JOURNAL OF THE PALAEONTOLOGICAL SOCIETY OF INDIA
VOL. 27, 1982, pp. 1—6.

LARGER FORAMINIFERA FROM A SEA-BED SAMPLE OFF THE KERALA COAST

JAGDISH PANDEY[1] AND S. S. BANSAL[2]

1. GEOLOGICAL LABORATORIES, ONGC, BARODA-390 009.
2. GEOLOGY SECTION, ONGC, NIRMAL, NARIMAN POINT, BOMBAY-400 021.

ABSTRACT

Borelis schlumbergeri (Reichel), *Nummulites cumingii* (Carpenter), *N. venosus* (Fichtel and Moll), *Operculina ammonoides* (Gronovius) and *O. ornata* Cushman are described from a sea-bed sample off the Kerala Coast, about 20 kilometres away from the shore. The sea-bed, 36.5 m below the mean sea level, contains a mixture of Sub-Recent and Recent fauna.

INTRODUCTION

A sea-bed sample, providing the material for this paper, was collected by one of us (Bansal) from ONGC exploration site Cochin well No. 1 (10° 24' N : 75° 51' E) located about twenty kilometres to the west of Kerala coast (Fig. 1.) The sea-bed at the site Cochin-1 lies 36.5m below mean sea level and it was sampled on 18th April, 1978 by a shallow scooping conducted by a diver.

The sea-bed sample—a calcareous sand—contains rich assemblage of larger foraminifera. The larger foraminifera from the Western Indian Shelf have been lately enumerated (Nair *et al.*, 1979) but remain undescribed yet. The larger foraminifer types are, therefore, described from the sea-bed sample at the site Cochin-1.

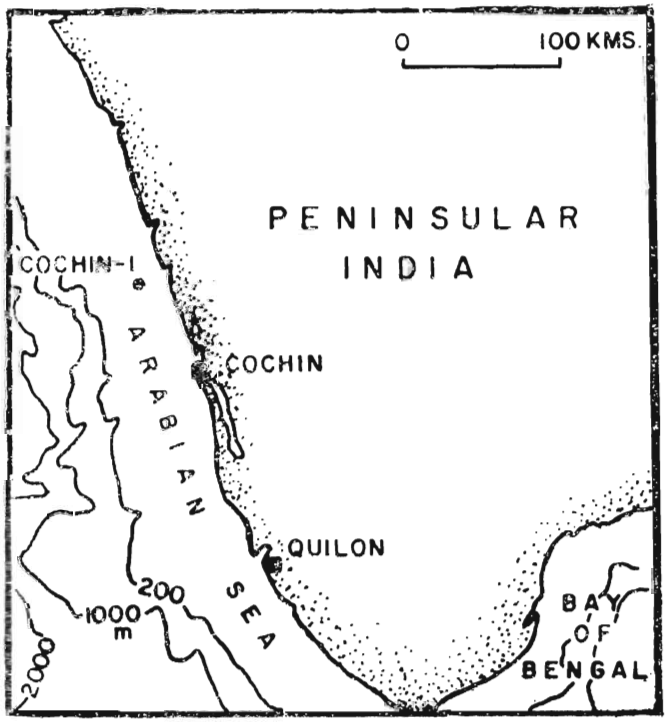


Fig. 1. Location map of ONGC site Cochin-1.

SAMPLE ANALYSIS

The medium to coarse quartzose sand with copious calcareous matter of organic origin constitutes the material scooped from the sea-bed.

On treatment with cold, dilute hydrochloric acid the molluscan, foraminiferal, bryozoan and other calcareous skeletal remains prove 32% by weight. The residue, a matured quartz sand, when subject to grain size analysis, shows the following distribution of particles.

>2 mm	0.5%
2 mm to 1 mm	5.6%
1 mm to 0.5 mm	41.0%
0.5 to 0.25 mm	40.24%
0.25 to 0.125 mm	11.95%
0.125 to 0.062 mm	1.15%

Under microscope, grains are generally subrounded and made essentially of quartz. The sample may apparently be interpretted as coming from a submerged beach or a deepened coastal shelf deposit. At present, basinward influx of the coarse sediments is too meagre in this area but the enrichment of organic calcareous detritus is possibly still continuous.

FORAMINIFERAL ASSEMBLAGE

COMPOSITION

Foraminifera are almost the sole constituents of the microfauna with rare ostracoda and a few bryozoa. Among the former, the larger types are above 90% in over-all composition and in the coarser material held above the 80 mesh sieve their exclusive suite includes a few large-sized *Elphidium indicum*—a smaller foraminifer.

The smaller foraminifera are all benthonic excluding

two specimens of *Globigerinoides* ex. gr. *immaturus* Le Roy. These include, in the order of their decreasing abundance, following species :

Elphidium indicum Cushman, *Quinqueloculina horrida* Cushman, *Ammonia annectens* (Parker and Jones), *Amphistegina* cf. *lessonii* d'Orbigny, *Elphidium crispum* (Linnaeus), *Cibicides* sp., *Quinqueloculina* sp.

The larger foraminifera, although abundant numerically, includes only the following five species in order of declining abundance.

Operculina ammonoides (Gronovius), *Nummulites venosus* (Fichtel and Moll), *Borelis schlumbergeri* (Reichel), *Nummulites cumingii* (Carpenter), *Operculina ornata* (Cushman).

PRESERVATION

The colour, fossilization and preservation characteristics of the forms apparently divide the recorded assemblage in two groups. The first is some what weathered and fossilized and the second is characterized by glistening, fresher and empty tests. Forms typically referable to the first category are *E. indicum*, *B. schlumbergeri*, *N. cumingii* and some forms of *O. ammonoides*. Subaerial exposure and fossilization of the fauna is better seen in *B. schlumbergeri* and *N. cumingii*. In these forms a few tests still contain glauconitic in-filling though in most of them a reddish infilling, possibly oxidized glauconite after subaerial exposure, is seen. The gleaming white, glossy, empty tests of newer assemblage include forms other than those listed. Apparently, the fossilization has not yet set in them.

In the chronological position, it seems, the fossilized assemblage is sub-Recent (Pleistocene) but mixed with the Recent sea-bed assemblage during sampling Mixing of these two assemblages in a very shallow scoop of the sea bed is suggestive of an extremely slow sedimentation rate during the Recent. The Recent sediments are possibly a few centimetres thick so that the mixing of the older sediments and microfauna with the thin upper veneer of Recent deposits was inevitable for the diver.

ECOLOGY

The salinity data for the site are not available. However, the site lies on a broad open shelf and salinity of the order of 36 or 35 gm/litre may be assumed for the site Cochin-1. Also, the sample could not be studied for living forms since the collected material was not under alcohol or some other preservative. The extent to which the Recent thanatcoenosis corresponds to the local biocoenosis is somewhat ambiguous. Nevertheless, the general composition of the fauna with rare and nearly equal admixture of *Ammonia* - *Amphistegina* - *Elphidium* and comparatively larger number of miliolid *Q. horrida* appear typical of the present depth after comparing the depth range and distribution of these forms in other areas (Phleger, 1960 ; Walton, 1964). The same fact is also applicable to the distribution of larger foraminifera in the Pacific (Cushman, 1933). The Recent thanatocoenosis is, therefore, contrued a nearly unaltered biocoenosis in this area characterised by negligible slope in the shelf.

The paucity of the planktonic forms in the assemblage is quite notable. It falls in line with the non-enumeration of planktonic foraminifera in the dredged samples of the Western Indian Shelf, at various depths, by Nair *et al.* (1979).

SYSTEMATIC DESCRIPTION

Family Alveolinidae EHRENBERG, 1839
Genus *Borelis* DE MONTFORT, 1808
Borelis schlumbergeri (REICHEL)
(Pl. I—1-2)

Neoalveolina pygmaea (Hanzawa) var. *schlumbergeri* Reichel, 1937, p. 110.
(Fide Ellis & Messina, 1940 *et seq.*).

Material : 41 specimens, all megalospheric.

Remarks : Forms typically subcylindrical to fusiform with equatorial to axial dimension ratios varying between 1 : 2.6 to 1 : 5.6 for the forms between 1.1 to 3.5 mm ; average equatorial to axial diameter ratio (index) works out 1 : 3.8. Scatter diagram and size distribution (Fig. 2) suggests that the studied forms constitute to a single population in size attribute, and maximum concentration (37.2%) lies between 1.6 to 2 mm. Extra large and

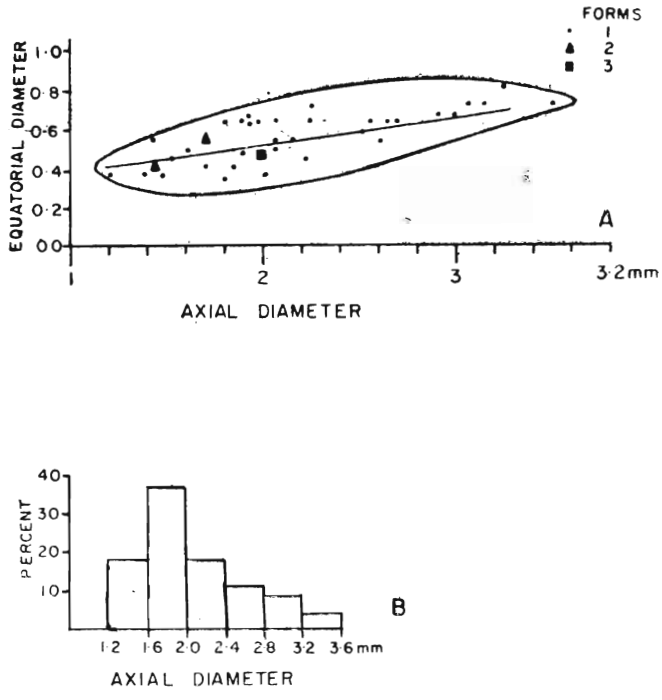


Fig. 2. Size distribution in *B. schlumbergeri*.

fully matured forms (2.0 to 3.6 mm) are fewer, constituting about 25% of assemblage.

Surface of the moderately weathered forms (Plate I—1, 2) reveals continuity of septula between the two chambers. A comparatively small proloculus (0.04-0.05 mm) is followed by irregular nepionic spire before regular coiling sets in. Chambers are divided into a single layer of chamberlets, all nearly of uniform size in each whorl and increasing in size from 0.01 mm in the initial regular whorls to 0.04 mm after 8 or 9 whorls.

Morphologically the examined population compares well with *Borelis schlumergeri* (Reichel) and hence referred to this species described originally from the Recent sediments of Mayotte Island, north-east of Madagascar.

Occurrence : The recorded population of *B. schlumbergeri* is referred to sub-Recent on account of its fossilization albeit it occurs in the Recent sediments of Madagascar region. First appearance of this species on Indian Shelf seems in an offshore well DCS-IA in N21 (Pandey and Guha, 1979, pl. 5, figs. B4, 9) and it possibly disappeared from the Western Indian Shelf at the close of Pleistocene.

Family Nummulitidae De Blainville, 1825
Genus *Nummulites* Lamarck, 1801
Nummulites cumingii (Carpenter)
(Pl. I—6-9)

Amphistegina cumingii Carpenter, 1859, p. 30 (Fide Ellis and Messina, 1940 *et seq.*).

Material : 34 specimens, all megalospheric.

Remarks : Small sized forms of *Nummulites* referred to this species in the material from the site Cochin-1 are characterized by somewhat globular test between 0.8 to 1.8 mm with an average value of diameter : thickness ratio=1 : 0.6 (min. 1 : 0.46 and max. 1 : 0.9). A scatter diagram of diameter—thickness plot (text-fig. 3) suggests a homogeneous population between 0.8 to 1.8 mm (juvenile forms below this size not considered) and a solitary form is recorded above 1.8 mm.

In moderately weathered specimens anastomosing sigmoid septal filaments make distinctive pattern in the umbonal area which may be taken as characteristic of the species ; and also, the examined forms display a comparatively thick, well developed marginal cord as well. The equatorial section shows a comparatively large proloculus (0.1 mm) followed by a rather rapidly opening spire with 30 chambers in three whorls (9, 9, 12 $\pm$1 per whorl) and moderately to highly curved septa.

The Cochin material is comparable with the pacific forms figured by Brady (1884) and Rasheed (1970) but lacks highly flared test as noted in some of the forms referred to this species by Carpenter (1859).

Occurrence : *N. cumingii* is a fossilized and a Sub-Recent species on the Western Indian Shelf. Its entry on the shelf appears to be no earlier than Pleistocene.

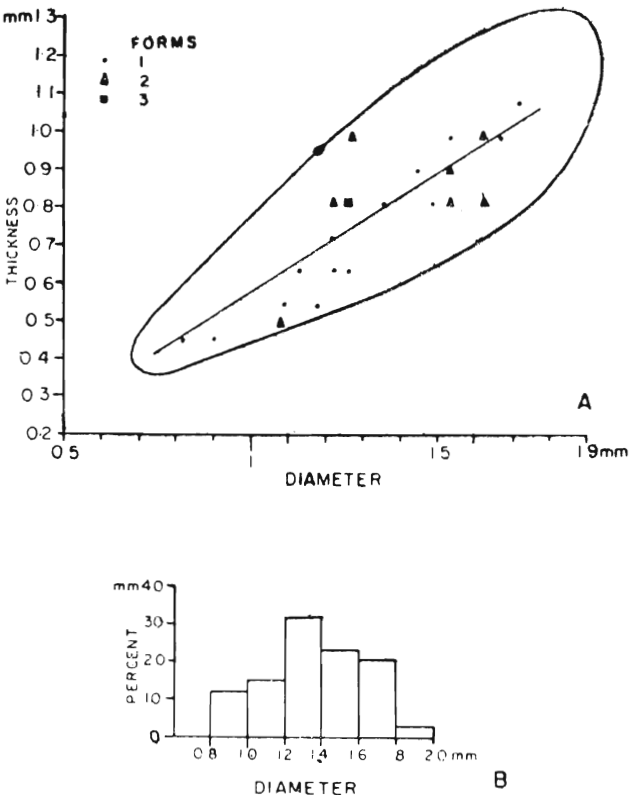


Fig. 3. Size distribution in *N. cumingii*.

Nummulites venosus (Fichtel and Moll)
(Pl. II—1-5)

Nautilus venosus Fichtel and Moll, 1978, p. 59, (fide Ellis and Messina, 1940 *et seq.*)

Material : 50 specimens ; all megalospheric.

Remarks : A small number of typically involute forms referable to *Nummulites* but grading imperceptibly into evolute types comparable *O. ammonoides* are placed in this species. In possessing a partially evolute to completely involute test, these forms are not only comparable to the material figured under *N. venosus* by Cushman (1933) and Rasheed (1970) from the Pacific but also include the forms named as *Operculina hanzawai* by Smout and Eames (1960) and which, as these authors noted, is highly anomalus in possessing early evolute and the last partially evolute whorl.

Forms referred to *N. venosus* are small. The scatter diagram and size histogram between 1.0 and 2.0 mm shows maximum concentration between 1.2 and 1.6 mm (text-fig. 4). Generally these forms are thinner than *N. cumingii*, possess an umbonal boss and straight to slightly curved sutures. Diameter-thickness ratio, varying between 1 : 0.21 and 1 : 0.41, gives an average of

1 : 0.30. The equatorial section shows a small proloculus (0.05 mm) and a rapidly opening spire of 3 whorls with about 45 chambers (9, 15, 21 ±1 per whorl) separated by straight septa that turn backward rather abruptly near the periphery.

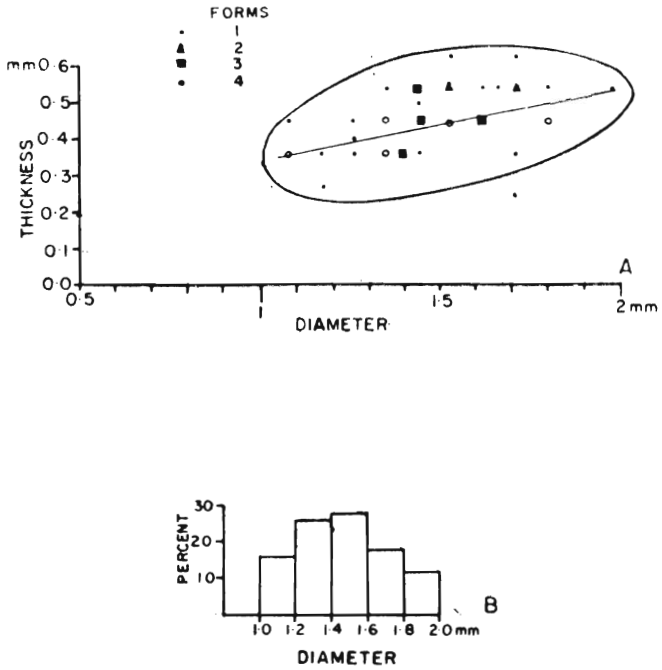


Fig. 4. Size distribution in *N. venosus*.

Occurrence : *N. venosus* seems to represent an exclusive Pleistocene-Recent population of *Nummulites* that grades gradually into *Operculina*, especially *O.* ex. gr. *ammonoides*. It occurs commonly in the Recent sediments of the Indian Shelf, wherever larger foraminifera proliferate.

Genus Operculina D'ORBIGNY, 1826

Operculina ammonoides (GRONOVIUS)

(Pl. III—1-9)

Nautilus ammonoides Gronovius, 1781, p. 282 (Fide Ellis and Messina, 1940 *et seq.*)

Material : 84 specimens; all megalospheric.

Remarks : The most abundant and very variable population of an *Operculina* in the typical size range of 1.2 to 3.5 mm has been referred to this species from the site Cochin-1. These evolute forms with nearly straight intercameral sutures are characterised by nominally to moderately high flaring of the test but their size wise distribution is homogeneous and a continuous gradation is seen in the plot of short to long segment of the equatorial diameter (text-fig. 5 b). Therefore, eventhough three end members may be made out in this population by surface ornamentation, in (Plate III : 1st—1 to 3 ; 2nd—4 to 7 ; 3rd—8, 9), these have been placed into a single species. The central characteristics of the forms include straight septa, nearly smooth test to moderately developed ornamentation of granules on the sutures, medium sized proloculus and an average 3 : 4 ratio between the smaller and larger segments of spire diameter.

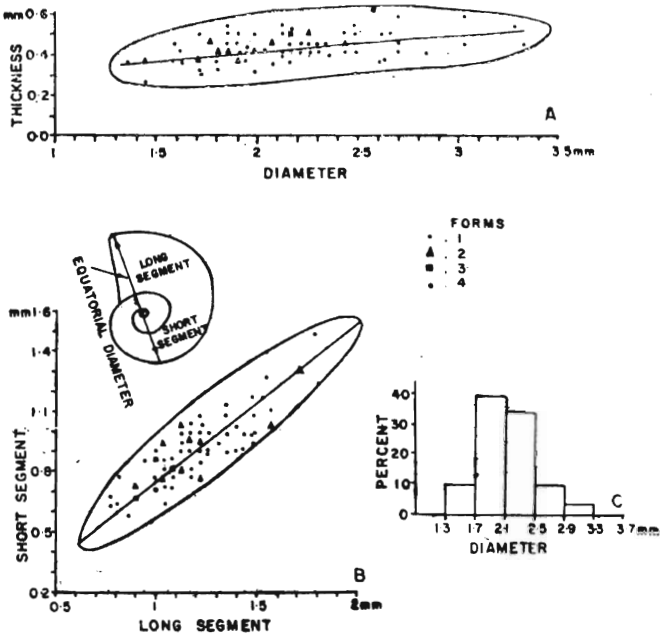


Fig. 5. Size distribution & other characteristics of *O. ammonoides*.

Occurrence : Fossil occurrence of *O. ammonoides* commences with the Pleistocene. The Recent distribution of the species represents it is restricted to patchy occurrences on the shallower shelf.

Operculina ornata CUSHMAN

(Pl. II—6-10)

Operculina bartschi var. *ornata* Cushman, 1921, 0. 378, (vide Ellis and Messina, 1940, et seq.).

Material : 22 specimens ; all megalospheric.

Remarks : Forms referable to *O. ornata* are fewer compared to *O. ammonoides* and their fresh, empty tests suggest their essentially Recent introduction in this area. They possess somewhat more rapidly enlarging spire with average ratio of short to long segments of spiral diameter = 3 : 5 (text-fig. 6b). Strongly curved, depressed, smooth or moderately raised sutures with or without coarsely set granules and a thick marginal cord distinguish these forms from *O. ammonoides*. However, possibly this species is too close to *Operculina gaimardii* d'Orbigny and their synonimy may be established after closer scrutiny of the type material of the two species.

Occurrence : *O. ornata* appears on the Western Indian Shelf during Pleistocene. Recent occurrence of this species, like *O. ammonoides*, is typically patchy.

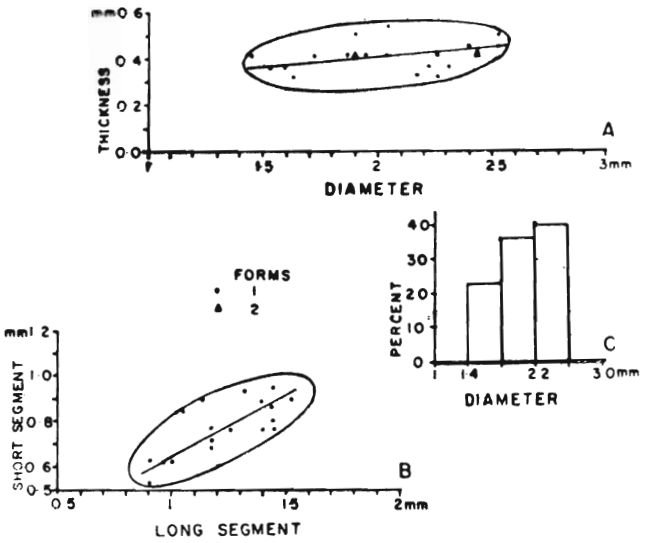


Fig. 6. Size distribution & other characteristics of *O. ornata*.

ACKNOWLEDGEMENT

The paper was read at the II National Seminar on Quaternary Environments with special reference to Western India, M. S. University, Baroda, 10th February, 1979, with kind permission of the General Manager, (Western Region), ONGC. The views expressed in the paper are of authors only and not necessarily of ONGC.

We are grateful to Dr. S. Ramanathan, Chief Geologist, ONGC, Baroda and Mr. K. L. N. Rao, Chief Geologist, ONGC, Bombay, for encouragements. Thanks are also due to Mr. D. C. Srivastava for petrological studies on the sample.

REFERENCES

BARKER, R. W. 1960. Taxonomic notes, on the species figured by H. B. Brady, in his report on the foraminifera dredged by H.M.S. Challenger during the years 1973-1876. *Soc. Econ. Pal. Min., sp. publ.* **9** : 238.

CUSHMAN, J. A. 1933. The foraminifera of the tropical pacific collections of the "*Albtros*" 1899-1900. *U.S. Nat. Mus. Bull.* **161** (2) (Lagenidae to Alveolinidae) : 1-79.

ELLIS, B. F. AND MESSINA, A. R. 1940. *et seq.* Catalogue of Foraminifera. *Amer. Mus. Nat. Hist., New York.*

LOEBLICH, A. R. (JR.) AND TAPPAN, H. 1964. In 'Treatise on Invertebrate Paleontology' (R. C. Moore *ed.*) part-C, Protista-2, pp. C55-C900. *Geol. Soc. Amer., Colorado.*

NAIR, R. R., HASHIMI, N. H. AND GUPTHA, M. V. S. 1979. Holocene limestones of part of the Western Continental Shelf of India. *Jour. Geol. Soc. Ind.* **20** : 17-23.

PANDEY, J. AND GUHA, D. K. 1979. Cenozoic Chronostratigraphy of the Western Indian Shelf. *Geological Report, ONGC (Baroda).* 25, (Unpublished).

PHLEGER, F. B. 1960. *Ecology and distribution of foraminifera.* John Hopkins Press, Baltimore. 297.

RASHEED, D. A. 1970. Some Recent Calcareous foraminifera belonging to the families Peneroplidae, Alveolinellidae, Nonionidae, Camerinidae, Lageninidae and Polymorphinidae from the Coral Sea, South of Papua (New Guinea), part IV. *Madras Univ. Jour.* **39-40** (1969-70) : 77-110.

SMOUT, A. H. AND EAMES, F. E. 1960. The distinction between *Operculina* and *Operculinella*. *Contr. Cushman Found. Foram. Res.* **11** : 109-114.

WALTON, W. R. 1964. Recent foraminiferal ecology and paleoecology. In *Approaches to Paleoecology* (John Imbrie and Norman Newelled) : 157-237. John Wiley and Sons. Inc., New York.

EXPLANATION OF PLATES

PLATE I

(All specimens under reflected light)

1-5. *Borelis schlumbergeri* (Reichel)
1. Surface view, Specimen Bf 284, ×17.
2. Same, a part of same specimen, ×70.
3. Axial section, Specimen BF 286, ×45.
4. Same, a part of same specimen, ×100.
5. Equatorial section, Specimen BF 287, ×40.

6-9. *Nummulites cumingii* (Carpenter)
6. Surface view, Specimen BF 288, ×30.
7. Equatorial section, Specimen BF 289, ×35.
8. Equatorial section, Specimen BF 290, ×35.

PLATE II

(Figures 2 and 3 under transmitted and other under reflected light)

1-3. *Nummulites venosus* (Fichtel and Moll)
1. Surface view, Specimen BF 292, ×34.
2. Equatorial section, Specimen BF 297, ×45.
3. Axial section, Specimen BF 298, ×45.

4. Surface view, Specimen BF 293, ×65.
5. Equatorial half-cut surface, Specimen BF 294, ×40.

6-10. *Operculina ornata* Cushman

6. Surface view, Specimen BF 302, ×18.
7. Surface view, Specimen BF 303, ×20.
8. Equatorial half-cut surface, Specimen BF 304, ×18.
9. Equatorial half-cut surface, Specimen BF 305, ×20.
10. Axial section, Specimen BF 306, ×25.

PLATE III

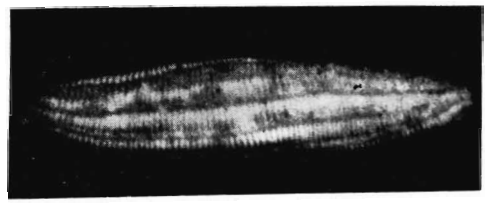
(All specimens under reflected light)

1-9. *Operculina ammonoides* (Gronovius)

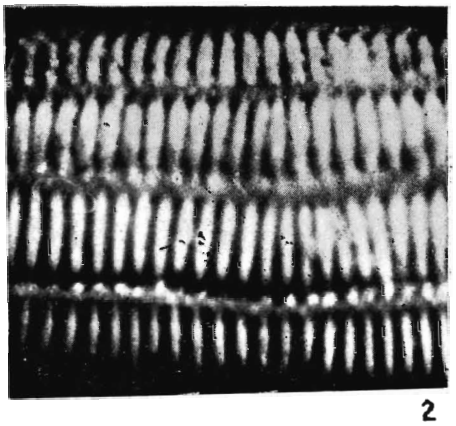
1-2. Surface and equatorial half-cut views, Specimen BF 307, ×24.
3. Axial section, specimen BF 312, ×30.
4. Equatorial half-cut surface, specimen BF 308, ×40.

5-6. Surface and equatorial half-cut views, Specimen BF 309, ×15, 19.
7. Surface view, Specimen BF 310, ×20.

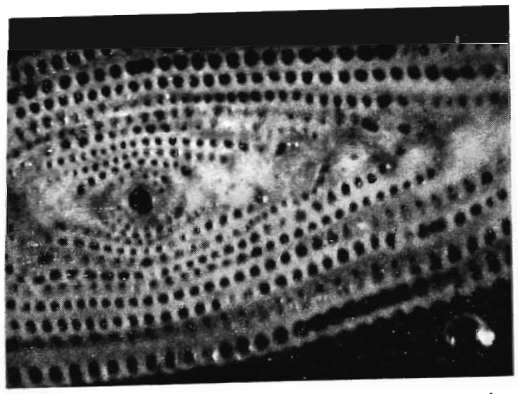
8-9. Surface and equatorial half-cut views, Specimen BF 311, ×16.



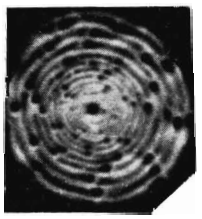
1



2

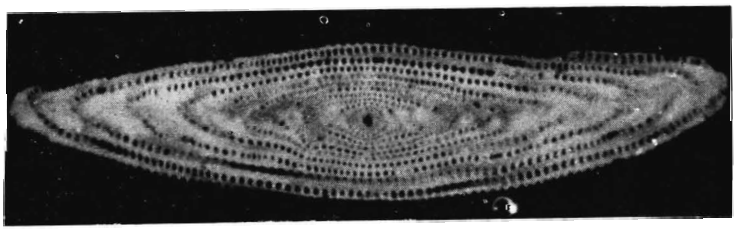


4

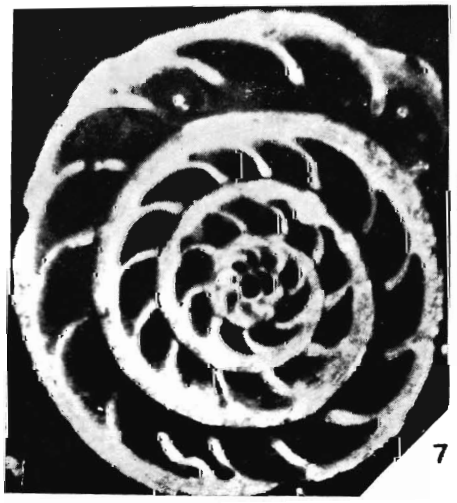


5

6



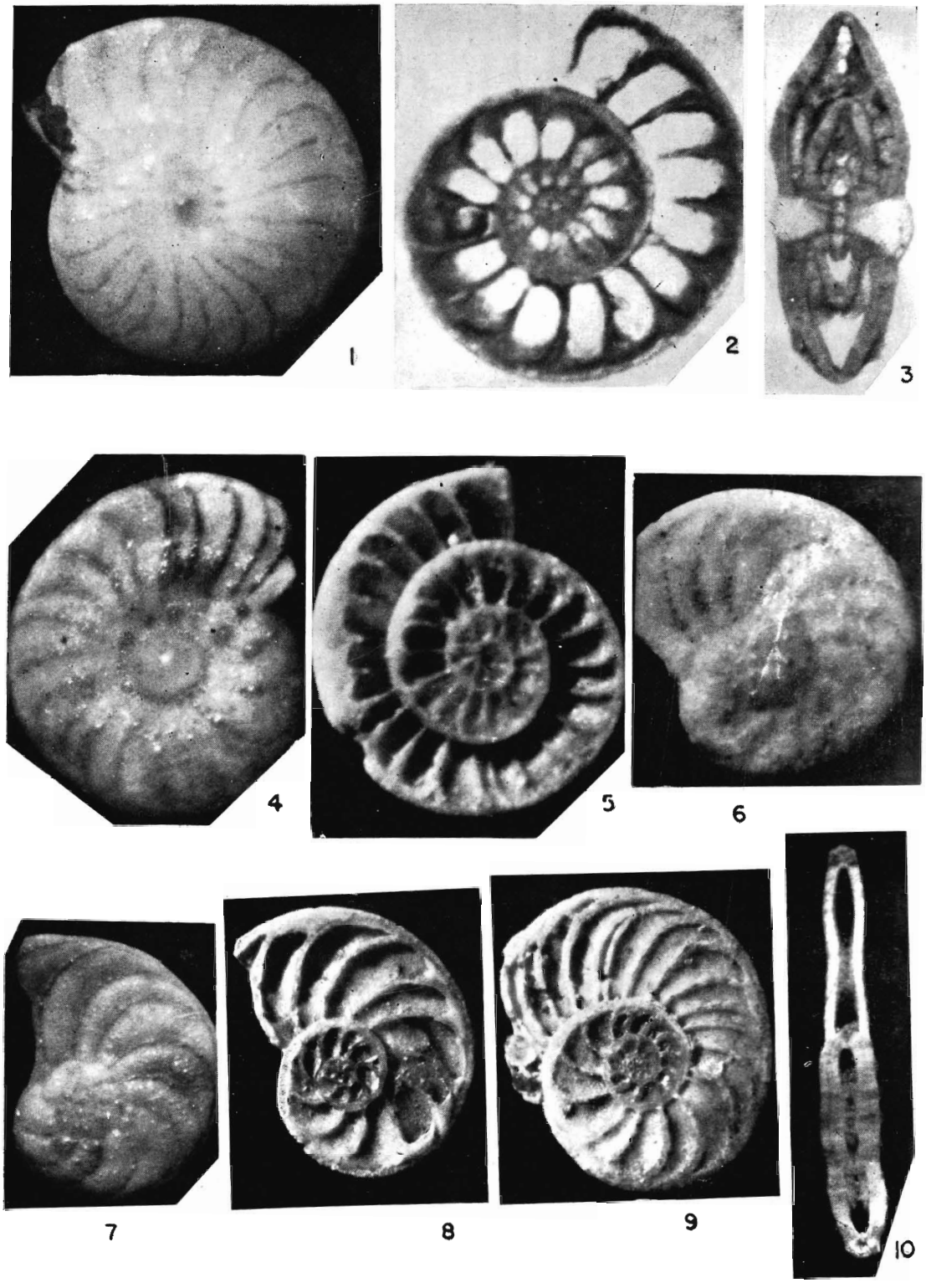
3

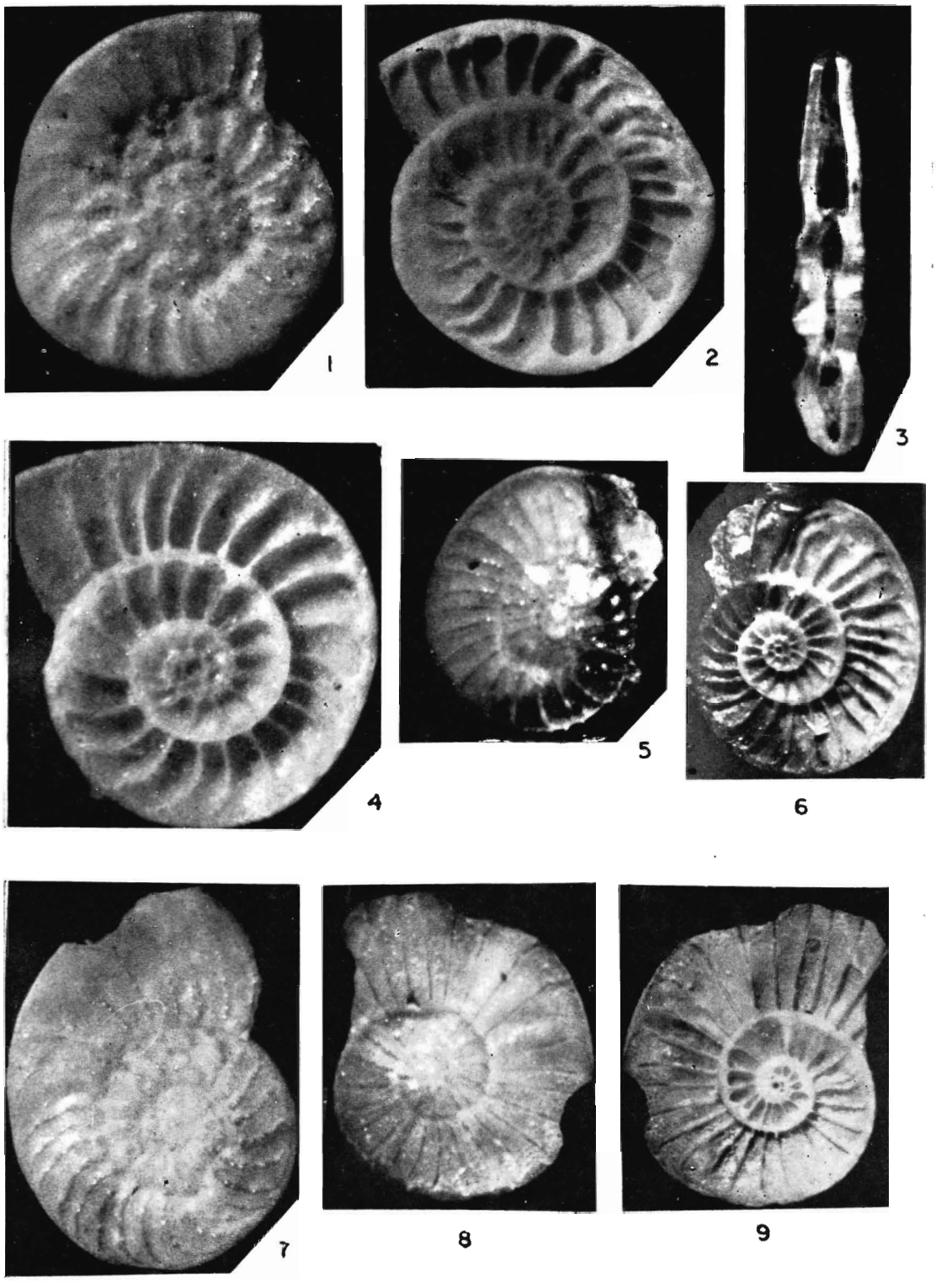


7

8

9


1
2
3
4
5
6
7
8
9
10


1
2
3
4
5
6
7
8
9