could not be observed.

Biarritzina proteiformis (Goës). Pl. 6, fig. 22-28.

Carpenteria balaniformis var. *proteiformis* Goës, 1882, Kongl. Svensk. Vet. Akad. Handl. 19, No. 4, p. 94, pl. 6, fig. 208-214; pl. 7, fig. 215-219.

Carpenteria proteiformis Brady, 1884, Rep. Voy. Challenger, Zool. 9, p. 679, pl. 97, fig. 8-14; Cushman, 1915, U.S. Nat. Mus. Bull. 71, pt. 5, p. 49, pl. 20, fig. 2; pl. 21, fig. 1; 1921, Bull. 100, vol. 4, p. 361, pl. 73, fig. 2, 3; Hofker, 1930, Siboga Rept. IVa, pt. 2, p. 130, pl. 46, fig. 5; pl. 51, fig. 1, 4, 5, 7; pl. 52, fig. 6-8.

This species was found in several specimens in sample A 7. The test begins with a small balaniform base; then many globular chambers form a stem, mostly with three chambers in a whorl. The end chambers show an areal, somewhat irregular, aperture, often with a short neck and mostly provided with a small tooth. The test begins with a short spirally or rasp-

berry initial set of large chambers in the megalospheric form. Then some balaniform chambers are added; in the stem the chambers are arranged around an axis partly formed by the poreless septa of the chambers. All the walls, also of the initial chambers, are primary double, without any indication of a granular primary wall. So this species belongs to the rare bilamellar Foraminifera. The poreless septa also are double. The walls are radial calcareous. In the inner lamellum the pores are of medium size and thickly set; in the outer lamellum they mostly fuse together into much coarser canals which open into small pits in the surface. The walls are thick.

This species has nothing to do with *Carpenteria* and Loeblich and Tappan therefore brought it in the genus *Biarritzina*. Whether that genus really belongs to this group, is somewhat uncertain, since HERON-ALLEN and EARLAND (1919, p. 28-30), in their revision of the specimens of Halkyard described the species *Columella carpenteriaeformis*, the type-species of *Biarritzina*, as having a finely arenaceous wall, and being related to *Trochammina*. Moreover Heron-Allen states that the wall consists of an inner calcareous layer pierced by fine pores, and an outer layer of very fine mud particles. He stated, however, that Halkyard's species must be close to *Carpenteria proteiformis* Goës.

The shape of the pores, ending into canals, and the fact that in outgrown specimens the chamberwalls of later chambers wedge in the chamber walls of former chambers, strongly suggest that the outer lamellum is formed later than the inner one, or that the inner lamellum is formed by the protoplasm of the chambers themselves, whereas the outer lamellum is formed by protoplasm covering the surface of the inner wall. This would suggest that in *Biarritzina* the inner wall is the primary wall, though a granular structure could not be detected. So it remains uncertain whether this genus belongs to the real bilamellate Foraminifera as understood by SMOUT (1954) and REISS (1957, 1958, 1963).

Since "*Carpenteria*" *proteiformis* Goës has been described for the first time from material from the Caribbean, the present author has compared specimens from the Pacific with specimens from off Barbados; outer form as well as structure of the test wall and the structure of the initial part are quite similar; this is of interest, while CUSHMAN (1931, p. 141) states: "Specimens very similar to the West Indian species occur in various parts of the Pacific, but whether or not they are the same needs further study". Typical for both West Indian and Pacific specimens

are the pores, ending in larger canals before they reach the surface of the test wall. This characteristic is not found in any of the other species of *Carpenteria* known to the author, nor is there the feature that the wall is double, as found in *Biarritzina* (see e.g. the description given here of *Carpenteria utricularis*).

Calcarina spengleri (Gmelin). Pl. 7, fig. 1-17.

Nautilus spengleri Gmelin; Linné, 1791, Syst. Nat., ed. 13, vol. 1, pt. 6, p. 3371.

Calcarina spengleri (Gmelin), d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, 7, p. 276; Hofker, 1927; Siboga Exp., Rept. 4a, pt. 1, p. 45, pl. 21, fig. 3-6, 8-10; pl. 22; Graham and Militante, 1959, Stanford Univ. Publ., Geol. 6, No. 2, p. 107, pl. 17, fig. 8, 9, 10-13. Here further literature.

This species was found in the stations A 5, B 7, B 6, C 7, E 2, F 4. In B 7 it was common. A striking fact is, that in the Bay of Jakarta it is always much smaller than at the coast of Lombok, where it is abundant, and in many other more eastern localities. The species is characterized by the strongly built, often club-like spines. Specimens with four spines have a large megalospheric proloculus; those with 6-8 spines have a much smaller proloculus, and the specimens with a multitude of spines which often are bifurcated and fan-shaped, often very irregularly built, are the microspheric specimens; several of the latter form were found in the material of the Bay of Jakarta; they were much smaller than those found elsewhere, yet they were mature, since they showed brood-chambers.

The inner structure is complicated by the following features: the chambers, originally in a spiral, overlap former whorls only at the ventral side; the dorsal side is flattened or slightly convex; the spines interrupt the spiral, or, in later chambers these spines may pierce the lumen of the chambers (especially in brood chambers); the original walls of the chambers are double, consisting of an inner hyaline primary wall and an outer not much thicker wall which seems to be laid down slightly later, as can be seen where two chamber walls connect: a next wall forms a triangular wedge in a former wall; both these primary walls which may be in some way called "bilamellar", are pierced very regularly by relatively coarse pores, except for the proloculus which shows much finer pores; these two walls in older chambers have been thickened by a third lamellum, much thicker than the two first lamellae, and pierced by much coarser canals running towards the surface and originating from several of the primary pores which fuse to form these canals; be-

tween the canals which can be seen on the surface of the test as distinct openings, many short columns are found which, especially at the ventral side, may pierce the whole test from the proloculus to the surface. These columns show growing lines, but are massive and hyaline; especially at the ventral side, the chamber walls bend inward to form distinct grooves between two chambers. These grooves of older whorls may form distinct canals with the walls of later chambers in the region of the umbilicus; moreover, where two chamber walls fuse at the marginal side, a hollow is left at this angle and the covering, later thickening, lamellum. From all these canals, those formed by the pores, by the bending chamber walls and by the canals at the angles between two chambers, the canals found in the spines originate; these canals open at the surface and the ends of the spines, forming at their sides fine grooves which can be seen as elongate lines at their outside.

Though the author studied this species in numerous sections going through the tests in various directions, no traces of toothplates could be found; this is in contradiction to REISS (1963, p. 87) where he says: "Toothplates present, usually contorted at their distal ends."

It is remarkable that most of the chambers show a distinct massive "spine" at the margin in their primary double wall; this characteristic is typical for *Pararotalia*; the apertures of *Calcarina spengleri* also show resemblance with those found in several species of *Pararotalia*. Typical also is the form of the megalospheric proloculus; it is circular in horizontal section, but distinctly oval in transverse section; this characteristic also is found in *Pararotalia*.

Many of the features found in *Calcarina spengleri* are also found in *Siderolites calcitrapoides* Lamarck; it may be that both have the same ancestral genus, *Pararotalia*, as already suggested by Reiss.

Baculogypsinoides spinosus Yabe and Hanzawa. Pl. 7, fig. 13-25; Pl. 8, fig. 1-6.

Siderolites tetraëdra (Gümbel), Cushman, 1919, U.S. Nat. Mus. Bull. 100, vol. 1, pt. 6, pl. 44, fig. 5; pl. 45, fig. 1-5; 1921, *ibid.*, vol. 4, p. 358, pl. 75, fig. 5; pl. 76, fig. 1-5.

Baculogypsina bonarellii var. *tricuspidata* Osimo, 1908, Rev. Ital. Pal., p. 48, pl. 2, fig. 13-16.

Baculogypsina tetraëdra (Gümbel), Hofker, 1927, Siboga Rept. IVa, pt. 1, p. 48-50, pl. 23; pl. 24, fig. 1-7, 9; textfig. 7, 8.

Baculogypsinoides spinosus Yabe and Hanzawa, 1930, Sci. Rep. Tohoku Imp. Univ., ser. 2, 7, No. 2, pp. 43-45,

pl. 2, fig. 7; pl. 9, fig. 13; Hofker, 1933, Vidensk. Medd. nat. Foren. 33, pp. 128-129; Yabe and Hanzawa, 1952, Inst. Geol. Pal. Sendai, Short Papers, No. 4, p. 17, pl. 2, fig. 9, 12-15.

The species was common in the stations A 7, A 5, B 7, B 6, B 5, C 7 and St. 5. The test is more or less globular, with several naked spines characterized by longitudinal grooves. On the surface of the test many columns are visible in the shape of rounded pustules. Between these columns the relatively large, irregular chambers are visible, of which the outer walls with distinct pores often are broken away. The microspheric forms always are small, but with very large, dentated, slender spines which often bifurcate at their ends, where they are slightly fan-shaped. The spines of the megalospheric forms are shorter, nearly smooth and often covered by chambers at their bases.

The microspheric form begins with a horizontal spiral (horizontal in regard of the plane of the spines) of about three whorls, and the proloculus in vertical sections shows to be situated slightly above the general spiral, so that here the test begins trochoidally. The walls of the third spiral are connected with the spines. In this initial spiral the chambers connect with each other by a single foramen, situated slightly ventrally; the later chambers show several sutural or slightly areal openings at the ventral sides. Very soon the spiral ends and then the test is built by chambers situated in layers around the initial spiral, forming the globular test. Some spines can be formed by distinctly pointed chambers, namely by their pores, as is the case in *Pararotalia*; other spines begin at the junction between two chambers. The canals of the spines begin as normal chamberwall pores, or they may be fed by intramural hollows, just as is the case in *Calcarina* and in *Siderolites*. Later chambers communicate by many foramina situated suturally and areally, as they are found in *Pararotalia*, in *Calcarina* and in *Siderolites calcitrapoides*. The walls of the chambers and the thickenings between the later chambers in the B-form are much heavier than in the A-generations.

In the megalospheric form we met with many different forms of tests; some have 3 spines, many have 4 spines, or 5, mostly arranged in a single plane, more or less, which corresponds with the plane of the megalospheric initial spiral. But there exist also much more irregular tests, having up to 8 spines which are not arranged in one single plane. It could be proved that in the case that there are more than 5 spines, the spines found not in a single plane are short and arise from later chambers than those of the initial spiral. The proloculus is round and always followed by a

second chamber which is reniform and separated from the proloculus by a very thin wall. Then one whorl of chambers is added before the spines are formed, one of which seems to begin in the wall of the proloculus itself or from an intramural hollow adjacent to the wall of the proloculus. The later chambers are more irregular and, in horizontal section, separated by the spines. On transverse section the proloculus is oval, just as is found in *Calcarina* and in *Siderolites*. The chambers of the initial spiral communicate by one nearly median placed foramen, later chambers have many of them. Later chambers not only communicate by foramina in the walls comparable with those separating the chambers of the initial spiral, but also in those perpendicular to those walls. So the later growth of the test seems to be in all directions. Especially transverse sections show the many columns, which consist of longitudinal prisms but have no canals whatever.

All these features strongly point to *Siderolites* and to *Calcarina*, which genera must both be strongly allied to *Pararotalia*.

The species has nothing to do with *Calcarina tetraëdra* Gümbel from the Eocene; this species has a raspberry type of first chambers, and the canals in the spines never emerge from pores in the walls of chambers; it has been placed by Hanzawa (l.c., p. 17-18) in the genus *Silvestrella*; this is not a synonym to *Baculogypsinoïdes* as LOEBLICH and TAPPAN believe (1964, p. 629).

This species *Baculogypsinoïdes spinosus* Yabe and Hanzawa is identical with *Siderolites tetraëdra* Cushman (not Gümbel), 1919. Since *Silvestrella* is not synonym with it, nomenclatorially it might be called *Baculogypsinoïdes tetraëdra* Cushman. But close investigations by the present author show that it is nearly conspecific with *Siderolites calcitrapoides* from the Maastricht Tuff Chalk. Is it a late offspring of that species, still living in the Pacific? Or were *Siderolites calcitrapoides*, *Calcarina* and *Baculogypsinoïdes* three offsprings from *Pararotalia*, which latter genus already is found in the Upper Cretaceous? In real *Calcarina* the initial spiral is the only one found in the test, whereas *Siderolites* as well as *Baculogypsinoïdes* show wild-growing chambers covering the initial spiral. Cushman as well as Loeblich and Tappan figure specimens, pretended to belong to *Baculogypsinoïdes* which may be young specimens of that species; but they also may belong to *Calcarina hispida* Brady, mostly also occurring in the gatherings in which *Baculogypsinoïdes* is found. In any case, the lectotype designated by LOEBLICH and TAPPAN (1964,

fig. 501, 4) is a trivial one, and may cause bias. It is therefore that I figure here the several forms in which *Baculogypsinoïdes* (*Siderolites*?) *spinosus* Yabe and Hanzawa (or *tetraëdra* Cushman?, not Gümbel) occurs in the Bay of Jakarta.

Asterorotalia pulchella (d'Orbigny). Pl. 8, fig. 8-10; Pl. 9, fig. 1-7.

Calcarina pulchella d'Orbigny, 1839, in De la Sagra, Hist., Phys., Pol. et Nat. de l'Isle de Cuba; Foraminifères, p. 80. *Rotalia trispinosa* Thalmann, 1933, Ecl. geol. Helv. 26, p. 248.

Rotalia pulchella (d'Orbigny), Hofker, 1930, Siboga Rep. IVa, pt. 1, p. 37, pl. 16, fig. 7-10.

Asterorotalia pulchella (d'Orbigny), Hofker, 1951, Siboga Rep., IVa, pt. 3, pp. 505-508, textfig. 343-344.

This species, the genotype of *Asterorotalia* Hofker, is found in the muddy samples in which only few other species of Foraminifera occur in the Bay of Jakarta, E 2, F 3, G 3 and H 4. It was extremely common in E 2.

There are two generations; the common one with three spines is the megalospheric generation, the form with four spines is the microspheric generation. The spines emerge from the dorsal sides of the specimens and often can be traced over this side to the central part of the dorsal side. Mostly the spines are bent slightly towards the ventral side. The spines are hollow, a longitudinal canal piercing its centre; the walls of this canal are slightly irregular, and in undamaged spines the canal opens at the end of the hyaline spines. When a section is made following a spine, it can be seen that its canal continues through the walls of all chambers of the different whorls till it ends in the chamber of the first coil following the proloculus. The spine begins within one of the initial chambers, may pierce the chambers of later coils or may continue just between two chambers of later coils. In the initial coil each third chamber forms a spine, and this is the cause why in the megalospheric form only three spines are formed, whereas in the microspheric generation there are four spines.

When we study the toothplates in the chambers enveloping or forming spines, it is found that a close connection exists between the toothplates and the spines; the toothplate, continuing axially from the foramen, and forming here the hook or loop so characteristic for all genera around *Streblus*, continues dorsally from the foramen into the wall of the spine, forming here its canal. This shows that the initial part of the spine always is formed by the septal flap of the

toothplate, and that thus the canal in the spine is a toothplate-foramen. So the spines in *Asterorotalia* are not homologous with the spines of *Calcarina*, nor with those found in some species of *Rotalidium*. It is remarkable that other species of the genus *Asterorotalia* do not form these spines. The spines of *Asterorotalia pulchella* may be homologous with the dorsal outgrowth of the toothplate forming the dorsal toothplate-foramina in *Pseudoeponides* Uchio. When the spines pierce the chamber lumina in *Asterorotalia pulchella*, they pierce the outer wall through the poreless marginal part.

The dorsal side of the test is slightly convex, the ventral side slightly concave in the centre, which is filled by one or several columns emerging from the proloculus or the tena of some chambers. At the dorsal side all chambers are visible, though they may be obscured, especially in the microspheric form, by chalk bosses found in the centre and on the sutures. At the ventral side only the chambers of the last formed whorl are visible, but their sutures are covered by elongate extra plates which have two openings, one near the margin at the indentation between two chambers, and one below an indentation of the plate where the protoforamen of the next chamber opens. The plate is porous but for its middle part, where the protoforamen is found and where also the ventral wall of the next chamber lacks the pores. The lobulate margin of the chambers shows a distinct poreless rim.

The toothplate in chambers without spines axially forms a large hook or loop and is attached to the protoforamen of a next chamber; thus it is the toothplate of that next chamber; it bends ventralward forming the gutter of the covering plate at the ventral side whereas a part bending upward forms the proximal part of the chamberwall; the distal part of the former chamber bends towards the axis of the test and forms here the simple septum. Whereas in forms like *Streblus* and *Elphidium* the toothplate adheres closely to the septum, forming a secondary "double septum", here a broad hollow exists between the septum and the toothplate (septal flap) of the next chamber. This hollow is closed ventrally by the porous plate, formed by the toothplate of the next chamber. Whereas in *Streblus* the toothplate with its hook forms the canal which connects the chamber with the spiral canal in the umbilical hollow, which thus is a toothplate foramen continuing between the fillings of the umbilicus as a spiral canal, in *Asterorotalia* this toothplate canal opens into the hollow formed by the suture and does not open into the central umbilical

cavity, but, conducted by the ventral porous plate, it opens near the margin. So it seems that *Asterorotalia pulchella* has the tendency to let its protoplasm stream in peripheral direction, the more so since the toothplate canals in the spines also open outwardly.

The aperture in the poreless marginal face is a peculiar one; as in *Streblus* it is slightly loop-shaped, nearly areal, directed toward the end of the chamber and furnished with a distinct collar which forms a dent or lip. The septal foramina formed by this aperture are large rounded openings so that they seem somewhat enlarged secondarily; they possess a thickened border especially at the ventral side.

Rotalidium concinnum (Millet). Pl. 9, fig. 8-17; Pl. 10, fig. 1-3.

Rotalia annectens (Parker and Jones) var. *concinna* Millet, 1904, Journ. Roy. Micr. Soc. London 16, p. 505, pl. 10, fig. 7.

Rotalia beccarii Linnaeus, Flint, 1897, Rep. U.S. Nat. Mus., p. 331, pl. 75, fig. 2.

This species belongs to those species related to the genus *Streblus* which show two foramina in the apertural face, which foramina have been described as protoforamen and deuteroforamen by BHATIA (1956, pp. 22-23). Bhatia believed that the species of Millet belonged in the variation of *Streblus papillosus* (Brady); *S. dentatus* and *S. papillosus*, described by BHATIA, are species which distinctly belong to that group of *Streblus*-like species which belong to the same genus in which also is placed *Rotalia japonica* Hada. The latter species has been placed in the genus *Rotalidium* by ASANO (1936) and has been placed in the synonymy of *Ammonia* (= *Streblus*) by LOEBLICH and TAPPAN (1964, p. 607), erroneously. All these species have the two apertures described by Bhatia, the more ventral one being the aperture of the "secondary chamberlet" which all these species have in common. So the genus *Rotalidium* cannot be congeneric with *Ammonia* or *Streblus*.

In *Rotalidium japonicum* Hada, which is common more to the east of the Indonesian Archipelago (coast of Borneo), the "secondary chamberlets" are placed just ventrally from chambers and nearly totally separated from them by a distinct suture. In *Rotalidium dentatum* (Parker and Jones), which is common at the west coast of India, the chamberlets are placed somewhat more alternating with the main chambers. In *Rotalidium concinnum* (Millet) the chamberlets mainly are separated from the main chambers by the

deep protoforamina which are found in the middle of the ventral sutures of the test; they are not distinctly separated by a suture from the main chambers and are always found just axially from these chambers. Characteristic of *Rotalidium* are the two foramina at the apertural face, whereas in *Streblus* (*Ammonia*) there is only one aperture. It is a question of taste, whether one prefers to gather these species in *Asterorotalia* or in a distinct genus, *Rotalidium*.

KEIJZER (1935) obviously had *Rotalidium concinnum* (Millet) when mentioning *Rotalia papillosa* Brady from the north coast of Java. This can be concluded from the transverse section given on his pl. 4, fig. 1, which is identical with the sections the present author made through *R. concinnum*, and also from the short description given by KEIJZER (p. 133): lenticular, absence of chalk buds, surface smooth and shining. Real *Rotalia papillosa*, which also belongs to *Rotalidium* or possibly better to *Asterorotalia*, is typically found in the Red Sea and in the Philippines, and shows strongly developed inflated dorsal sutures and strongly developed chalk buds along the ventral sutures of the main chambers, as also emphasized by Bhatia. Our species here, however, is very "neat": *concinnum*. In the figure mentioned given by Keijzer, the double foramina can be seen very clearly. *R. concinnum* must be closely allied to *Rotalia annectens* Parker and Jones, which is common on the coasts of India, though it differs from *R. concinnum* since it does not have the lobulate periphery of the latter, whereas the small "secondary chamberlets" of *R. annectens* alternate with the main chambers. *R. annectens* also belongs to *Rotalidium* (or to *Asterorotalia*), and may be closely allied to *R. dentatum* (Parker and Jones). The figures given by Flint as *R. beccarii* show all the characteristics of *R. concinnum*; the two other species described by Flint of *Rotalia*, *R. pulchella* and *R. schroeteriana*, are with *R. "beccarii"* (= *R. concinnum*) mentioned from a locality unknown. Obviously this locality was on the north coast of Java, since here all three occur together abundantly.

Of *R. concinnum* microspheric and megalospheric specimens were found in the following localities: 6B, 5A, 5B, 3G and 4H. The microspheric specimens are lenticular, relatively larger than the megalospheric forms, with about 14 chambers in the last formed whorl; the smaller megalospheric generation has also a lenticular test, but the number of chambers of the last formed whorl in adult specimens never exceeds 12. At the dorsal side all chambers are visible, in the centre mainly by their pores, since the walls are ex-

tremely thick at the dorsal side. The chamber sutures at the dorsal side are nearly radiate. The periphery is lobulate, especially in the later chambers. At the margin a rounded poreless keel is visible, as is the case in all species of *Rotalidium*. At the ventral side (as well as at the dorsal side) the sutures are radiate and distinctly depressed. Each chamber at the proximal suture shows a deep and distinct indentation, the protoforamen which can be seen with high magnification as a distinct opening running inward. The larger part of the ventral chamber wall is pierced by very fine pores, but for the poreless tenon of the "secondary chamberlet" near to the umbilical region. This region is filled up by several irregularly placed knobs of clear calcitic substance, and transverse sections reveal that they are formed by the very much thickened poreless tena of the chamberlets of the former whorl.

From the protoforamen the toothplate starts, a thin-walled, much complicated structure. The inner wall of the protoforamen, or possibly better of the beginning of the toothplate, is roughened by many irregular fine knobs pointing outward. The main toothplate here forms a funnel, closed towards the lumen of the chamber except for a large opening of the funnel around the protoforamen so that protoplasm may run from the chamber through this opening to the protoforamen. The longer part of the funnel forms the proximal wall of the chamber. The ventral part of the funnel wall runs towards the opposite distal wall forming the septal flap; it divides the main chamber from the ventral accessorial chamberlet, whereas the main funnel wall near to the main foramen between two adjacent main chambers forms the axial inflated wall of the foramen. The septal flap of the funnel mainly runs towards the distal foramen (deuteroforamen or better toothplate-foramen) of the accessorial chamberlet, so that a direct communication is formed between the protoforamen and this toothplate foramen. A narrow part of the funnel communicates with the normal deuteroforamen of the main chamber, which foramen always is slightly loop-shaped, with the ventral part of it slightly areal, and to this areal part of the deuteroforamen the toothplate attaches. In all species of *Rotalidium* the septal flap of one toothplate is twisted in such a way as to form the larger part of the side-walls, possibly also the ventral porous wall of the accessorial chamberlet of the former chamber. This means that an undamaged test always shows the foramen (toothplate foramen) which lies ventrally from the main deuteroforamen in a wall part which distinctly is retreated in respect to the deuteroforamen. This would lead to the supposition that the accessorial

chamberlet is formed together with the main chamber, but by protoplasm streaming out from the former accessorial chamberlet, hence the funnel leading from the protoforamen towards the toothplate foramen of the chamberlet to get the protoplasm to the later formed next accessorial chamberlet. So, it is right as REISS (1963) suggested, that main chamber and accessorial chamber are produced at one instar; but they are built by two different parts of the protoplasm. Where the septal flap touches the ventral outer wall, pores are lacking in that wall, indicating the boundary between the main chambers and the accessorial chamberlets. Since the first chambers around the proloculus (two or three whorls) do not show this boundary and have a porous part of the wall comparable with that found in the main later chambers, it is presumed that the first chamber whorls of the microspheric generation are lacking the accessorial chamberlets, thus pointing to *Ammonia* (*Streblus*). This would lead to the conclusion that *Rotalidium* derived from *Ammonina* (*Streblus*). *Rotalidium* is known only from the latest Tertiary (Pliocene) and the Recent, whereas *Ammonia* (*Streblus*) is known from the Oligocene on.

It is remarkable that the few microspheric specimens found in the samples all coiled to the right, whereas all the abundant specimens of the macrospheric generation were left-coiling (see in this respect also *Pseudorotalia schroeteriana*).

Pseudorotalia schroeteriana (Carpenter, Parker and Jones). Pl. 10, fig. 4-18.

Rotalia schroeteriana Carpenter, Parker and Jones, 1862, Intr. Study Foraminifera, p. 213, pl. 13, fig. 7-9.

Faujasina sp., Williamson, 1853, Trans. Micr. Soc. London, ser. 2, 1, p. 87, pl. 10, fig. 1-6.

Rotalina schroeteriana (Carpenter, Parker and Jones), Eger, 1893, Sitz. Ber. Kgl. Bayer. Akad. Wiss., 2. Cl., 18, pt. 2, p. 422, pl. 19, fig. 10-12.

Rotalia schroeteriana Parker and Jones, Hofker, 1927, Siboga Rep., vol. IVa, pt. 1, p. 39-42, pl. 18, 19; pl. 21, fig. 1, 2, 7, 11, 13; Keijzer, 1935, Thesis, Leiden, p. 132, pl. 4.

Pseudorotalia schroeteriana (Carpenter, Parker and Jones), Reiss and Merling, 1958, Israël Geol. Survey, Bull. 21, p. 13, pl. 1, fig. 15-17.

In the megalospheric form this species has the form of a reversed conus, in such a way that the dorsal, spiral side is flat or slightly convex, whereas the ventral side is strongly conical; in the microspheric generation the test in the adult form is more or less lenticular. This has already been stated by Carpenter (l.c., p.

213), who describes the microspheric generation as the "Fiji-variety".

Though KEIJZER (1935) declared that no trimorphism occurred in *R. schroeteriana*, contrarily to what was found by the present author in 1927, with the material now at hand from the Bay of Jakarta, where the species is extremely common in the southern muddy stations, all outgrown microspheric specimens are lenticular, whereas all outgrown megalospheric specimens are reversed conical; moreover, measuring the diameter of 233 specimens, three distinct tops were found, at 1.0 mm, 1.3 mm and 1.5 mm. The tops must belong to three variation curves; that with the tops at 1.0 mm mostly have a very large proloculus with larger diameter of about 112 μ , though other diameters also occur (young specimens of the other generations, even of the microspheric ones); specimens of the curve with the top at 1.3 mm have smaller proloculi, of about 89 μ ; typical specimens of the curve with top at 1.5 mm show to be microspheric with diameter of the round proloculus of about 13 μ . Since in the curve with top at 1.5 only microspheric specimens occurred, it is obvious that the three generations (top at 1.0 is A_2 ; top at 1.3 is A_1 ; top at 1.5 is B) can be distinguished by their largeness in outgrown specimens (See textfig. 3).

In *Pseudorotalia schroeteriana* the toothplate can be seen in transverse section at the base of the chambers as a strongly folded plate which runs from the

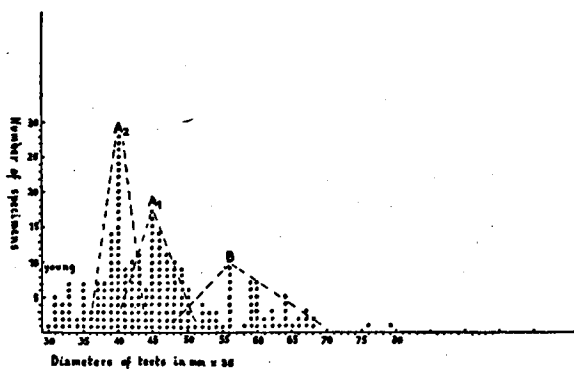


Fig. 3. Diagram showing the diameters (horizontal) of tests of *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones) from G3, which, on section, showed to following groups:

30-35 mostly young specimens belonging to 3 generations.
35-45 mostly specimens of generation A_2 , with some young specimens of A_2 and B.

48-80 some outgrown specimens of generation A_2 , but from 52 on all specimens belonging to generation B.

protoforamen to the ventral axial part of the deutero-foramen; at its distal part it forms an elongate plate which runs along the distal part of the former septum and forms gutters giving rise to openings along the suture, which openings especially in the microspheric generation may, near the margin, open alternately. This plate is the septal flap. In horizontal section the folded part of the toothplate forms a strong hook axially in each chamber, which hook leads to the protoforamen, where it gives passage to the protoplasm in the ventral part of each suture. It can be easily observed on such sections (taken ventrally from the first coil of chambers) that each septum is simple, and seems to be doubled by the septal flap, running from the folded part of the toothplate toward the margin, and here attaching itself to the outer chamber wall of the chamber to which the toothplate belongs. So, each next chamber proximally attaches its wall to the wall of a former chamber and is also attached to the septal flap of its toothplate, in order that each chamber seems to be surrounded by a wall, whereas in reality its wall forms only the distal septum and the outer wall. Between the septum of a former chamber and the septal flap of a next chamber a canal exists which opens axially at the foramen of the former chamber, and distally into the sutural canals which in outgrown specimens may be seen as openings at the dorsal suture of the chamber and not only at the ventral sutures. Near to these canal openings (toothplate-foramina) at the sutures the protoplasm laid down heaps of calcite, which form the ornamentation of calcitic knobs at the sutures.

When observing the direction of coiling of a large set of specimens, one finds that the microspheric specimens all are coiled to the right, whereas all megalospheric specimens are coiled to the left. In a set of 43 specimens, all belonging to one station, 13 were microspheric and coiled to the right, and 30 were megalospheric and coiled to the left. A similar phenomenon was stated in *Planulina wuellerstorffi* from a deep sample in the North Atlantic. Here 120 specimens were coiling to the left and 55 to the right; of these specimens coiling to the right 11 were microspheric, whereas no microspheric specimens were found coiling to the left. The present author found that *Globigerina daubjergensis* Brönnimann from the Danian of Denmark changed its modus of coiling during the Danian from left to right; but it was also shown, that during that time more and more microspheric specimens occur. Had in the latter case the change of coiling to do with the change in modus of reproduction? These observations may lead to the

conclusion that microspheric forms of Foraminifera have the tendency to get a dexterous coiling (see also *Rotalidium concinnum*). (See: HOFKER, 1962, p. 122 and 125.)

Parrellina hispidula (Cushman). Pl. 11, fig. 1-7.

Elphidium hispidulum Cushman, 1936, Cushman Lab. For. Res., Contr. 12, p. 83, pl. 14, fig. 13; 1939, Geol. Survey, Prof. Paper 191, p. 63, pl. 18, fig. 2.

"Test somewhat compressed, elliptical in peripheral view, slightly umbonate, periphery rounded; chambers mostly indistinct, the last two or three slightly inflated, about 10 in the adult coil, of rather uniform size and shape; sutures in the early portion with a row of low papillae, later smoother and slightly depressed, slightly curved; wall finely spinose, umbo with a few raised bosses of irregular size, early portion of test with fine rounded costae parallel to the periphery, later nearly obsolete; aperture consisting of several small openings at the base of the rounded, triangular apertural face. Diameter 0.50 mm; thickness 0.20 mm. The types are from depths of 4 to 14 fathoms in Albany Passage, Australia."

This species occurs, often abundantly, in the north-western part of the Bay of Djakarta. It does not belong to *Elphidium*, since the retral processes are lacking. Moreover, the slightly yellowish material of the test, the rough surface by fine sharp pustules directed towards the distal end of the test, which pustules later coalesce into the fine costae, and the inconspicuous oral openings at the base of the apertural face, without doubt point to the vicinity of *Parrellina imperatrix* or to *Parrellina miletti*. The wall of the last formed chambers is thin, but that of the earlier coils is secondarily thickened. The pores in the wall are distinct but seem to be closed near the surface by the secondary thickening in the earlier walls, or are covered by the protruding points of the papillae, which are directed distally. In the apertural face right and left from the small oral openings the toothplate canal opens in a shallow groove.

The toothplate consists of two canals in the basal angles of each chamber, running towards the septal wall of a former chamber and forming here an arched septal flap which forms fine canals opening left and right from the suture, just as is found in *Parrellina imperatrix*. Nowhere a typical retral processus can be observed. Where the canal formed by the septal flap and the former septal wall opens, several anastomosing canals can be seen in which the adjacent pores of the

outer wall also open. These canals are identical with those found in *Parrellina imperatrix*. From the toothplate canals running near to the umbilical region large canals emerge to the periphery in the umbilical region, just beginning at the place where the toothplate folds into the septal flap. These canals obviously formed the irregular calcitic bosses filling up the umbilical region and open between these bosses. All the toothplate canals of the successive chambers together form the umbilical spiral canal.

Several species exist which must be gathered in the genus *Parrellina*. HORNIBROOK described one of them, *Parrellina wadeae* Hornibrook, from the Oligocene of New Zealand (1961, p. 142, pl. 18, fig. 386; pl. 28, fig. 548, 549); CUSHMAN described another, as *Elphidium papillosum* Cushman, Recent, from New South Wales (1936, p. 83, pl. 14, fig. 12); the genotype of the genus, *Parrellina imperatrix* (Brady), has been described by many authors and the present author (1956, p. 161, pl. 24, fig. 18-20); this species is a recent one and is found in the Australian region; *Polystomella verriculatum* Brady is another species belonging to *Parrellina*, and is found around Australia, Recent (see CUSHMAN, 1939, l.c., p. 61, pl. 17, fig. 13); *Elphidium miletti* (Heron-Allen and Earland) also belongs to *Parrellina*; it has been described by the present author (1956, l.c., p. 161, pl. 24, fig. 23) as *Notorotalia miletti*, for all species of *Parrellina* are very close to *Notorotalia*, except for the fact, that the latter genus comprises trochoidal species. There are indications that *Polystomellina* also is very close to *Parrellina*, as already mentioned by LOEBLICH and TAPPAN (1964, p. 642). The wide-spread species *Thalmanita madruagaensis* (Cushman and Bermudez), typical for the Montian part of the Paleocene, may be the first species of the whole group mentioned above. It is also remarkable, that *Elphidiella arctica* (Parker and Jones) shows many striking features also found in the group around *Parrellina* (yellowish wall matter, pustules between pores, sutural toothplate-openings left and right from the suture, septal flaps narrow and identically formed). *Elphidiella* is also found from the Paleocene on.

Elphidium batavum nov. spec. Pl. 11, fig. 8-19.

Elphidium craticulatum Cushman (not Fichtel and Moll), 1933, U.S. Nat. Mus. Bull. 161, p. 48, pl. 11, fig. 5; 1939, Geol. Survey U.S.A., Prof. Paper 191, pl. 15, fig. 17.

In 1933 Cushman described a species found by him at Vavau Anchorage, Tonga Arch., and Nairai, Fiji, as

E. craticulatum (Fichtel and Moll), mentioning, however, that "at neither of these localities were the specimens at all well developed". The same form was found abundantly in the Bay of Jakarta, in the samples A 6, B 6, B 5, C 7, D 6, 5 (near D 4), D 3, E 5, E 2, F 7, F 6, F 4, F 3, G 3, H 4.

The species could be easily taken for a small *E. craticulatum* (*Cellanthus*) except for the following differences: it has a distinct poreless but not protruding keel; it never shows the forked toothplate canals at the sutures, not even in the microspheric generation (outgrown specimens of *Cellanthus* show them even in the megalospheric generation); in horizontal section the septa always are slightly oblique and curved, not straight and perpendicular to the margin as in *Cellanthus*; the retral processes are much larger, especially those at the margin, than in *Cellanthus*; in transverse section the chamber walls are much thicker than in *Cellanthus*; the toothplate septal flaps are narrower than in *Cellanthus*.

Thus this species is a true *Elphidium*, somewhat resembling *E. crispum*, but in the adult specimens of much larger size; the umbilical hyaline calcitic knob is higher developed than that of *E. crispum*; the number of chambers in the last formed whorl is larger (in *E. crispum* never more than 20 in the microspheric form, here 25-28); the last formed chambers form a lobulated periphery which never is found in *E. crispum*; the tests are much thicker than those of *E. crispum* (larger : shorter diameters = 2 : 1); the outer ornamentation of *E. batavum* is not so conspicuous as in *E. crispum*, due to the much higher developed retral processes of the latter species.

It may be that *E. batavum* forms a link between *E. crispum* as found in the Mediterranean and *Cellanthus craticulatus*; references of *E. crispum* from the Pacific should be checked once again; it might be that most of them refer to the new species. *E. batavum* also has affinities to *E. indicum* Cushman, but is much larger, with much more chambers and a larger knob in the centre.

DESCRIPTION OF ELPHIDIUM BATAVUM NOV. SPEC.

Test large, diameter 1 mm and more, round, lenticular; length : breadth about 2 : 1. Last formed chambers distinctly inflated, with lobulate periphery and depressed sutures. Chambers overlapping both sides of the test with breadth up about 1/3 of the diameter, as the centre is occupied by a large only slightly protruding calcitic knob which is pierced by distinct canals. Openings of toothplate foramina at the sutures about 8 at one side. Margin acute by poreless rim.

Retral processes existant but inconspicuous between the sutural openings, though in older chambers they may form indistinct striae parallel to the periphery. Toothplates similar to those of other *Elphidium*-species. Sutural toothplate foramina with small pustules directed outwardly at the inner wall of these openings. Micro- and megalospheric forms nearly identical in outgrown specimens. Wall smooth, shining, with very fine pores.

Nummulites complanatus (Defrance). Pl. 11, fig. 20-23; Pl. 12, fig. 1-14.

Lenticulites complanatus Defrance, 1822, Dictionnaire des Sci. Nat., p. 453.

Operculina complanata (Defrance), Brady, 1884, Chall. Exp., Zool. 9, p. 743, pl. 112, fig. 3, 4, 5, 8.

Operculina complanata (Defrance), var. *granulosa* Brady, 1884, l.c., p. 743, pl. 112, fig. 6, 7, 9.

Operculina complanata (Defrance), Hofker, 1927, Siboga Exp., vol. 4a, pt. 1, p. 61, pl. 31, pl. 32, fig. 2-9, pl. 33.

Operculina complanata (Defrance), Keijzer, 1935, Thesis, Leyden, p. 124, fig. 22.

Operculina complanata (Defrance) Bannink, 1948, Thesis Leyden, p. 74, p. 122 (group 1); pl. 11, fig. 89, 90.

Operculina granulosa (Gronovius), Bannink, 1948, l.c., p. 81, p. 122 (group 2); pl. 19, fig. 177, 178, 181, 182, 183.

Thousands of specimens of "*Operculina*" have been found in the samples 5A and 6A; they also occur in many other samples from the Bay of Jakarta. The specimens seldom reach a diameter larger than 3 mm. This indicates that circumstances are not optimal.

Nomenclaturally I follow here the suggestion made by Cole in the Treatise by LOEBLICH and TAPPAN (1964, p. 645), to call all species with planospiral tests and simple chambers *Nummulites*.

There has been much confusion about the name of the *Nummulites* (*Operculina*) species living in the region of the Indonesian and Philippine Archipelagos. According to the present author's investigations in 1927, *N. complanatus* has three distinct generations which differ considerably. The B-generation is a very flat form, with a spiral broadening conspicuously in the end, and only forming calcitic tubercles in the centre, with minute tubercles all over the surface of each chamber. The A₁-generation has a smaller test, and the spiral is not so broadening in the end; often it shows distinct tubercles on the sutures of the earlier sutures and a distinct pustule in the centre on both sides; the A₂-generation has much more ornamentation on the surface of the test wall, consisting of rows of pustules and a large central one, whereas the spiral broadens very gradually and never shows the slightly

flaring end part of the spiral. B- and A₁-generations are very compressed flat forms, whereas the A₂-generation has a distinctly thicker test, especially in the central part, with more overlapping chambers. The generations B and A₁ must be placed in the flat groups mentioned by Bannink as the *complanata* group, whereas the tests of generation A₂ distinctly belongs to his *granulosa* group. In the B-generation all whorls of the spiral have very compressed chambers which do not overlap previous whorls; in the A₁-generation the first whorls slightly overlap former whorls, whereas later whorls are much compressed, not overlapping; in the A₂-generation all whorls are overlapping even the last formed whorl. It is obvious that these three generations of one species always being found together, even in the Bay of Jakarta, where circumstances are far from favorable, would belong to the following "groups" described by Bannink:

- 1) Microspheric form (B-form); all whorls very much compressed, later spiral distinctly flaring: group 1, *Operculina complanata* (Defrance); all whorls totally evolute, whorls rapidly increasing in breadth, width of third whorl greater than 6.6 x the width of the first coil.
- 2) Megalospheric A₁-form; initial coils involute, but later coils evolute: later whorls distinctly flaring: group 4, *Operculina cruciensis* Pictet and Renévier.
- 3) Megalospheric A₂-form; all coils more or less involute, width of the coils very gradually increasing; group 6, *Operculina ammonoides* (Gronovius).

It is obvious that the grouping proposed by BANNINK is meaningless, since he did not account for the different generations within a species.

KEIJZER sectioned many specimens of the "megalospheric generation" only, and believed to show that there exists in *Operculina complanata* only one megalospheric generation, with proloculi having diameters ranging from 50 to 145 μ with a top at about 80 μ . Obviously he threw the specimens belonging to the A₁-generation into the B-group, from which he does not mention the diameter of the proloculus.

In reality there are three generations, the B-generation with proloculi ranging in diameter from 13-24 μ ; the A₁-generation with proloculi ranging in diameter from 27-42 μ ; the A₂-generation with proloculi having diameters ranging from 51-120 μ . The tops of the three curves are found at 20, 35 and 80 μ . The specimens of the A₁-generation easily can be distinguished from those of the B-generation by the larger second

chamber forming with its thickened wall a bilocular embryo, as is found in the A_2 -generation, whereas in the B-generation such a bilocular embryo does not exist, the second chamber mostly being smaller than the proloculus and not having a thickened wall.

Analysis of the different spirals observed can best be carried out having in mind that the Foraminifera increase their volume adding new chambers of which the volume has a ratio with the former chamber as to 1 : 1.618 (Sectio divina) as the present author will prove in another paper. It is obvious that the spiral involved will have the shape of the "Spirale des Lebens" described by GOETHE, and that in horizontal section the spirals of very flat and evolute tests more or less reach that spiral, whereas forms with involute chambers show spirals which are more contracted. This is found in *Operculina complanata*. When we draw the spiral of an horizontal section and construct two perpendiculars through the centre of the proloculus we can construct the diagonal lines connecting the cross points with the spiral. In the ideal spiral these successive diagonals show the ratio 1.27. The more the chambers overlap, the more this ratio withdraws from that value. (See explanation of pl. 12, fig. 5.) Measurements reveal:

B-generation	A_1 -generation	A_2 -generation
means 1.31	1.23	1.20
1.28	1.22	1.19
1.26	1.27	1.19
—	—	—
total means 1.28	1.24	1.19

We do not know why the three generations differ in the building of their spirals. Are these differences caused by differences in density of the protoplasm? It will be obvious that the surface for respiration caused by the exposed surface of pores will be larger in the B- and A_1 -generations than is the case in the A_2 -generation. In the B-generation many nuclei are developed, less in the A_1 -generation; in the A_2 -generation the nuclei are few in number, and certainly haploid, whereas in the B- and A_1 -generations they are diploid. Is that the cause of a change in the structure of protoplasm leading to the change in test building? It would be worth while to study these problems in living populations.

Nummulites complanatus (Defrance) is found in the Bay of Jakarta in the following localities: 7C, 7F; 6A (abundant), 6B, 6D, 6F; 5A (abundant), 5B, 5E; 4D; 3D, 3C.

CUSHMAN described several forms of "*Operculina*"

(1933, pp. 55-56), under two names, "*O.*" *gaimardi* d'Orbigny and "*O.*" *granulosa* (Leymeri)?; they both occurred in two localities together, viz. Mokaujar Anchorage and Nairai, Fiji, whereas a single specimen of his *gaimardi* also occurred with few specimens of his *granulosa* at St. 3983 Albatross. It seems that his *gaimardi*-types are microspheric specimens of "*O.*" *venosa*, whereas his *granulosa*-types mostly are conform those found in the Bay of Jakarta, according to the figures; the very flat form figured by CUSHMAN on pl. 15, fig. 6, is the microspheric form. Obviously the same population as found in the previously mentioned localities also occurs in the Bay of Jakarta, but in Cushman's references together with "*O.*" *venosa*, which is not found so far West in the Archipelago. GRAHAM and MILITANTE (l.c., 1959) found both groups of tests, *complanata* and *ammonoides* in many stations of the Philippines.

Heterostegina curva Möbius. Pl. 12, fig. 15-20.

Heterostegina curva Möbius, 1880, Beitr. Meeresfauna Mauritius u. Seichellen, p. 105, pl. 13.

GRAHAM and MILITANTE (1959, p. 76) believe that *H. curva* belongs in the synonymy of *H. suborbicularis* d'Orbigny; however, they figure a specimen, pl. 11, fig. 19, which is identical with that figured by Möbius. All the specimens found in the Bay of Jakarta (mostly in A 7) have the characteristics of *H. curva* Möbius, a small test with only a very restricted flange, measuring not more than about 3-5 mm in diameter. Moreover, the specimens described by the author as *H. suborbicularis* from the eastern part of the Indonesian Archipelago in the megalospheric generation have 10 or 11 simple chambers before the chambers with one division appear for the first time; in the figure by Möbius there are at least 16 undivided chambers; this also is the case in the specimens studied from the Bay of Jakarta.

The tests are lenticular, often with a curved flange; there is a hyaline part in the centre which is flush with the surface; the overlapping chamberparts are strongly curved, in an S-like manner. On horizontal section the 16 first chambers in the megalospheric specimens are simple; then 9 chambers follow with one chamberlet, and then gradually the number of chamberlets augments. The first chamber following the proloculus is reniform. All septa show the canals so that they seem double; these canals communicate with those found in the secondary septa; they run at the margin into the marginal chord. On transverse

section the overlapping parts of the chambers are narrow; right and left from the marginal chamber-(septal)-foramen a narrow toothplate canal may be seen, connected with the two septal canals which are rather broad. The pores in the walls are very fine,

leaving a central pillar with nearly no canals free, running conically from the proloculus to the central surface.

The species is known from Mauritius, from the Bay of Jakarta and from the Philippines.

REFERENCES

- ASANO, K., 1936: *Rotalidium*, a new genus of Foraminifera from the Pacific. Imp. Acad. Tokyo, Proc. 12, No. 10.
- BHATIA, S. B., 1956: Recent Foraminifera from shore sands of Western India. Contr. Cushman Found. For. Res. 7, pt. 1.
- BRADY, H. B., 1884: Report on the Foraminifera dredged by HMS. Challenger. Challenger Rept. Zool. 9.
- CUSHMAN, J. A., 1931: Foraminifera of the Atlantic Ocean. U.S. Nat. Mus. Bull. 104, pt. 8.
- 1933: The Foraminifera of the tropical Pacific collections of the "Albatross", 1899-1900. U.S. Nat. Mus. Bull. 16, pt. 2.
- 1936: Some new species of *Elphidium* and related genera. Cushman Lab. For. Res., Contr. 12.
- 1939: A monograph of the foraminiferal family Nonionidae. U.S. Geol. Survey, Prof. Paper 191.
- GRAHAM, J. J. and MILITANTE, P. J., 1959: Recent Foraminifera from the Puerto Galera area of northern Mindanao, Philippines. Stanford Univ. Publ., Geol. Sci., 6 no. 2.
- HERON-ALLEN, E. and EARLAND, A., 1919: The fossil Foraminifera from the Blue Marl of the Côte des Basques, Biarritz, by E. Halkyard. Notes from the Manchester Museum 24.
- HOFKER, J., 1928: *Polyphragma cribrosum* Reuss. Natuurhist. Maandblad 17, no. 7.
- 1927: Foraminifera of the Siboga-Expedition, Tinoporidae, Rotaliidae, Nummulitidae, Amphisteginidae. Siboga Reports, IVa, pt. 1.
- 1930: Foraminifera of the Siboga Expedition, Astro-rhizidae, Rhizamminidae, Anomalinidae, Peneropliidae. Siboga Reports, IVa, pt. 2.
- 1933: Foraminifera of the Malay Archipelago. Vidensk. Medd. Dansk Naturh. Foren. 93.
- 1956: Foraminifera dentata; Foraminifera of Santa Cruz and Thatch-Island, Virginia Archipelago, West Indies. Spolia Zool. Mus. Hauniensis. 15.
- 1957: Die Foraminiferen der Oberkreide von Nordwestdeutschland und Holland. Beih. geol. Jahrb., H. 27.
- 1962: Studien an planktonischen Foraminiferen. N. Jahrb. Geol. Pal., Abh., 114.
- 1964: Foraminifera from the Tidal Zone in the Netherlands Antilles and other West-Indian Islands. Studies on the Fauna of Curaçao and other Caribbean Islands 21.
- HORNIBROOK, N. de B., 1961: Tertiary Foraminifera from Oamaru District (N.Z.). New Zealand geol. Survey, Bull. 34 (1).
- KEYJZER, C. J., 1935: On variability in East Indian Foraminifera. Thesis Leiden.
- LOEBLICH, A. R. Jr. and TAPPAN, H., 1955: Revision of some recent Foraminiferal genera. Smiths. Misc. Coll. 128, no. 6.
- 1964: in Treatise on Invertebrate Paleontology; pt. C, Protista 2, vol. 1, 2.
- MILLET, F. W., 1898-1904: Report on the recent Foraminifera of the Malay Archipelago. Roy. Micr. Soc. London, 17 pts.
- REISS, Z., 1957: The Bilamellidea, nov. superfam., and remarks on Cretaceous Globorotalids. Contr. Cushman Found. For. Res., 8, pt. 4.
- 1958: Classification of lamellar Foraminifera. Micropal. 4, no. 1.
- 1963: Reclassification of perforate Foraminifera. Geol. Survey Israel, Bull. 35.
- SMOUT, A. H., 1954: Lower Tertiary Foraminifera of the Qatar Peninsula. British Mus. (Nat. Hist.), London.

ERRATUM

Fig. 1, 2, 3, and 4 of plate 9 have been
printed upside down.

PLATE I

- Fig. 1, 2. *Sagenina frondescens* (Brady). Two specimens from A7; $\times 8$.
- Fig. 3-5. *Sagenina frondescens* (Brady). Three transverse sections; $\times 80$.
- Fig. 6-8. *Placopsilina bradyi* Cushman and McCulloch. Three specimens from A7; $\times 16$.
- Fig. 9-11. *Placopsilina bradyi* Cushman and McCulloch. Apertures; $\times 24$.
- Fig. 12. *Placopsilina bradyi* Cushman and McCulloch. Longitudinal section, showing the pores in the test wall; $\times 80$.
- Fig. 13-17. *Bdelloidina aggregata* Carter. Specimens from A7; $\times 16$.
- Fig. 18. *Bdelloidina aggregata* Carter. Transverse section; $\times 40$.
- Fig. 19. *Bdelloidina aggregata* Carter. Longitudinal section, showing the pores in the walls; $\times 40$.
- Fig. 20. *Bdelloidina aggregata* Carter. Horizontal section through two chambers, showing foramina and labyrinthic inner structure of walls; $\times 40$.
- Fig. 21, 22. *Textularia kerimbaensis* Said. Two specimens from three sides, from A7; $\times 16$.
- Fig. 22a. *Reophax scorpiurus* Montfort. Specimen from A5; $\times 16$.
- Fig. 23-25. *Textularia kerimbaensis* Said. Longitudinal sections, 24 with small proloculus; $\times 34$.
- Fig. 26-28. *Bigenerina nodosaria* d'Orbigny. A_2 -generation, from three sides; from D6; $\times 16$.
- Fig. 29. *Bigenerina nodosaria* d'Orbigny. Individual of Fig. 26-28, longitudinal section, showing the large proloculus and the very short set of biserial chambers; $\times 32$.

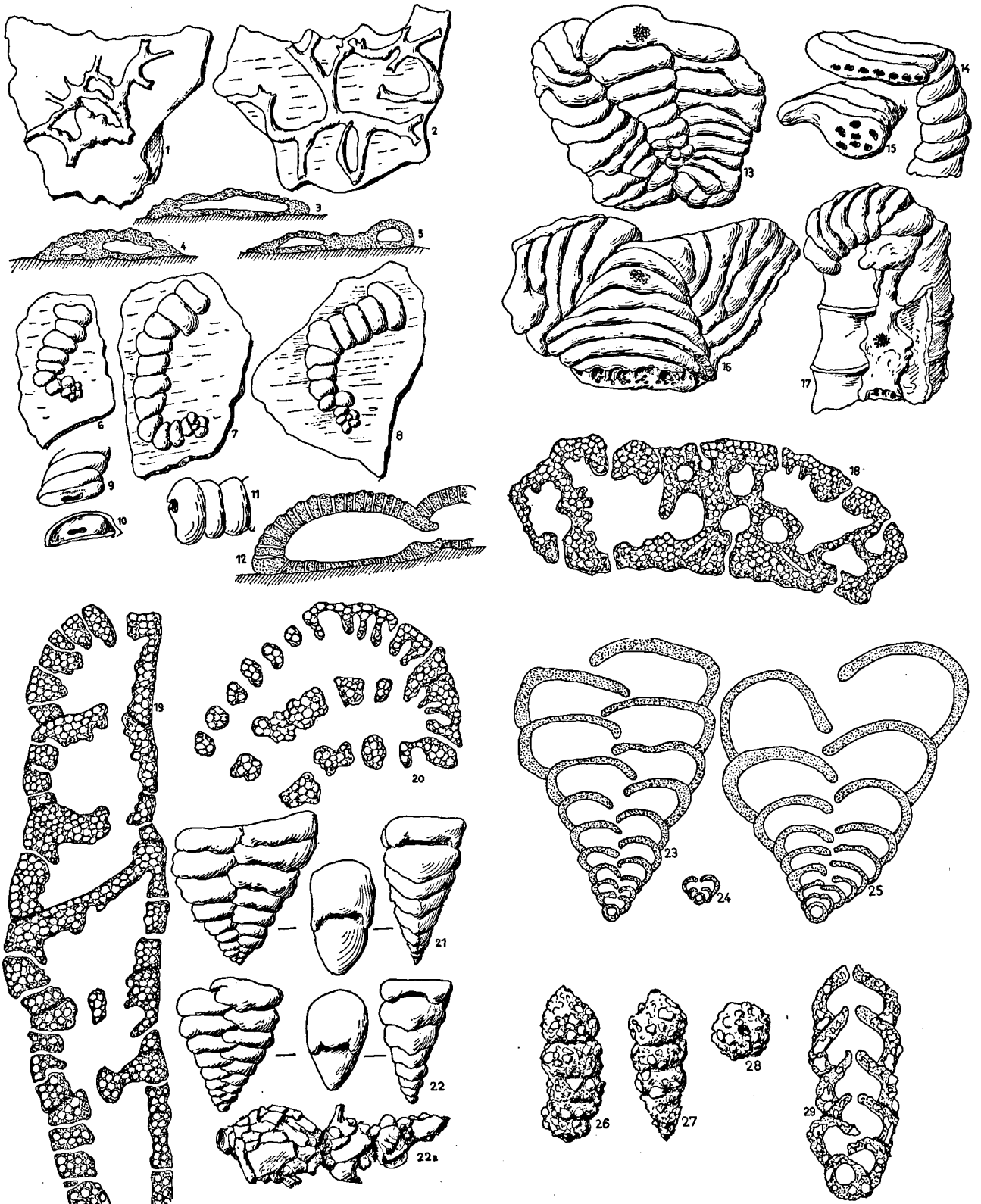


PLATE 1

PLATE 2

- Fig. 1, 2. *Bigenerina nodosaria* d'Orbigny. Test of A₁-generation, seen from two sides; from D6; × 16.
- Fig. 3. *Bigenerina nodosaria* d'Orbigny. Test of Fig. 1, 2; horizontal section, showing the small megalosperic proloculus and the set of biserial chambers; × 32.
- Fig. 4, 5. *Bigenerina nodosaria* d'Orbigny. Test of B-generation, seen from two sides; from D6; × 16.
- Fig. 6. *Bigenerina nodosaria* d'Orbigny. Horizontal section through specimens of Fig. 4, 5, showing the very small proloculus and the large set of biserial chambers; × 16.
- Fig. 7-9. *Valvotextularia foliacea* Heron-Allen and Earland. Microspheric specimen from three sides; from A5; × 16.
- Fig. 10. *Valvotextularia foliacea* Heron-Allen and Earland. Horizontal section through specimen Fig. 7-9 showing the pores in the walls and the slightly spirally initial part; same locality; × 32.
- Fig. 11-13. *Valvotextularia foliacea* Heron-Allen and Earland. Megalosperic specimen; from three sides; same locality; × 16.
- Fig. 14. *Valvotextularia foliacea* Heron-Allen and Earland. Horizontal section through megalosperic specimen; × 32.
- Fig. 15-17. *Valvotextularia rugulosa* (Cushman). Test from three sides; from A7; × 16.
- Fig. 18, 19. Two transverse sections through *Valvotextularia rugulosa* (Cushman), showing the porous outer walls, whereas parts of walls show an agglutination of much coarser grains than the parts with pores; × 20.
- Fig. 20. *Valvotextularia rugulosa* (Cushman). Longitudinal section; × 20.
- Fig. 21-26. *Clavulina pacifica* Cushman. Two tests from three sides; from A5; × 16.
- Fig. 27-29. *Spiroloculina communis* Cushman and Todd. Individual from three sides; from D6; × 22.
- Fig. 30-31. *Spiroloculina communis* Cushman and Todd. Larger specimen from two sides; from D6; × 22.
- Fig. 32, 33. *Spiroloculina communis* Cushman and Todd. Sections through the specimens Fig. 27-29 and 30-31. Transverse sections; × 80.

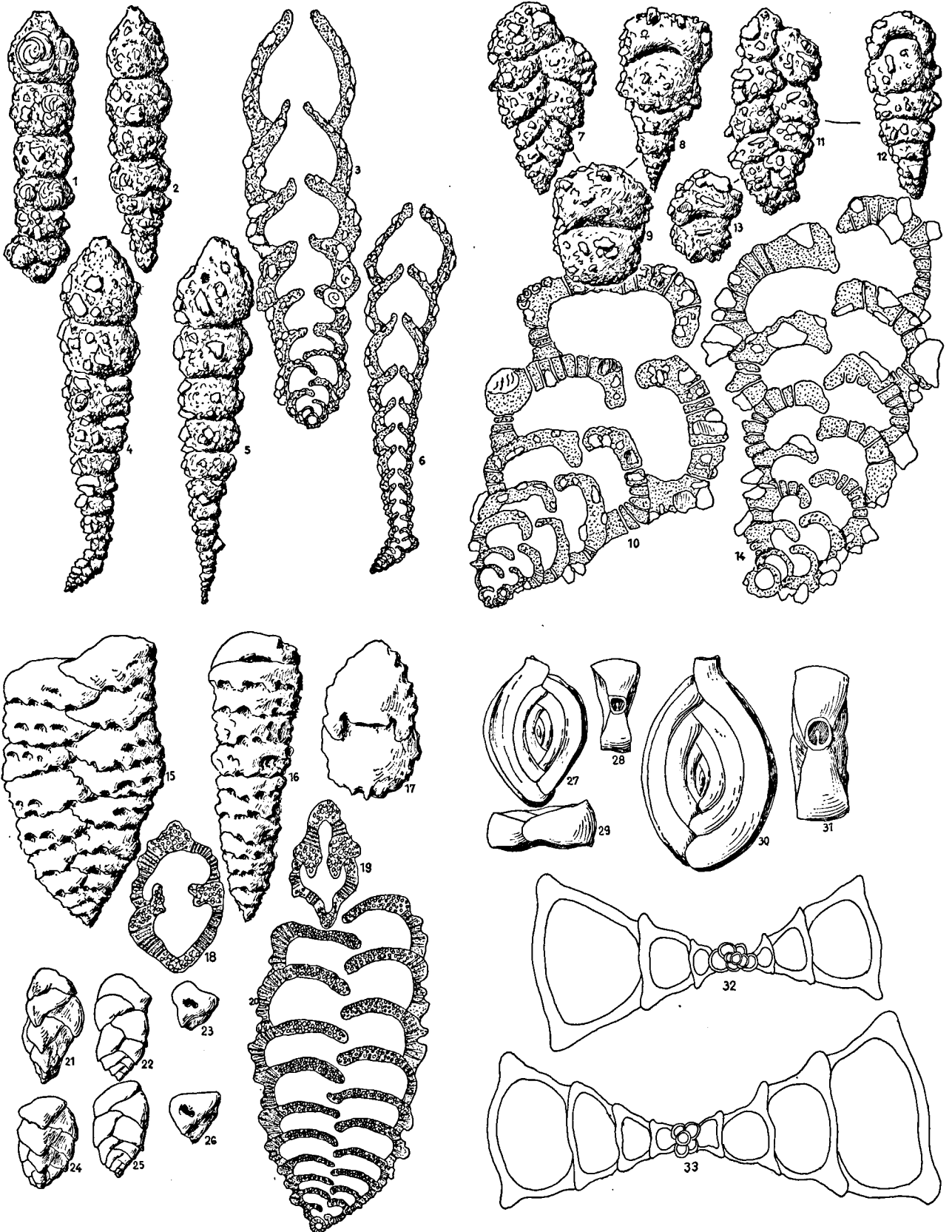


PLATE 2

PLATE 3

Fig. 1-3. *Quinqueloculina bidentata* d'Orbigny. Test from three sides, from F7; $\times 16$.

Fig. 4. Transverse section through *Quinqueloculina bidentata* d'Orbigny; $\times 150$.

Fig. 5, 6. *Quinqueloculina curta* Cushman. Test from two sides; from D6; $\times 16$.

Fig. 7. Transverse section through *Quinqueloculina curta* Cushman from fig. 5, 6; $\times 32$.

Fig. 8-10. *Quinqueloculina (Miliola) kerimbatica* Heron-Allen and Earland. Microspheric test; from three sides; from St. 5; $\times 16$.

Fig. 11. Transverse section through that specimen; $\times 24$.

Fig. 12-14. Another microspheric specimen of *Quinqueloculina (Miliola) kerimbatica* Heron-Allen and Earland; from D6; $\times 16$.

Fig. 15. Transverse section through that specimen; $\times 32$.

Fig. 16-18. *Quinqueloculina (Miliola) kerimbatica* Heron-Allen and Earland. Three sides of megalospheric specimen; from D6; $\times 16$.

Fig. 19. Transverse section through this specimen; $\times 40$.

Fig. 20-22. Another individual of megalospheric *Quinqueloculina (Miliola) kerimbatica* Heron-Allen and Earland; from three sides; from St.5; $\times 16$.

Fig. 23. Transverse section through the specimen of Fig. 20-22; $\times 24$.

Fig. 24-27. *Quinqueloculina bicarinata* d'Orbigny. Megalospheric specimen; from D6; $\times 16$.

Fig. 28. *Quinqueloculina bicarinata* d'Orbigny. Aperture with tooth; $\times 32$.

Fig. 29. Transverse section through the specimen of Fig. 24-27; $\times 80$.

Fig. 30-32. Three sides of *Quinqueloculina bicarinata* d'Orbigny. Microspheric; from D6; $\times 16$.

Fig. 33. Transverse section through specimen Fig. 30-32; $\times 32$.

Fig. 34. Same section, central part; $\times 80$.

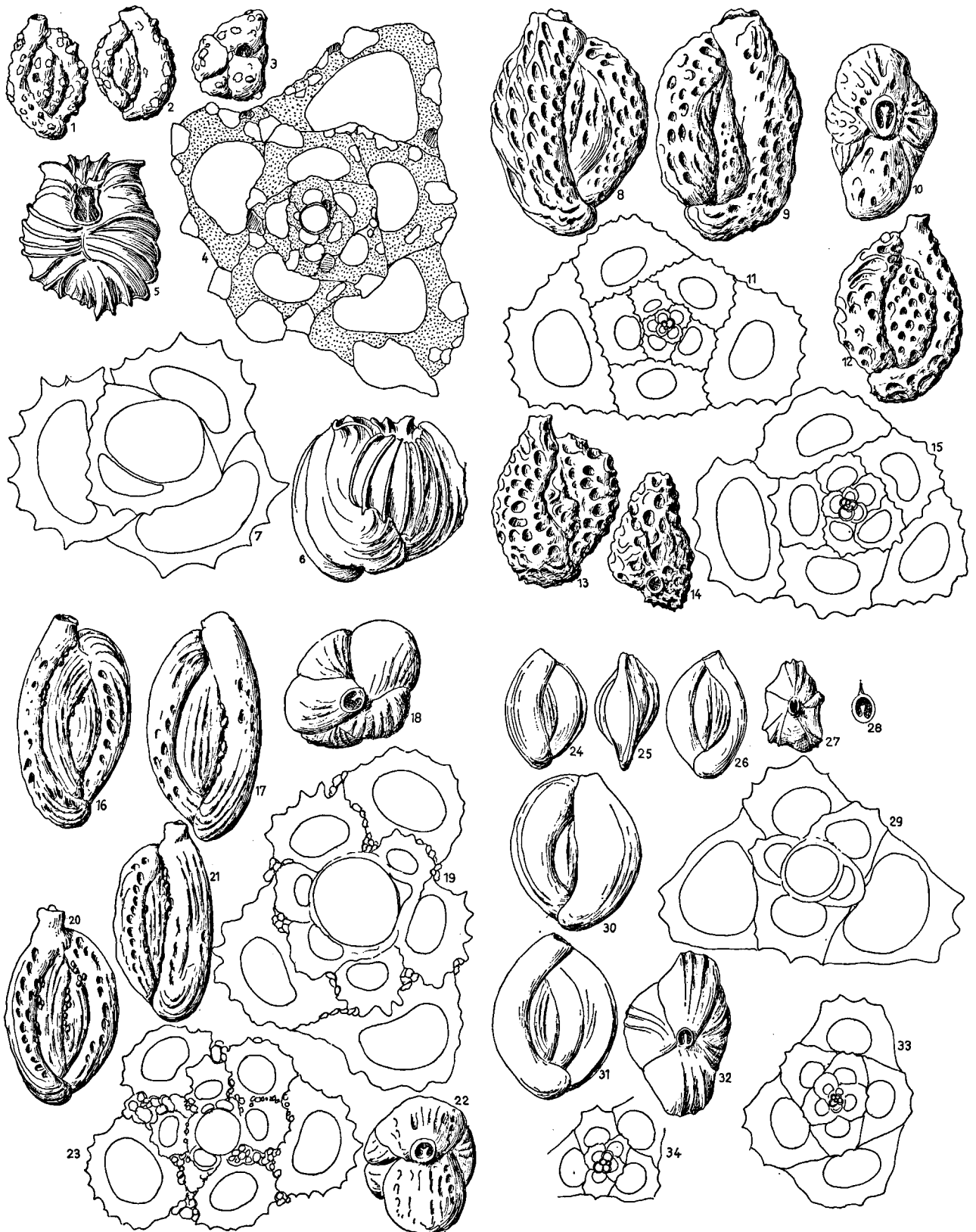


PLATE 3

PLATE 4

- Fig. 1-3. *Flintina bradyana* Cushman. Three sides of outgrown test; from D6; 1, 2 \times 16; 3 \times 24.
- Fig. 4. Apertural chamber of foregoing chamber; \times 16.
- Fig. 5. Transverse section through specimen Fig. 1-3; \times 20.
- Fig. 6. *Flintina bradyana* Cushman. Apertural face of a test from A7, oblique sideview; \times 16.
- Fig. 7-9. *Triloculina tricarinata* d'Orbigny. Three sides; from A5; \times 80.
- Fig. 10. *Triloculina tricarinata* d'Orbigny. Transverse section through specimen Fig. 7-9; \times 80.
- Fig. 11-13. *Triloculina rupertiana* (Brady). Three sides; from A7; \times 16.
- Fig. 14. *Triloculina rupertiana* (Brady). Part of outer surface of test wall; \times 80.
- Fig. 15. Transverse section through specimen Fig. 11-13; \times 80.
- Fig. 16, 17. *Schlumbergerina areniphora* Munier-Chalmas. Specimen from two sides, from off Sorong, Papua; \times 16.
- Fig. 18. Transverse section of specimen 16, 17; \times 80.
- Fig. 19. Same section, central part; \times 240.
- Fig. 20, 21. *Schlumbergerina areniphora* Munier-Chalmas. From two sides; from D6; \times 16.
- Fig. 22. Tangential transverse section, showing the sigmoid arrangement of later chambers of individual Fig. 20, 21; \times 16.
- Fig. 23. Transverse section of specimen Fig. 20, 21; \times 80.
- Fig. 24. Central part of the section Fig. 23; \times 240.
- Fig. 24a, 25. *Dendritina striatopunctata* Hofker. Normal specimen; from two sides; from D6; \times 16.
- Fig. 26. *Dendritina striatopunctata* Hofker. Very large specimen with evolute end-stage; from A6; \times 16.
- Fig. 27. *Dendritina striatopunctata* Hofker. Pitted surface; \times 240.
- Fig. 28. *Dendritina striatopunctata* Hofker. Central part of tranverse section; \times 80.
- Fig. 29. *Dendritina striatopunctata* Hofker. Part of horizontal section of slightly abnormal individual, showing change of direction of growth in the initial part; \times 80.
- Fig. 30. Part of section of the wall of *Dendritina striatopunctata* Hofker, showing that the pits are somewhat more hyaline lenses of calcitic material; \times 240.

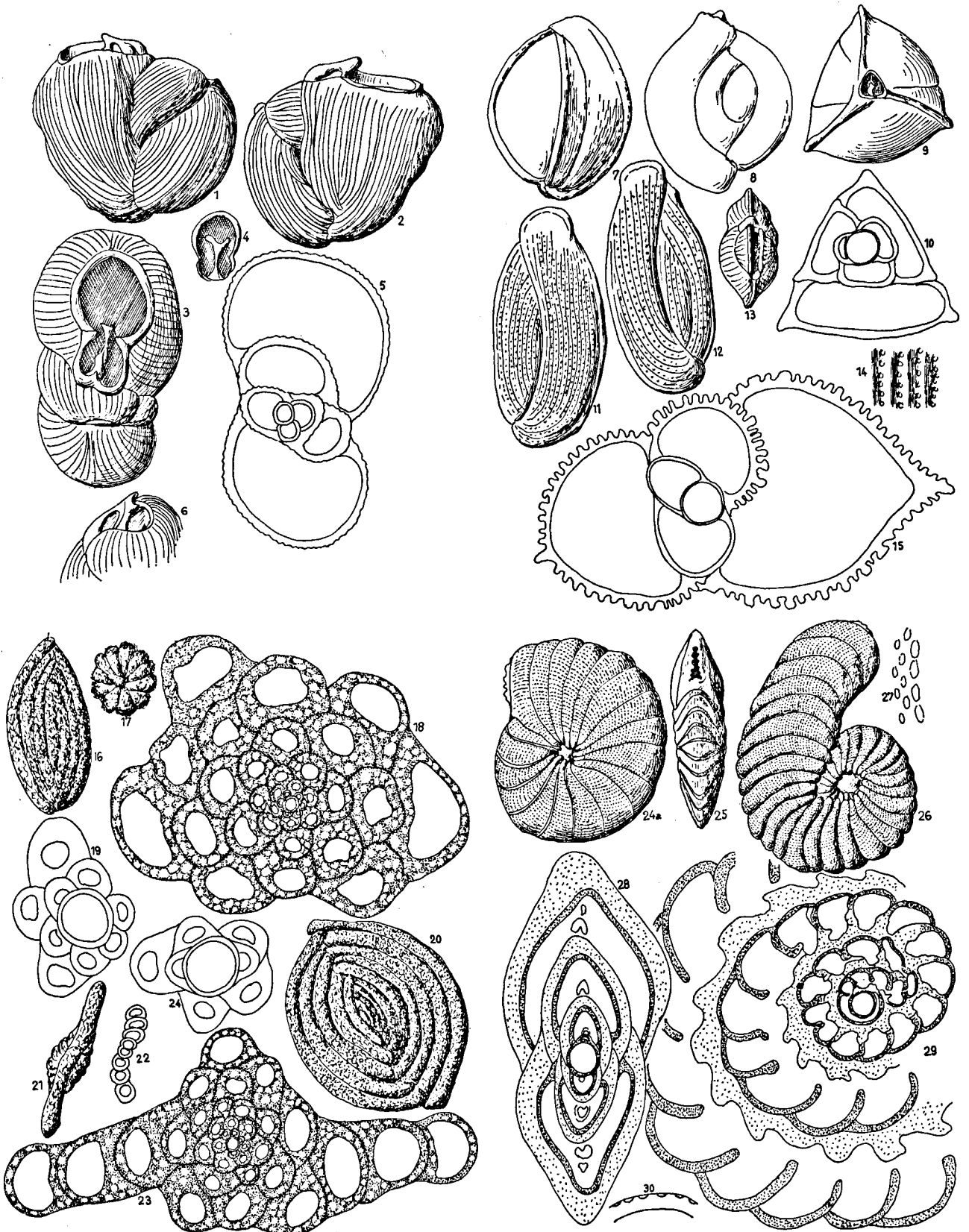


PLATE 4

PLATE 5

Fig. 1, 2. *Discogypsina vesicularis* (Goës). Test seen from two sides; from A7; $\times 12$.

Fig. 3. Transverse section of the specimen Fig. 1, 2; $\times 32$.

Fig. 4. Central part of horizontal section of *Discogypsina vesicularis* (Goës), showing proloculus and deutoconch with some of the surrounding chambers; the walls of these chambers are simple, granular; $\times 80$.

Fig. 5. *Discogypsina vesicularis* (Goës). Part of horizontal section, showing the median chambers (later chambers); this section proves that later chambers have secondary thickening of walls at the outer side, but that each chamber began with the granular primary wall; $\times 80$.

Fig. 6, 7. *Discogypsina vesicularis* (Goës). Transverse section through two later median chambers; they only show pores in their walls at the dorsal side; $\times 80$.

Fig. 8. *Discogypsina vesicularis* (Goës). Transverse section through some initial chambers, showing their simple walls; $\times 80$.

Fig. 9. *Discogypsina vesicularis* (Goës). Part of transverse section, showing later lateral chambers, with their inner granular primary walls and outer more hyaline secondary thickenings, and some of the sideways foramina; $\times 80$.

Fig. 10-12. Several forms of *Sphaerogypsina globulus* (Reuss); from A7; $\times 16$.

Fig. 13, 14. Sections through centre of the globular form of *Sphaerogypsina globulus* (Reuss); 13, specimen from the Miocene at "Grünes Kreuz", near Vienna, Austria, the type-locality; 14, specimen from the Bay of Jakarta, Recent; from A7; $\times 32$.

Fig. 15. *Sphaerogypsina globulus* (Reuss). Central part; from A7; $\times 150$.

Fig. 16. *Sphaerogypsina globulus* (Reuss). Initial part of pyriform specimen; from A7; $\times 150$.

Fig. 17. *Sphaerogypsina globulus* (Reuss). Pyriform specimen, longitudinal section. The initial part is found in the narrower part of the test; from A7; $\times 32$.

Fig. 18. *Sphaerogypsina globulus* (Reuss). Some chambers of initial part of pyriform specimen, showing the granular primary chamber wall; $\times 150$.

Fig. 19. *Sphaerogypsina globulus* (Reuss). Lateral chambers from specimen from Miocene Leithakalk, "Grünes Kreuz", near Vienna, Austria. The granular primary wall is found covered by hyaline chalk only at the outer side; $\times 240$.

Fig. 20. Transverse section of the lateral chambers of pyriform specimen of *Sphaerogypsina globulus* (Reuss). The granular primary wall is found between an inner and an outer layer of hyaline substance; from A7; $\times 240$.

Fig. 21. Idem, *Sphaerogypsina globulus* (Reuss) from off Mallorca, Mediterranean. Only in the chambers at the surface the granular primary wall is found within an outer hyaline layer, whereas in former chambers there is also formed an inner hyaline layer; $\times 240$.

Fig. 22, 23. Two views of a specimen of *Gypsina plana* (Carter); from A7; $\times 4$.

Fig. 24. Part of transverse section through the specimen of Fig. 22, 23; $\times 32$.

Fig. 25. *Gypsina plana* (Carter). Part of transverse section with lateral chambers, with pores only at the outer walls and basal foramina to adjacent chambers; $\times 80$.

Fig. 26, 27. *Gypsina plana* (Carter). Transverse sections through lateral chambers, showing the granular primary wall in the middle of two hyaline inner and outer layers; $\times 240$.

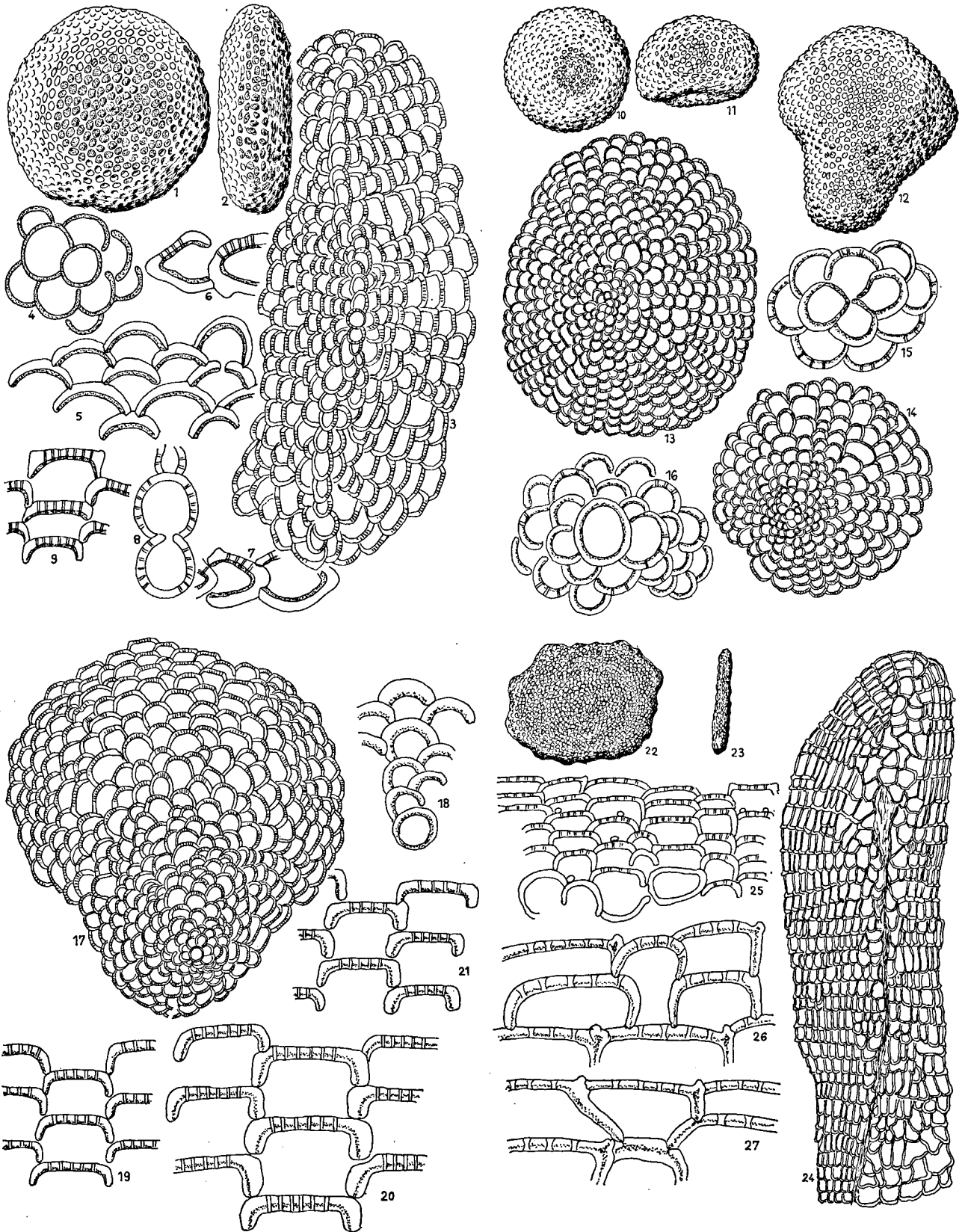


PLATE 5

PLATE 6

Fig. 1, 2. *Miniacina miniacea* (Pallas). Specimen from two sides; from A7; $\times 16$.

Fig. 3. *Miniacina miniacea* (Pallas). Horizontal section through a specimen from A7, which was growing on a flat piece of shell; $\times 40$.

Fig. 4. *Miniacina miniacea* (Pallas). Very young specimen, showing only the initial chambers; from A7; $\times 16$.

Fig. 5. *Miniacina miniacea* (Pallas). Transverse section; from A7; $\times 40$.

Fig. 6. *Miniacina miniacea* (Pallas). Outer chambers; the walls of later chambers wedge into those of former chamber, indicating that the walls thickened secondarily; the primary granular wall is found as a middle layer; but a young next wall closing a hollow between two chambers only shows the primary granular lamellum; $\times 150$.

Fig. 7. *Miniacina miniacea* (Pallas). Later chambers in transverse section; $\times 150$.

Fig. 8. *Miniacina miniacea* (Pallas). Initial chambers; $\times 150$.

Fig. 9-11. *Planorbulinella larvata* (Parker and Jones). Test from three sides; from B6; $\times 16$.

Fig. 12. *Planorbulinella larvata* (Parker and Jones). Central part of megalospheric specimen in horizontal section; $\times 40$.

Fig. 13. *Planorbulinella larvata* (Parker and Jones). Some chambers in horizontal section; there is a distinct granular middle primary lamellum; $\times 240$.

Fig. 14. *Planorbulinella larvata* (Parker and Jones). Embryo of Fig. 12; $\times 240$.

Fig. 15. *Planorbulinella larvata* (Parker and Jones). Some chambers at periphery, showing here the granular primary wall as an inner lamellum; $\times 240$.

Fig. 16-18. *Carpenteria utricularis* (Carter). Test from three sides; from A7; $\times 16$.

Fig. 19. *Carpenteria utricularis* (Carter). Transverse section, showing the walls to be simple and granular, whereas the ornamentation is hyaline; $\times 40$.

Fig. 20. Proloculus and next chamber of transverse section of Fig. 19; $\times 150$.

Fig. 21. Wall and ornamentation of outer wall of Fig. 19; $\times 150$.

Fig. 22, 23. *Biarrizina proteiformis* (Goës). Small test in two positions; from A7; $\times 16$.

Fig. 24. *Biarrizina proteiformis* (Goës). Same specimen, longitudinal section; $\times 40$.

Fig. 25, 26. From section of Fig. 24, wall parts, showing the bilamellar structure; $\times 80$.

Fig. 27. *Biarrizina proteiformis* (Goës). Section through wall of proloculus; $\times 80$.

Fig. 28. *Biarrizina proteiformis* (Goës). Wall of outgrown specimen; $\times 32$.

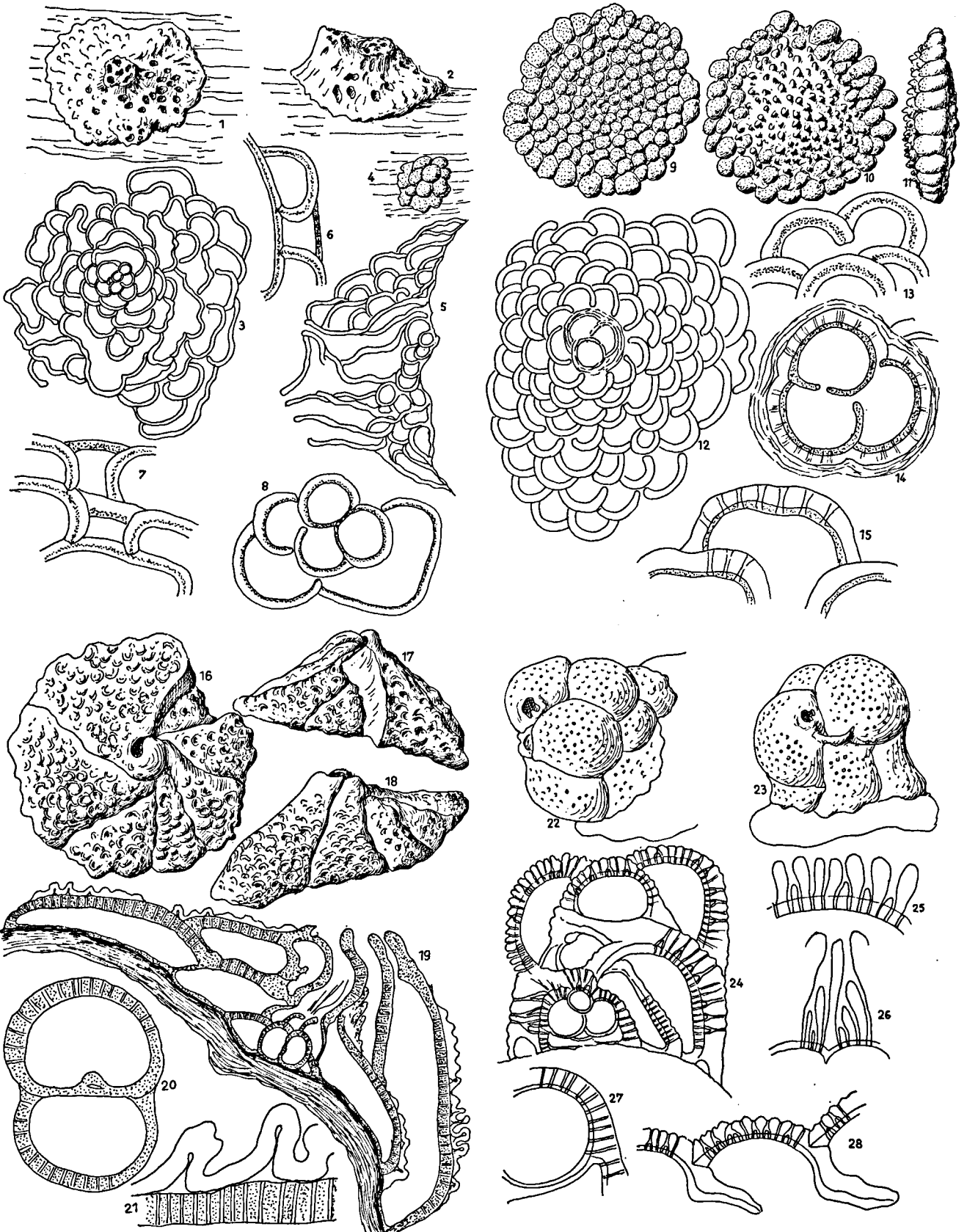


PLATE 6

PLATE 7

Fig. 1-3. *Calcarina spengleri* (Gmelin). Normal megalospheric specimen from three sides; from B6; $\times 16$.

Fig. 4, 5. *Calcarina spengleri* (Gmelin). Specimen with four spines, and sketch of initial chambers, showing the large megalospheric proloculus; from B7; 4: $\times 16$; 5: $\times 80$.

Fig. 6, 7. *Calcarina spengleri* (Gmelin). Specimen with seven spines, and sketch of initial chambers, showing small megalospheric proloculus; from B7; 6: $\times 16$; 7: $\times 80$.

Fig. 8. *Calcarina spengleri* (Gmelin). Central part of test, horizontal section, of microspheric specimen; from off Flores; $\times 80$.

Fig. 9-11. *Calcarina spengleri* (Gmelin). Microspheric specimen, from three sides; from B6; $\times 16$.

Fig. 12. *Calcarina spengleri* (Gmelin). Tangential transverse section of microspheric specimen, showing a spine penetrating a chamber; $\times 16$.

Fig. 13. Horizontal section, part, through *Calcarina spengleri* (Gmelin), showing the hook at each chamber, the secondary thickening, the pores running together into larger canals opening at the surface, and interlamellar hollows at the angles between two chamber walls; $\times 80$.

Fig. 14. Transverse section through microspheric specimen of *Calcarina spengleri* (Gmelin) of Fig. 9-11; $\times 80$.

Fig. 15. *Calcarina spengleri* (Gmelin). Megalospheric specimen, transverse section; $\times 80$.

Fig. 16, 17. *Calcarina spengleri* (Gmelin). Some of the outer chambers in horizontal sections, showing situation of pores, interlamellar hollows, and in 17 base of a spine with its canals deriving from pores and from interlamellar canals; $\times 80$.

Fig. 18, 19. *Baculogypsinoides spinosus* Yabe and Hanzawa. Trispinose specimen from A7; $\times 16$; with its horizontal section of initial part (Fig. 19); $\times 80$.

Fig. 20, 21. *Idem*, with four spines, same indications.

Fig. 22, 23. *Idem*, with five spines, same indications.

Fig. 24, 25. *Baculogypsinoides spinosus* Yabe and Hanzawa. Microspheric specimen; from A7; $\times 16$; with horizontal section, central part; $\times 80$.

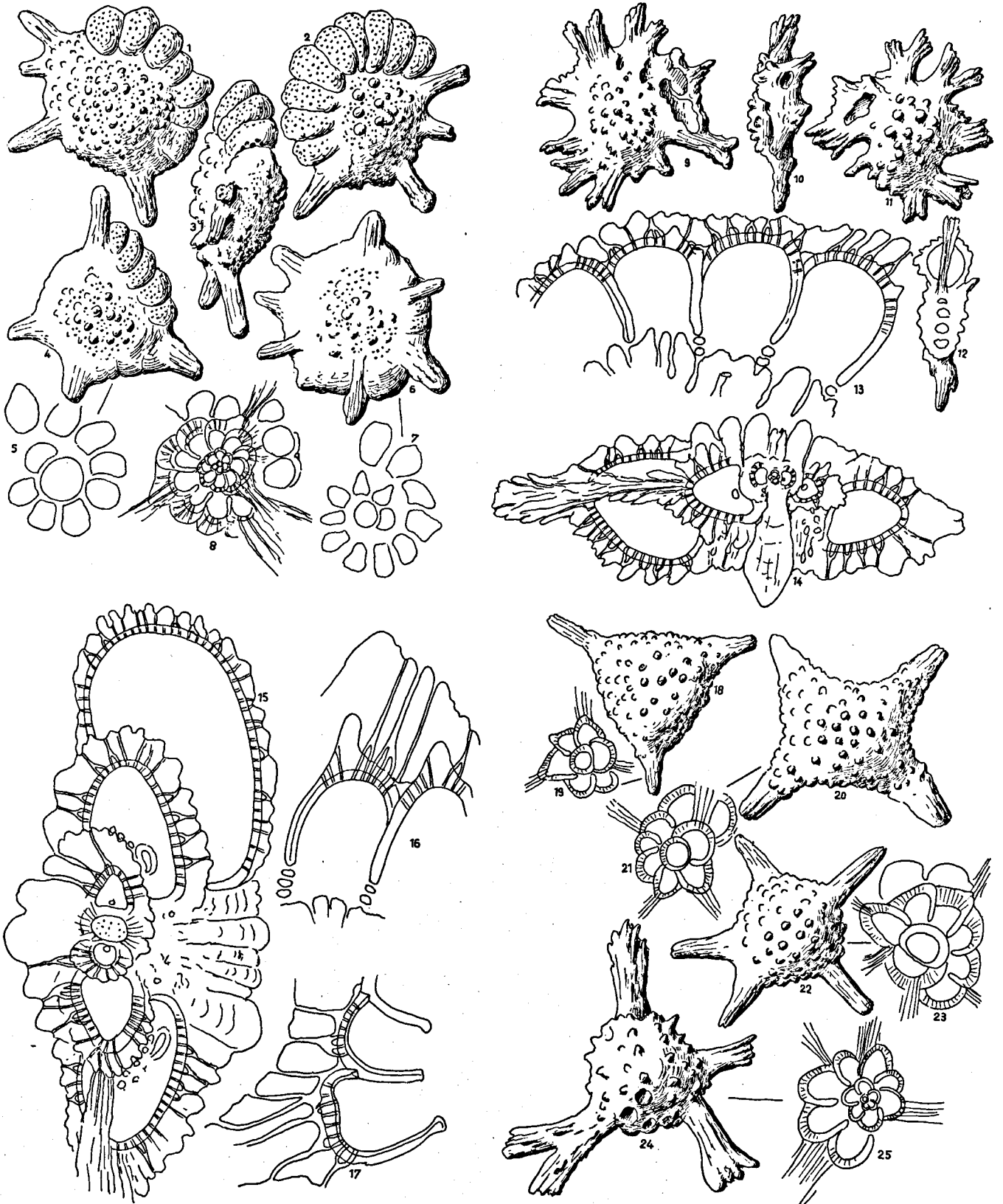


PLATE 7

PLATE 8

Fig. 1. *Baculogypsinoides spinosus* Yabe and Hanzawa. Megalospheric specimen with many irregularly placed spines; from A7; $\times 16$.

Fig. 2. *Baculogypsinoides spinosus* Yabe and Hanzawa. Microspheric specimen; same locality; $\times 16$.

Fig. 3. *Baculogypsinoides spinosus* Yabe and Hanzawa. Horizontal section through megalospheric specimen; in some of the chambers foramina can be seen; $\times 40$.

Fig. 4. Same specimen, same section, showing some initial chambers with the pores, the interlamellar hollows at the angles of the chambers, giving rise to the bases of the canals in a spine; $\times 80$.

Fig. 5. *Baculogypsinoides spinosus* Yabe and Hanzawa. Horizontal section through microspheric specimen; $\times 40$.

Fig. 5. *Baculogypsinoides spinosus* Yabe and Hanzawa. Transverse section through megalospheric specimen; $\times 40$.

Fig. 6. *Baculogypsinoides spinosus* Yabe and Hanzawa. Transverse section through microspheric specimen; $\times 40$.

Fig. 8-10. *Asterorotalia pulchella* (d'Orbigny). Microspheric specimen from three sides; from E2; $\times 80$.

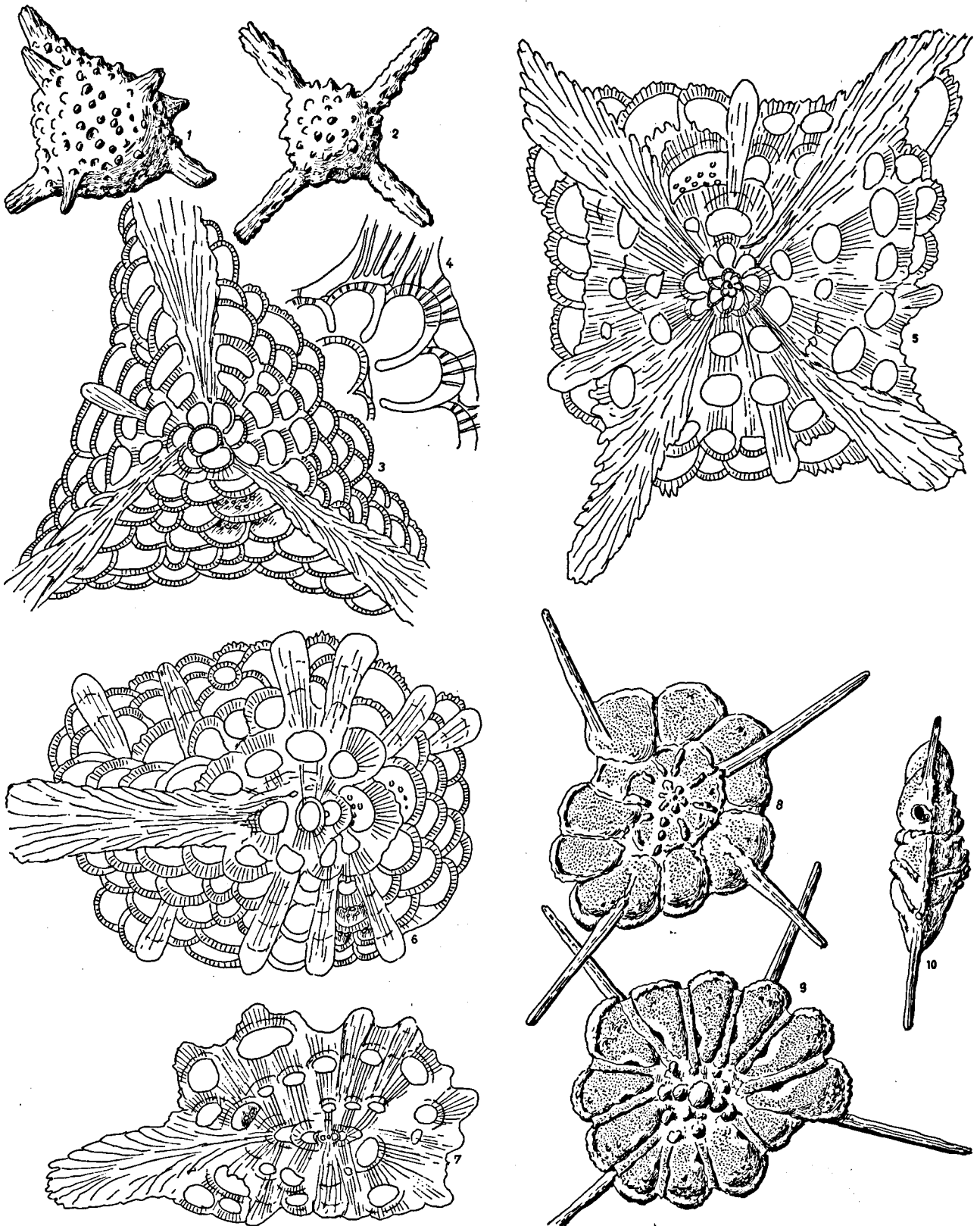


PLATE 8

PLATE 9

Fig. 1-3. *Asterorotalia pulchella* (d'Orbigny). Megalospheric specimen from three sides; from E2; $\times 80$.

Fig. 4. *Asterorotalia pulchella* (d'Orbigny). Apertural face with aperture of megalospheric specimen Fig. 1-3; $\times 80$.

Fig. 5. *Asterorotalia pulchella* (d'Orbigny). Part of transverse section of megalospheric specimen, showing the connection of the toothplates with the hollow spines; $\times 240$.

Fig. 6. *Asterorotalia pulchella* (d'Orbigny). Two chambers with the porous plate within, leaving the protoforamen free, seen from the ventral side; $\times 240$.

Fig. 7. *Asterorotalia pulchella* (d'Orbigny). Some chambers ground down from dorsal side on, showing the connection of the folded part of the toothplates (hooks of the toothplates) and the ventral porous plate between two chambers; that plate undoubtedly belongs to the toothplate of a former chamber, as can be seen by the foraminiferal (deuteroforaminiferal) opening of the septum connected with the toothplate; $\times 240$.

Fig. 8-10. *Rotalidium concinnum* (Millet). 8, dorsal side; 9, ventral side with the protoforamina and the porous plates axially from the main chambers; 10, apertural face with two apertures, the dorsal one that of the main chamber, the ventral one that of the porous plate which in reality belongs to the former chamber. Megalospheric specimen; from A5; $\times 40$.

Fig. 11. Transverse section through megalospheric individual of *Rotalidium concinnum* (Millet); showing toothplates between main chambers and so-called secondary chamberlets, and initial chambers not having these chamberlets which can be detected by their single septal foramina (toothplate-foramina); $\times 60$.

Fig. 12. *Rotalidium concinnum* (Millet). Folded part of toothplate, seen from the dorsal side, and opening into the protoforamen; proximal wall of chamber is formed by the toothplate; $\times 150$.

Fig. 13. *Rotalidium concinnum* (Millet). Part of test ground down from dorsal side, showing folded parts of toothplates and inner walls of main chambers whereas the folded parts of toothplates connect with the porous plates of the so-called secondary chamberlets; $\times 80$.

Fig. 14-16. *Rotalidium concinnum* (Millet). Microspheric specimen; 14, dorsal side; 15, ventral side with the protoforamina; 16, apertural face with the two foramina, the dorsal one of the main chamber, the ventral one of the so-called secondary chamberlet; $\times 40$.

Fig. 17. *Rotalidium concinnum* (Millet). Transverse section through microspheric specimen; $\times 60$.

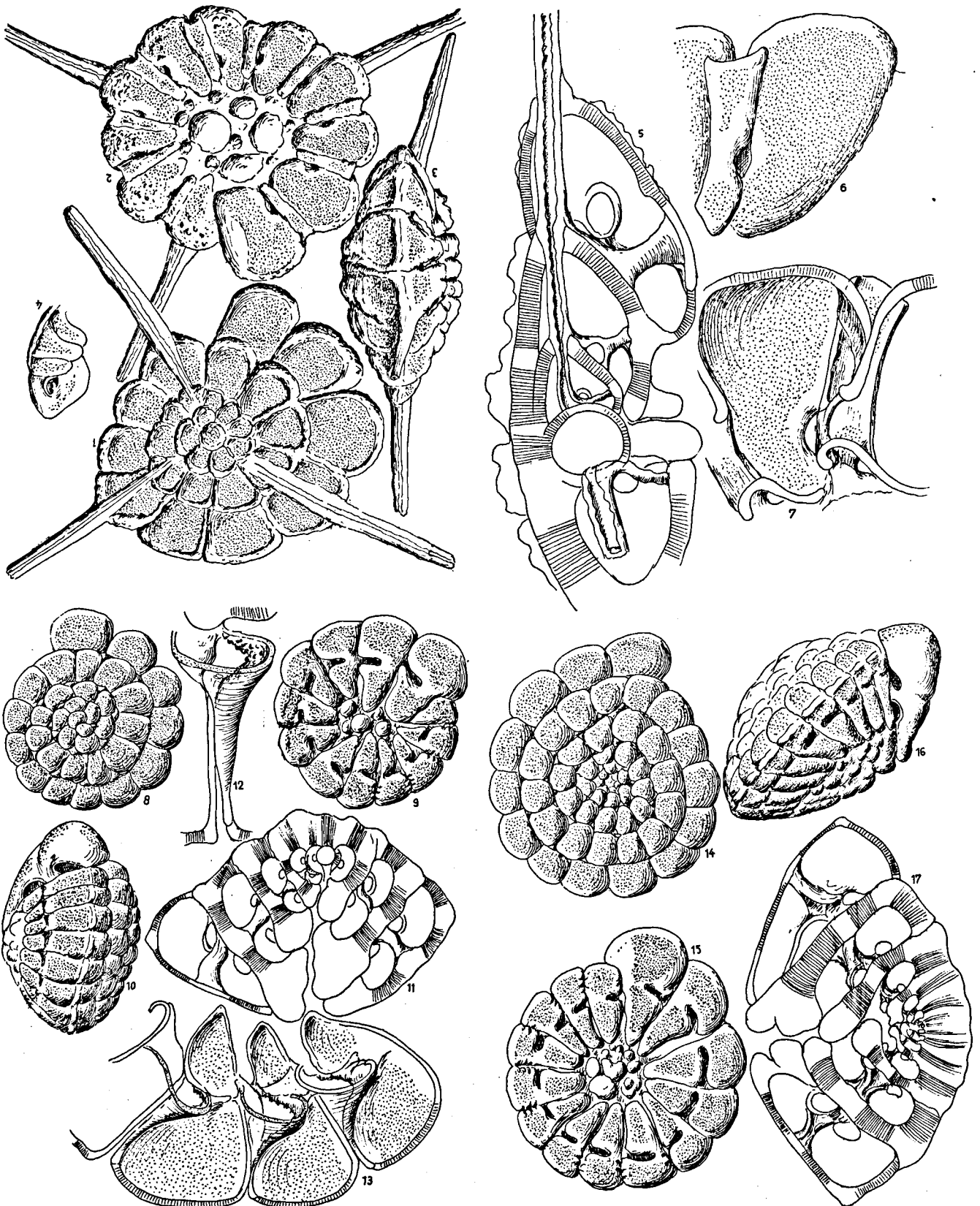


PLATE 9

PLATE 10

Fig. 1. Transverse section through chamber of *Rotalidium concinnum* (Millet); seen from distal side; p.f.: protoforamen; t.pl.: toothplate; d.f.: deuteroforamen; t.f.: toothplate-foramen of the so-called secondary chamberlet; s.f.: inner wall of the so-called secondary chamberlet, formed by the "septal flap" of the toothplate; $\times 150$.

Fig. 2. Another chamber, but now seen from the reverse side, the proximal side, so that we look into the folded part of the toothplate; t.: connection of toothplate with axial border of deuteroforamen; d.f.: deuteroforamen; t.f.: toothplate foramen of the so-called secondary chamberlets; s.f.: septal flap of toothplate; t.pl.: folded part of toothplate; p.f.: protoforamen; $\times 150$. (N.B. This section is not from the same chamber as that of Fig. 1.)

Fig. 3. *Rotalidium concinnum* (Millet). Oblique section through some outer chambers, perpendicular on these chambers, and seen from the axial side; the wall, formed by the toothplate, which divides the main chamber above from the so-called secondary chamberlet below is seen very clearly; moreover the fact, that the foramen of the chamberlet is a toothplate-foramen, formed by the toothplate; $\times 80$.

Fig. 4-6. *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones). Microspheric specimen from three sides; from G3; $\times 16$.

Fig. 7. Transverse section through specimen Fig. 4-6 showing the toothplates and in one chamber the septal flap forming the sutural toothplate-foramina; $\times 40$.

Fig. 8-10. *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones). Outgrown megalospheric specimen from three sides; from G3; $\times 16$.

Fig. 11. *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones). Transverse section through young microspheric specimen; $\times 40$.

Fig. 12. *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones). Horizontal section near to the dorsal surface of megalospheric specimen. Seen from ventral side; from G3; $\times 40$.

Fig. 13. *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones). Transverse section through megalospheric specimen of Fig. 8-10; $\times 40$.

Fig. 14. *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones). Horizontal section near to the dorsal surface of microspheric specimen. Seen from ventral side; $\times 40$.

Fig. 15. Part of section of Fig. 14, showing the toothplate-foramina at the suture, one of them bifurcating; $\times 150$.

Fig. 16. *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones). Three of the "hooks" of the folding toothplates; $\times 150$.

Fig. 17. Part of transverse section through a chamber of *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones), showing the septal foramen (s.f.), the protoforamen (p.f.), the folded part of the toothplate (t.pl.), the septal flap of the toothplate (s.f.) and the sutural toothplate foramina (t.f.); $\times 150$.

Fig. 18. Part of horizontal section through *Pseudorotalia schroeteriana* (Carpenter, Parker and Jones), taken below the proloculus and the initial chambers, showing the chamber walls and some of the hooks of the toothplates; $\times 40$.

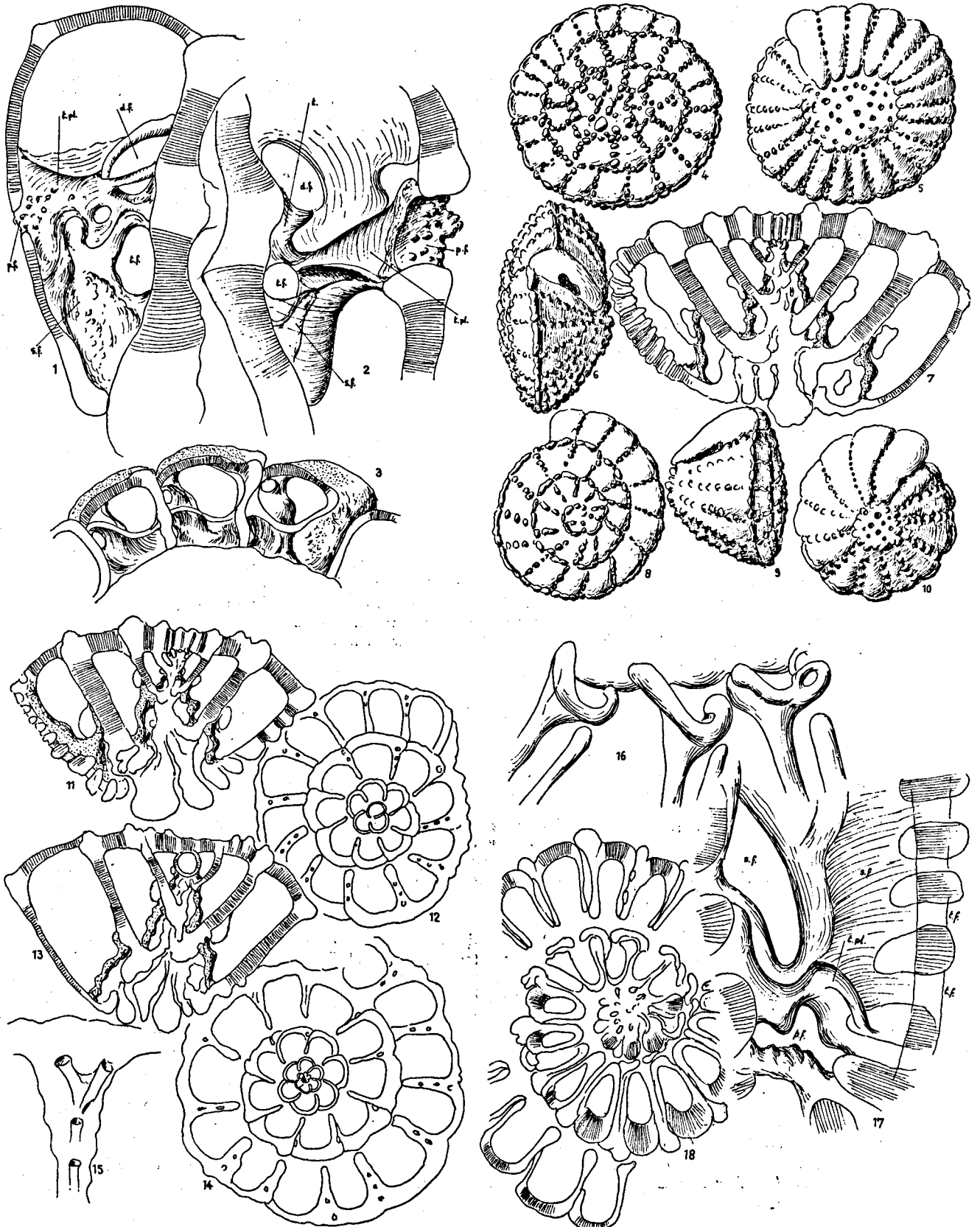


PLATE 10

PLATE 11

Fig. 1, 2. *Parrellina hispidulum* (Cushman). From two sides; in Fig. 2 the larger openings of the toothplate foramina can be seen right and left from the row of small foramina at the suture; from A5; $\times 80$.

Fig. 3. Transverse section through *Parrellina hispidulum* (Cushman), showing toothplates and septal flaps; $\times 60$.

Fig. 4. Horizontal section through *Parrellina hispidulum* (Cushman), showing toothplates (septal flaps) at the periphery; $\times 150$.

Fig. 5. Part of transverse section through *Parrellina hispidulum* (Cushman) showing the sectioned toothplates forming the toothplate canals (spiral canals) in the angles of the chambers and the septal flaps emerging from the toothplates; from the toothplate-canals large canals run through the central knob to the surface; the septal flaps form the sutural toothplate foramina; all toothplate-structures can be distinguished by the granular structure of their walls; $\times 240$.

Fig. 6. Part of horizontal section through *Parrellina hispidulum* (Cushman), showing septal flap (granular) and sutural canals running from the toothplate canal to the surface; $\times 240$.

Fig. 7. Part of horizontal section through *Parrellina hispidulum* (Cushman) slightly obliquely taken, showing the structure of the septal flap of the toothplate and the canals formed by it; $\times 240$.

Fig. 8, 9. *Elphidium batavum* nov. spec. Test from two sides; from A5; $\times 50$.

Fig. 10. *Elphidium batavum* nov. spec. Transverse section through the initial part of megalospheric specimen. The toothplates (t.pl.), septal flaps (s.f.), toothplate foramina (t.f.) with the fine dents in their walls and opening near the septal foramina (s.for.) clearly can be seen. From the

toothplate-canals (t.c.) canals are running through the central calcitic knob to the surface; $\times 240$.

Fig. 11. Peripheral part of a horizontal section through *Elphidium batavum* n.sp., showing the retral processus (r.p.), the septal flap of the toothplate (t.pl.) and the cavity between the septal flap and the septal wall (t.c.); $\times 240$.

Fig. 12. Part of horizontal section through *Elphidium batavum* nov. spec.; $\times 50$.

Fig. 13, 14. *Elphidium batavum* nov. spec. Central parts of horizontal sections through the centre of microspheric specimens; $\times 240$.

Fig. 15. Idem, megalospheric specimen; $\times 80$.

Fig. 16. Idem, proloculus and first chamber, with its toothplate; $\times 240$.

Fig. 17. *Elphidium batavum* nov. spec. Part of periphery of horizontal section, going just through a toothplate-foramen at the suture, with the toothplate (t.pl.), the toothplate foramen (t.f.) with its inner dentate wall, and the toothplate canal (t.c.); $\times 240$.

Fig. 18, 19. Two parts of tangential transverse section through *Elphidium batavum* nov. spec., showing the toothplate (septal flap) (t.pl.), the toothplate canal between septum and toothplate (t.c.) and a sutural toothplate foramen (t.f.); $\times 240$.

Fig. 20. *Nummulites complanatus* (Defrance). Horizontal section through a microspheric specimen, with the diagonals for analysis of the spiral. This analysis gave as ratio between the two successive diagonals in average 1.305; $\times 40$.

Fig. 21. *Nummulites complanatus* (Defrance). Transverse section through microspheric test; $\times 52$.

Fig. 22, 23. *Nummulites complanatus* (Defrance). Initial chambers on horizontal sections of microspheric specimens; $\times 150$.

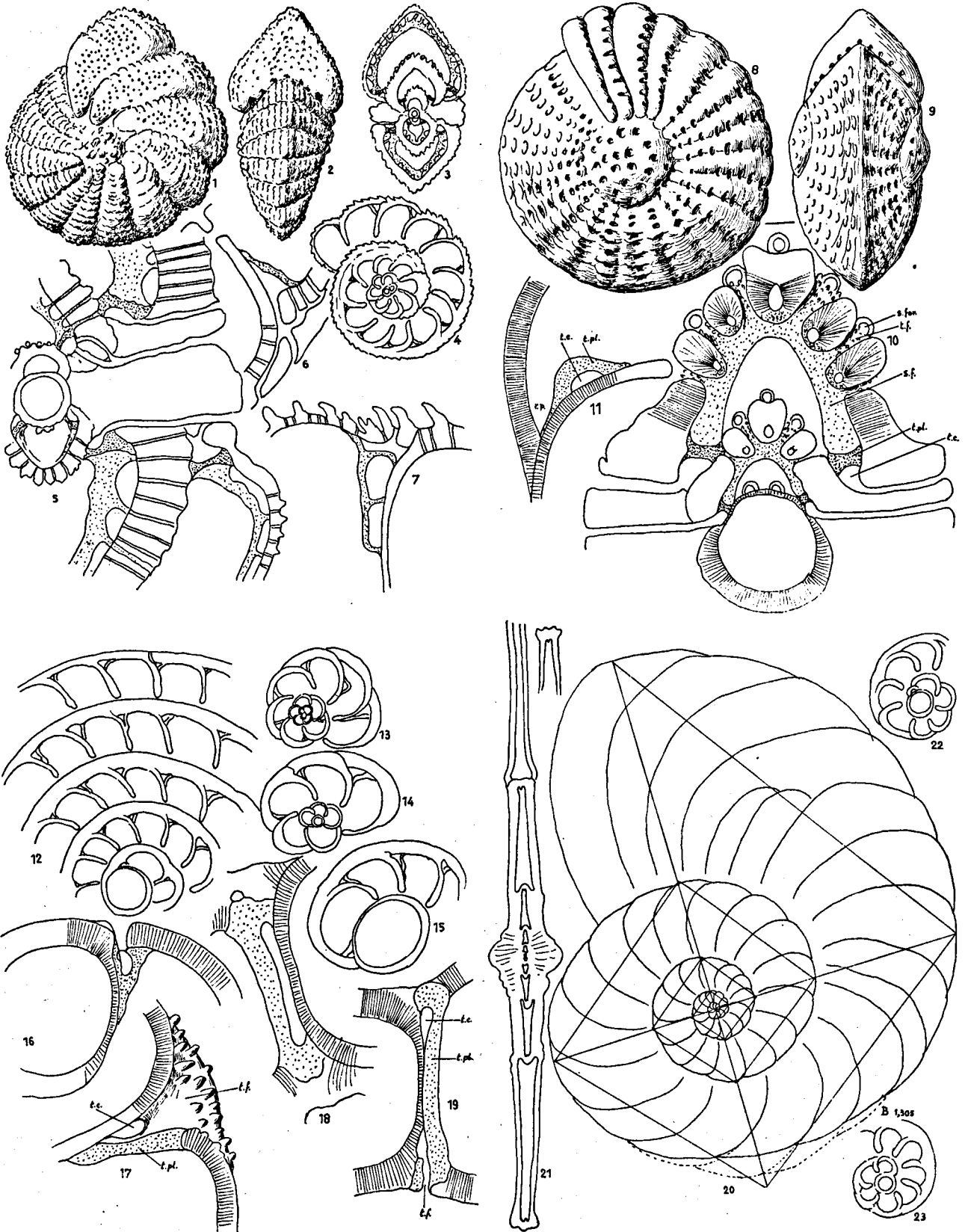


PLATE 11

PLATE 12

Fig. 1. *Nummulites complanatus* (Defrance). Horizontal section through megalospheric A_1 -specimen, with the diagonals for analysis of the spiral. This analysis gave the ratio between two successive diagonals as 1.27; $\times 40$.

Fig. 2. *Nummulites complanatus* (Defrance). Transverse section, showing that in this generation the chambers are more embracing than in the microspheric generation; $\times 52$.

Fig. 3, 4. *Nummulites complanatus* (Defrance). Initial chambers in horizontal section through two individuals of the A_1 -generation; $\times 150$.

Fig. 5. The ideal rectangular triangle which is built up with the golden section (section dorée, sectio divina). The perpendicular from the angle of 90° on the hypotenuse divides this line in two parts here of 32 mm and 19.8 mm length (as the original drawing has been reduced by a factor 0.4 the figures given on the plate are not longer correct); these two parts d and e have a proportion $d : e = 1.618 : 1$, the golden section. In this triangle we find:

$$d : a = a : (d + e).$$

In indicating 1.618 as Phi (from Phidias, who used the sectio divina for his architectonic and sculptural works),

we get:

$$\text{Phi} : a = a : (\text{Phi} + 1) = a : \text{Phi}^2.$$

$$a^2 = \text{Phi}^3.$$

$$a = \sqrt{\text{Phi}^3} = \sqrt{4.236} = 2.061.$$

Moreover we get from the triangle:

$$e : b = b : (d + e)$$

$$1 : b = b : (\text{Phi} + 1) = b : \text{Phi}^2$$

$$b^2 = \text{Phi}^2$$

$$b = \text{Phi} = 1.618.$$

In this way we get:

$$a : b = 2.061 : 1.618 = 1.27$$

and this is just the average value we get when one of the diagonals as given in Fig. 1 is divided on the next one: 1.27. It is obvious that the A_1 -generation of *Nummulites complanatus* shows this ideal spiral which has been given the name of "Spirale des Lebens" by Goethe. The spirals of the B-generation are mostly slightly more extended, showing the figure 1.28, those of most of the A_1 -specimens show a smaller figure (average 1.24), those of the

A_2 -generation a yet smaller figure, (average 1.19), due to the stronger embracing of the chambers. The typical flat tests show the best approximation to the ideal proportion of the golden section, 1.27 or 1.28.

So we may resume that *Nummulites complanatus* shows a remarkable instance of the application of the golden section in a living organism, as also was stated for man, several vertebrates, molluscs, plants and flowers, by Leonardo da Vinci.

REFERENCES

- COLMAN, S., 1913: Nature's harmonic unity.
 COOK, T., 1914: The curves of life.
 GHYKA, M. C., 1931: Le nombre d'or; vol. 1, les rythmes.
 LUCA PACIOLI, 1509: De divine proportione; ed. 1956, Milano.
 ZEISIG, A., 1884: Der goldene Schnitt.
 Fig. 6. *Nummulites complanatus* (Defrance). Horizontal section through specimen of the A_2 -generation, with the diagonals for analysis of the spiral giving a ratio of 1.19; $\times 40$.
 Fig. 7. *Nummulites complanatus* (Defrance). Transverse section through specimen of the A_2 -generation, showing the strong overlapping of the chambers; $\times 52$.
 Fig. 8, 9. *Nummulites complanatus* (Defrance). Horizontal sections through initial parts of two specimens of the A_2 -generation; $\times 150$.
 Fig. 10. Diagram of diameters of proloculi of *Nummulites complanatus* (Defrance), showing three tops, indicating that there are three generations.
 Fig. 11, 12. *Nummulites complanatus* (Defrance). Total test in two views, of generation B or A_1 ; from A6; $\times 10$.
 Fig. 13, 14. *Nummulites complanatus* (Defrance). Total test in two views of the generation A_2 ; from A6; $\times 10$.
 Fig. 15, 16. *Heterostegina curva* Möbius. Specimen from two sides; from A7; $\times 16$.
 Fig. 17. Horizontal section through *Heterostegina curva* Möbius; $\times 40$.
 Fig. 18. Part of section of Fig. 17, showing the canals in septa and secondary septa; $\times 150$.
 Fig. 19. *Heterostegina curva* Möbius. Transverse section; $\times 60$.
 Fig. 20. Part of section of Fig. 19, showing toothplate (t.pl.), toothplate canal (t.c.), septal flap of the toothplate (s-f.), marginal chord with its canals (m.ch.) and the basal canal of the marginal chord (b.c.); $\times 150$.

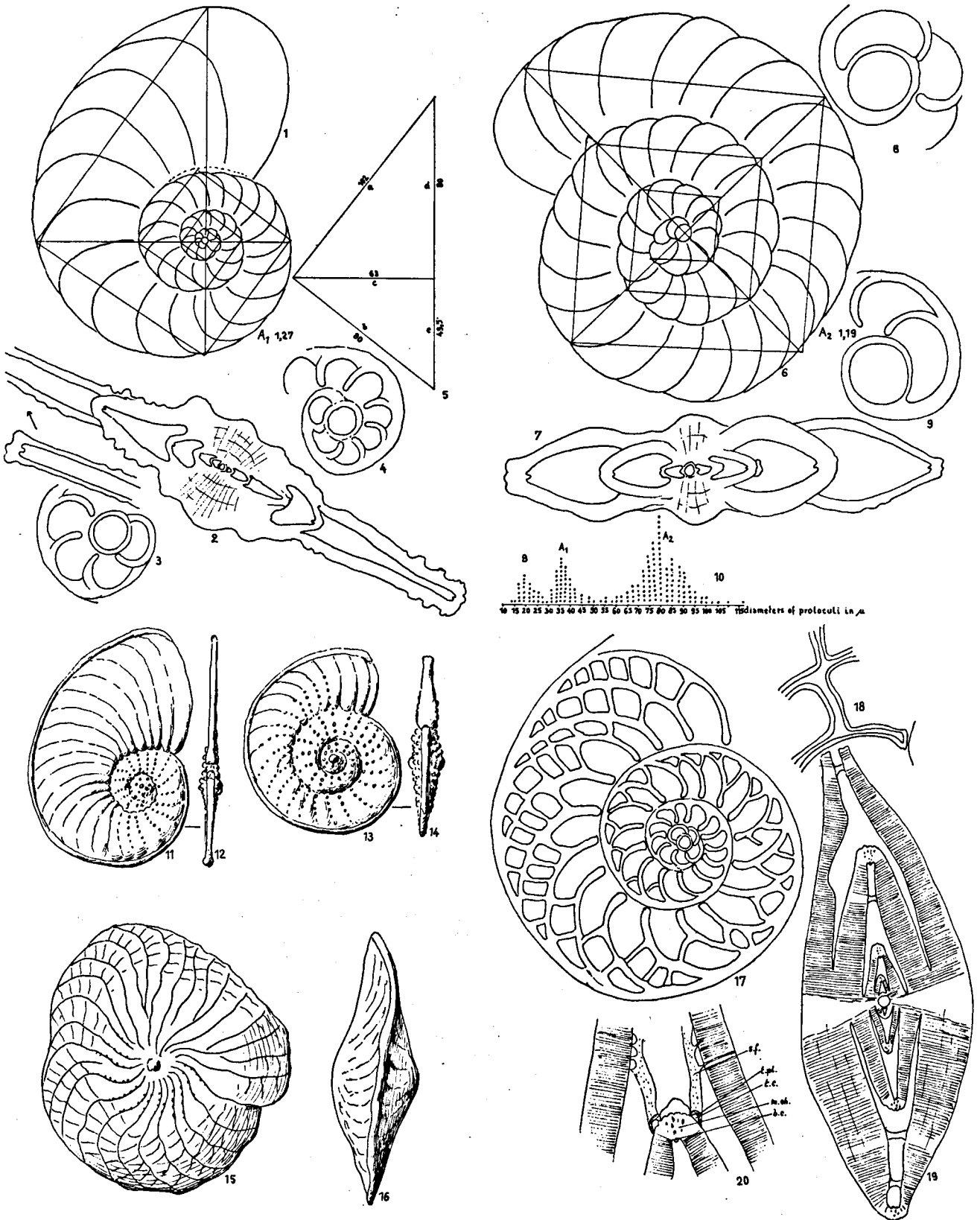


PLATE 12