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MICROFAUNA FROM A MIDDLE HOLOCENE TERRACE, LOWER MAHI VALLEY, WESTERN INDIA

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ABSTRACT

The unpaired valley fill terraces, provide data set in support of the evolution of the Lower Mahi valley. The sediments of the Kothiyakhad section comprising alternate units of muds/clays and silty-sands have yielded a good population of foraminiferids and fresh water ostracods, indicating their deposition in an estuarine environment. A total of 25 genera of foraminiferids from the mud units and 3 genera of ostracods from the silty-sand units have been identified. The Kothiyakhad section has been considered to be one of the type sections for Mid to Late Holocene palaeoenvironmental changes in western India.

Key words : Stratigraphy, Holocene, Mahi Valley, foraminiferids, ostracods.

INTRODUCTION

A series of climate-related data have been generated from ocean and lake sediments, ice-cores and tree rings. However, on continents, these do not provide a complete record and it becomes necessary to investigate other systems. Continental records, when used in combination with oceanic data, help in palaeoenvironmental reconstruction. In the Lower Mahi valley, numerous interesting geomorphic features provide evidence in support of its evolution during Holocene through a complex interplay of tectonism, climate and base level changes.

Microfaunal studies have been a major lacuna in the continental Late Quaternary sediments of the Lower Mahi valley. The only reference made to the occurrence of foraminiferids from the Holocene terrace sediments is that of Raj, Maurya and Chamyal (1998). Elaborating further upon the foraminiferids, Kusumagar, Raj, Chamyal and Yadav (1998) realised their palaeoenvironmental significance. The authors have documented evidences in respect of geomorphology and micropalaeontology from all along the Lower Mahi valley over a distance of 30km from its mouth. However, Kothiyakhad is the main locality (fig. 1) that displays a better sequence of events, hence the micropalaeontologic data is based mainly on this section. Also, an attempt is made to provide data set in respect of palaeoenvironmental changes supplementing the findings of Raj *et al.* (1998) and Kusumgar *et al.* (1998).

GEOGRAPHIC SETTING

The Mahi river in Gujarat, arising from Aravalli mountain near Galiakot at an elevation of about 400m, flowing south-westward and crossing the vast alluvial stretch, meets the Gulf of Cambay (fig. 1). It runs for about 275km in Gujarat, of which about 110km and 30 km respectively fall in the alluvial plain and estuarine zone; the two major geomorphic units of the Lower Mahi valley. Kothiyakhad is an important location of the present study (fig. 1). The present-day tidal effect is observed a few kilometers upstream of this location nearly up to Singrot. The climate around Kothiyakhad

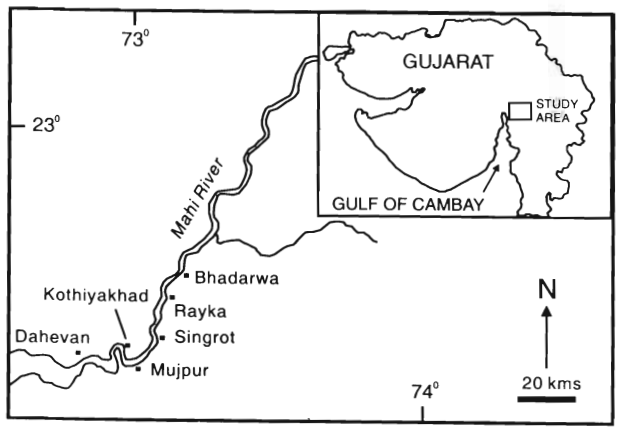

Fig. 1. Location map.

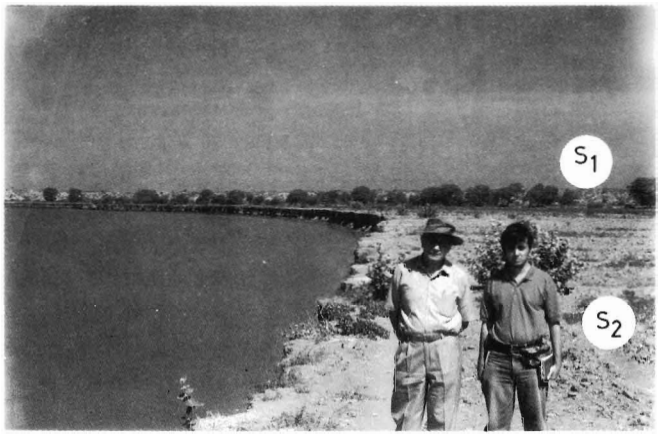

Fig. 2. Photograph showing S_1 and S_2 surfaces at Kothiyakhad.

is more or less sub-humid and the rainfall of the area is around 700mm with mean daily temperatures of about 40°C during May-June and 20°C in December-January.

In general, the topography of the Lower Mahi valley is that of an alluvial plain with a remarkably very broad estuary of about 12km width. At Kothiyakhad, two distinct surfaces (fig. 2), an older and a younger surface (S_1 and S_2), have been mapped (Maurya *et al.,* 1997). S_2 surface occurs as a 3-6 m high, flat terrace and has been mapped all along the Lower Mahi valley as an unpaired terrace whose cliffy sections are cleaned by recent erosion. The fresh active cliffy face at Kothiyakhad provides a succession of diverse lithological sediments and helps in building local stratigraphy (fig. 3).

STRATIGRAPHY

The stratigraphy of the unconsolidated sediments of the valley fill terraces has been described (Maurya *et al.*, 1997; Kusumgar *et al.*, 1998). The two major

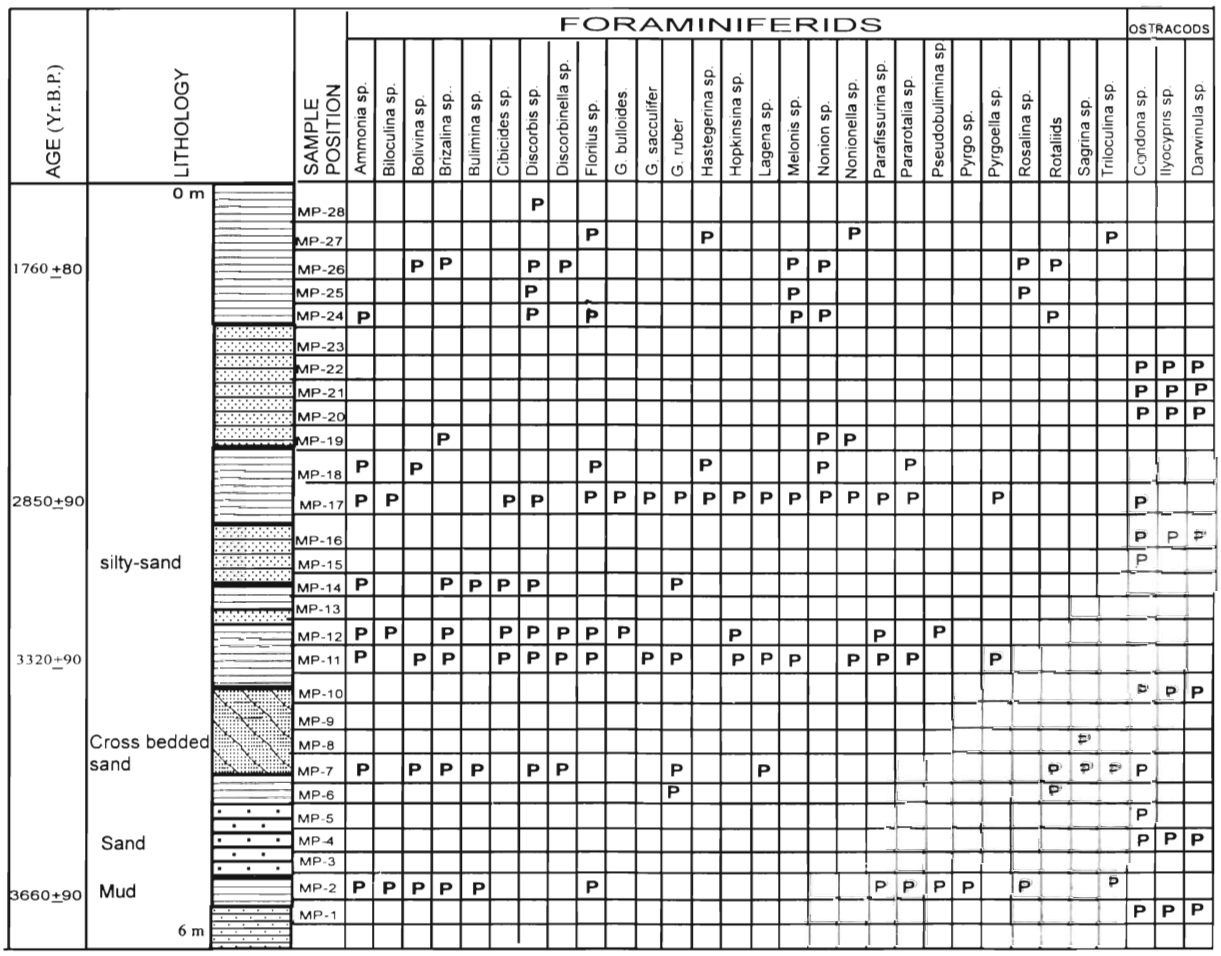

Fig. 3. Composite litholog with radiocarbon dates (Kusumgar *et al.*, 1998) and distribution of microfauna in the Kothiyakhad section

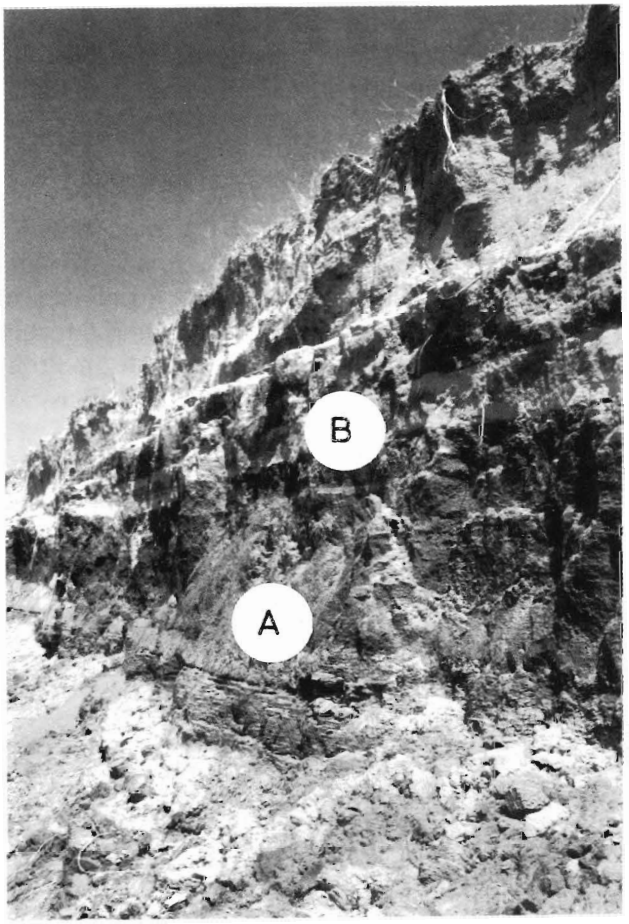

Fig. 4. Photograph of the Kothiyakhad section (A) mud/clay (B) silty-sand.

units identified are : 1) dark greyish brown clay with organic content and 2) greyish silty sand (figs. 3,4). These occur in alternation with an erosional contact and the base is unexposed. The clay units are found rich in foraminiferids, whereas the silty-sand units have preserved fresh water ostracods. Kusumgar *et al.* (1998) have assigned an age of 3600 to 1700 yr B.P. (fig. 3) to these sediments.

MICROFAUNAL STUDIES

The Kothiyakhad section is located on the north bank of Mahi estuary approximately 30km inland from the shore-line of the Gulf of Cambay (figs. 1, 4). The base of the section terminates abruptly in the river water which makes it unapproachable during high tide periods. The exposed section is dominantly made up of silty-sands and intercalated mud layers (fig.4). For detailed micropalaeontological studies 28 samples (MP-1 to MP-28) at an interval of 15cm were collected from the Kothiyakhad section (fig. 3). The samples were first kept in a porcelain pan in 20% H_2O_2 solution to remove the clay content and to clean the microfauna. Each sample was washed thoroughly using new sets of sieves to avoid any contamination. The presence of both foraminiferids and ostracods were noticed in various samples (fig. 3).

MICROFAUNA

In general, it was found that the muddy units have yielded good populations of foraminiferids as compared to various silty-sand units and cross-bedded sandy units which are found to be rich in fresh water ostracods. A total of 25 genera of foraminiferids were identified from the mud units. Considering the morphology of the benthic forms, these are classified into two groups (Kusumgar *et al.*, 1998); Angular-Asymmetrical and Rounded-Symmetrical Morpho-Groups. The Angular-Asymmetrical morphogroup comprises species of the genera *Brizalina, Bulimina, Bolivina, Biloculina, Lagena, Triloculina, Pseudobulimina, Hopkinsina, Sagrina,* (Pl. I-IV) and the Rounded-Symmetrical morphogroup consists of the species of the genera *Ammonia, Cibicides, Discorbis, Discorbinella, Florilus, Hastigerina, Melonis, Nonion, Nonionella, Pyrgo, Pyrgoella, Pararotalia, Parafissurina, Rosalina* (Pl. V and VI) and few other rotaliids. A few planktic forms identified are *Globigerinoides sacculifer* (Brady), *Globigerina bullodies* (Parker, Jones and Brady), *Globigerinoides ruber* (d'Orbigny) (Pl. III, figs. 34-36; Pl. V, fig. 49). The silty-sand units have yielded mainly 3 genera of ostracods namely, *Conodona* (Baird), *Ilyocypris* (Brady and Norman) and *Darwinula* (Brady and Robertson) (Pl. VII). These are represented by several species; a detailed work on ostracods is in progress.

DISCUSSION

Preliminary reports on foraminiferids from the Holocene continental terrace sediments in the Lower Mahi valley have been used to decipher palaeoenvironmental changes (Kusumgar *et al.*, 1998; Raj *et al.*, 1998). However, the ostracods are

documented for the first time. Palaeoenvironmental changes envisaged from the neighbouring area during the Late Holocene by Prasad, Kusumgar and Gupta (1997) and Gupta and Prasad (1998), have been found very useful, though the records lack microfaunal evidence. It is in this context that the Kothiyakhad section in the Lower Mahi valley was selected for microfaunal vis-a-vis palaeo-environmental studies. It is a climatically sensitive region bounded by the Thar desert in the NW, Aravalli mountains to the N and NE and the Arabian sea in the S. The microfauna found in the various lithological units of the Kothiyakhad section (fig. 3) suggests their deposition in diverse environments. The mud units are rich in small size foraminiferids indicating their deposition in an estuarine environment. The small size is attributed to the mixing of the fresh water of the river (Phleger, 1960). Presence of Angular-Asymmetrical morphogroup indicates their deposition in a brackish shallow-intertidal-muddy environment (Murray, 1973; Cerreta and Murray, 1996), whereas the Rounded–Symmetrical morphogroup points to their deposition in the proximal part of the estuary mouth under turbulent environment (Nigam and Khare, 1994).

Horizontally laminated sand or cross-bedded silty-sand units are devoid of forminiferids and the presence of ostracods indicates the influence of fresh water in their deposition, suggesting possibility of 3-4 small sub-stages of regressions within one major transgressive phase. The microfaunal data reveal that the oldest mud/clay unit marks the transgression of the sea at the beginning of the formation of the estuary. The silty-sand unit points to seaward migrating bay line. The overlying clay unit represents a new phase of the transgression replacing the fluviatile conditions by increasing marine influence. Such alternations prevailed from 4000yr B.P. to 1700 yr B.P. (Kusumgar *et al.*, 1998) in the Mahi estuary. This suggests that the position of the estuary remained the same but the bay line moved relatively closer as attested by the increased forminifers. According to Prasad *et al.* (1997) and Gupta and Prasad (1998), the climate between 4.8 to 3ka was wet and the present-day conditions set in ~2ka in the entire region of Nal Sarovar. The data on microfauna and radiocarbon dates of the Kothiyakhad section are in conformity with the climatic conditions prevailing in the neighbouring areas. The Kothiyakhad section in the Lower Mahi valley which has yielded a good assemblage of forminiferids and ostracods thus has been identified as one of the type sections for the Mid to Late Holocene palaeoenironmental changes in western India.

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EXPLANATION OF PLATES

Plate I

1. *Pararotalia* sp. umbilical view
2-3. *Pararotalia* spp. spiral views
4-8 *Melonis* spp. lateral views
9. *Rosalina* sp. umbilical view
10,11. *Ammonia* spp. spiral views
12. *Melonis* sp. (?) lateral view

Plate II

13. *Pyrgo* sp. lateral view
14. *Pararotalia* sp. umbilical view
15-16. *Pararotalia* spp. spiral views
17-18. *Pararotalia* spp. umbilical views
19-20. *Discorbis* spp. spiral views
21. *Discorbis* sp. umbilical view
22. *Discorbinella* sp. umbilical view
23. *Melonis* sp. lateral view
24. *Florilus* sp. lateral view

Plate III

25. *Florilus* sp. lateral view
26-27. *Nonionella* spp. lateral views
28-32. *Nonion* spp. lateral views
33. *Cibicides* sp. spiral view
34. *Globigerinodes sacculifer* (Brady) umbilical view
35-36. *Globigerinoides ruber* (d'Orbigny)

Plate IV

37-48 *Florilus* spp. lateral views.

Plate V

49. *Globigerina bullodies* (Parker, Jones and Brady)
50. *Parafissurina* sp. lateral view
51-58. *Brizalina* spp. lateral views
59. *Bolivina* sp. lateral view
60. *Brizalina* sp. lateral view
61-62. *Bulimina* spp. lateral views

Plate VI

63-68. *Triloculina* spp. lateral views

69. *Lagena* sp. lateral view

70. *Sagrina* sp. lateral view

71,72. *Bulimina* spp. lateral views

73. *Lagena* sp. lateral view

74. *Hopkinsina* sp. lateral view

Plate VII

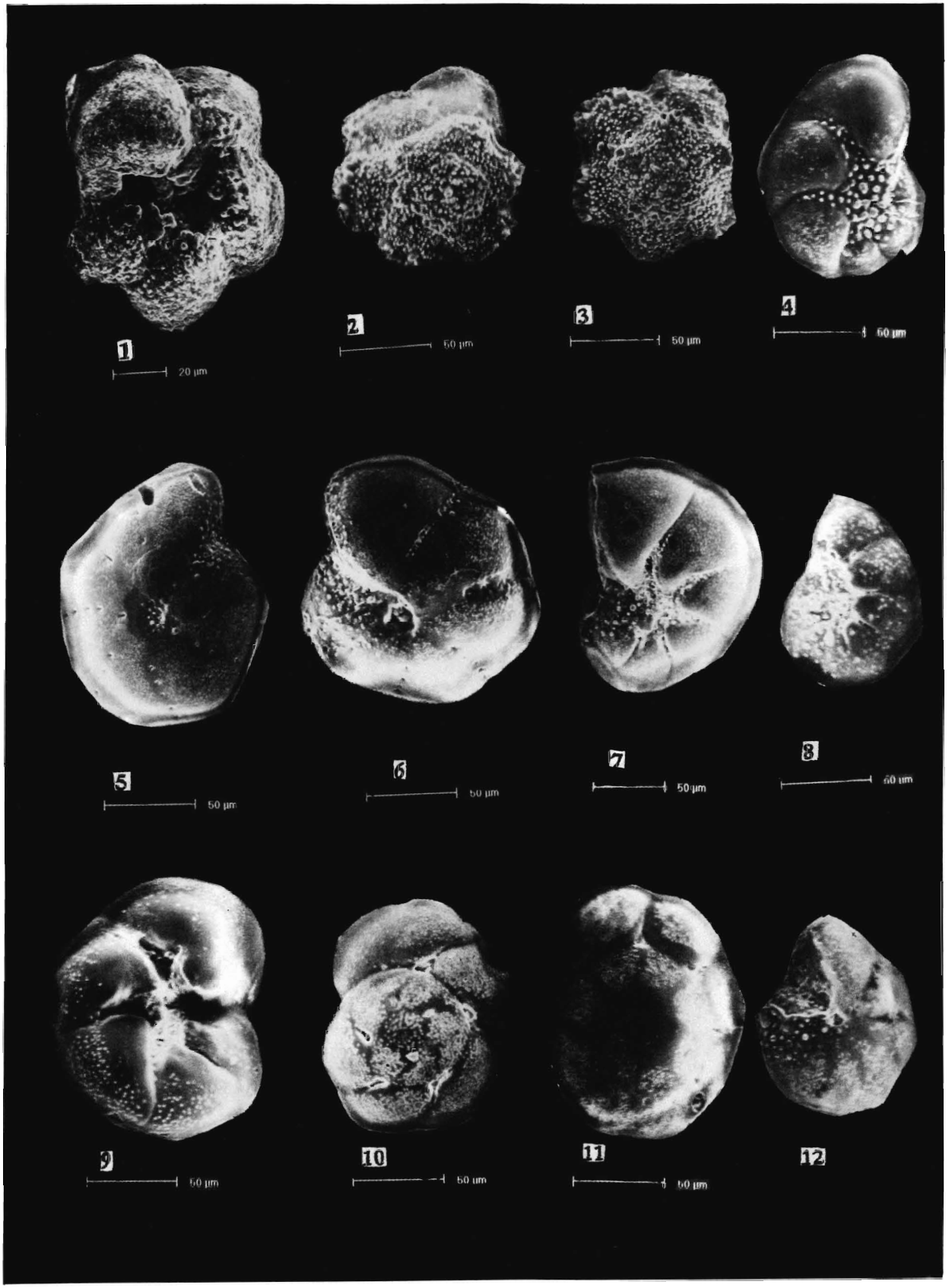
1-6. *Condona* spp. lateral view

7. *Ilyocypris* sp. lateral view

8. *Ilyocypris* sp. internal view

9-10. *Ilyocypris* spp. lateral view

11-13. *Darwinula* spp. lateral view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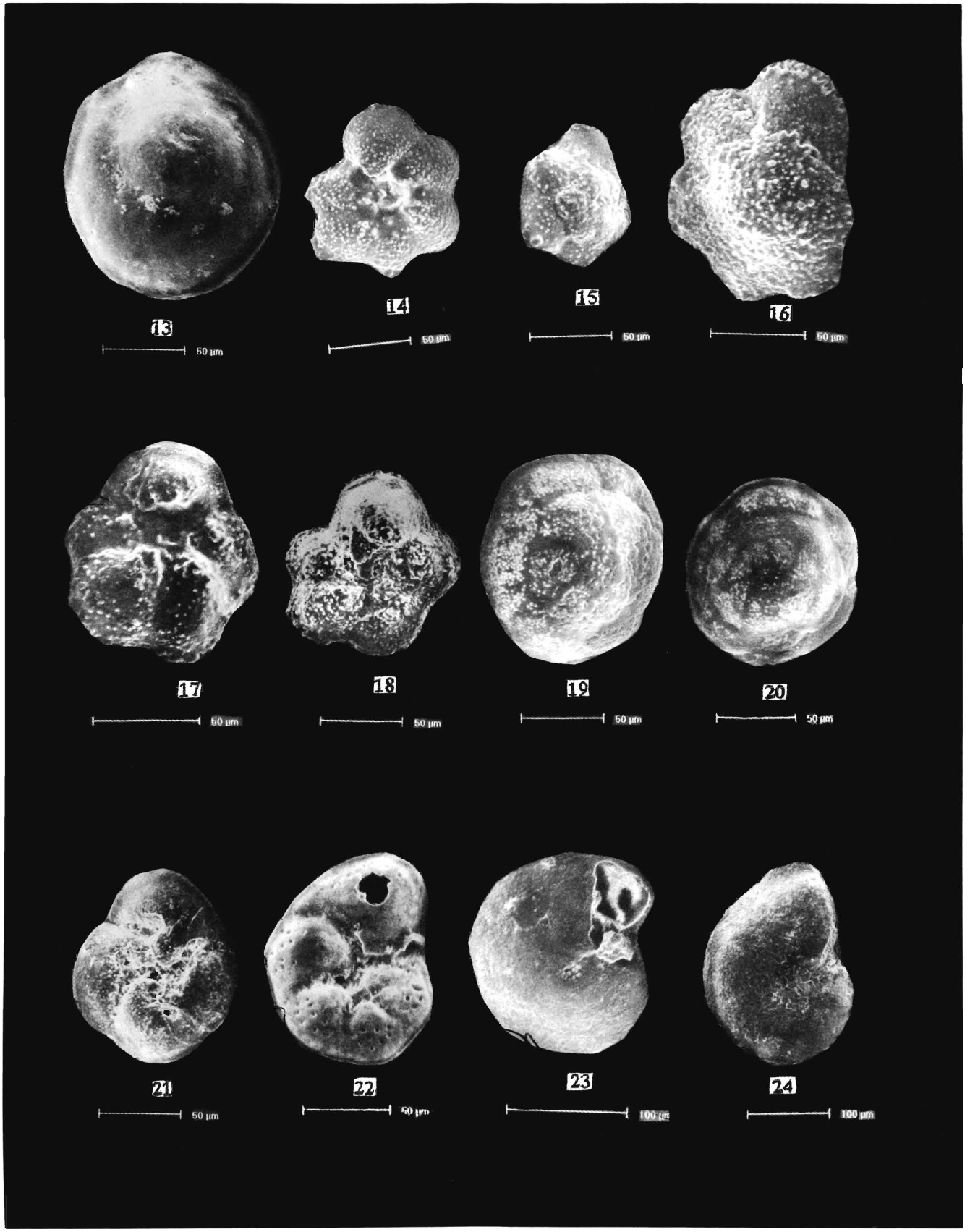
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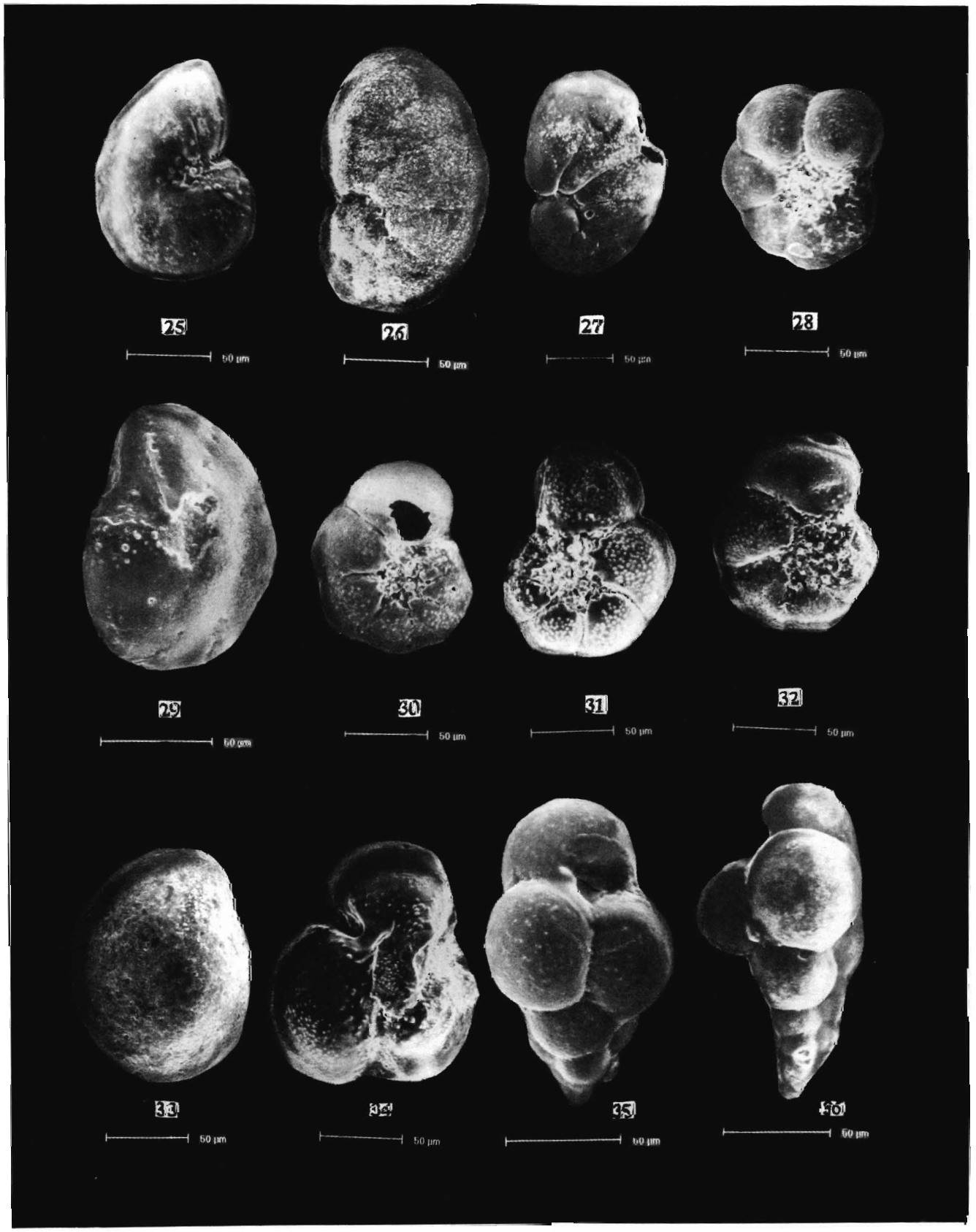
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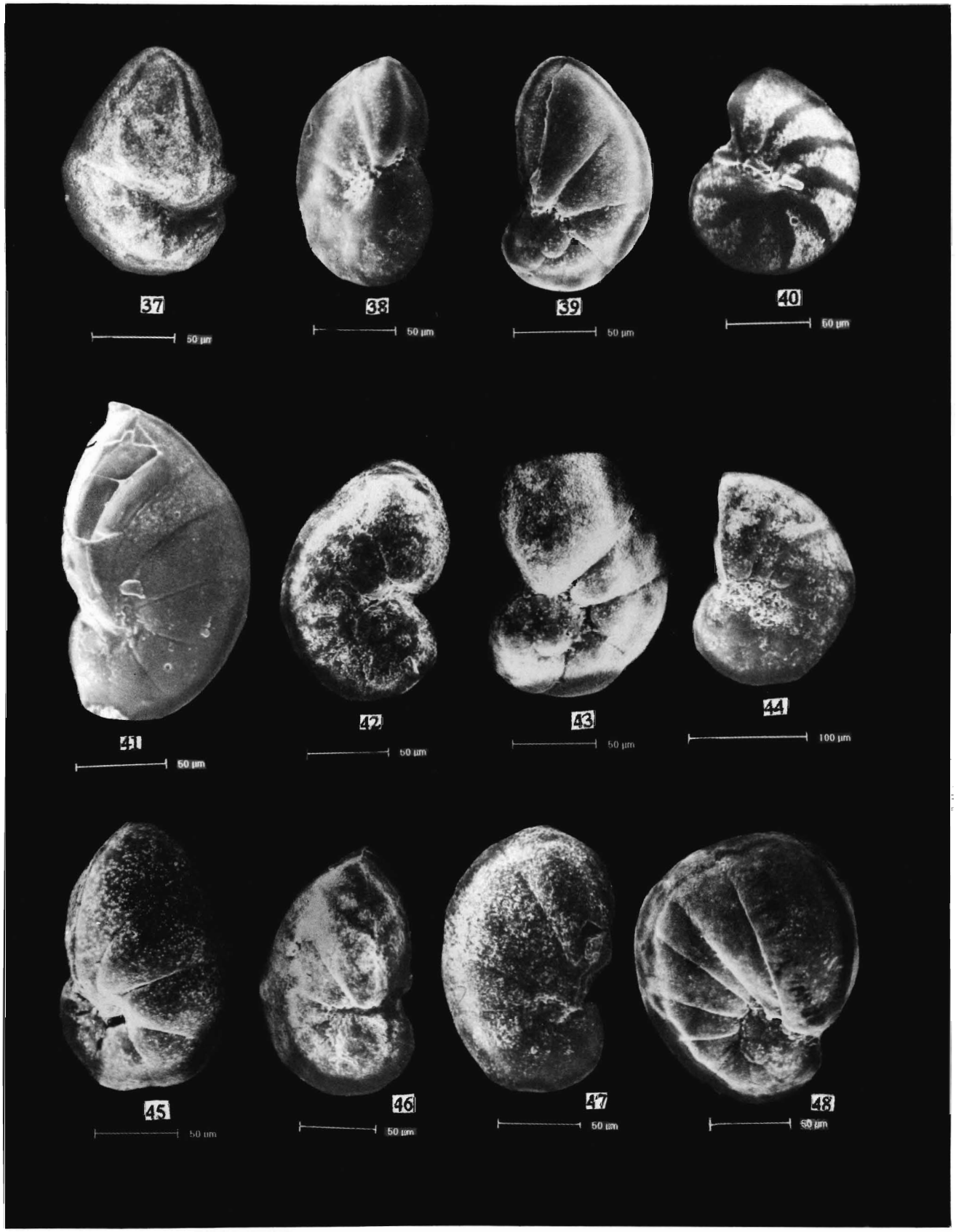
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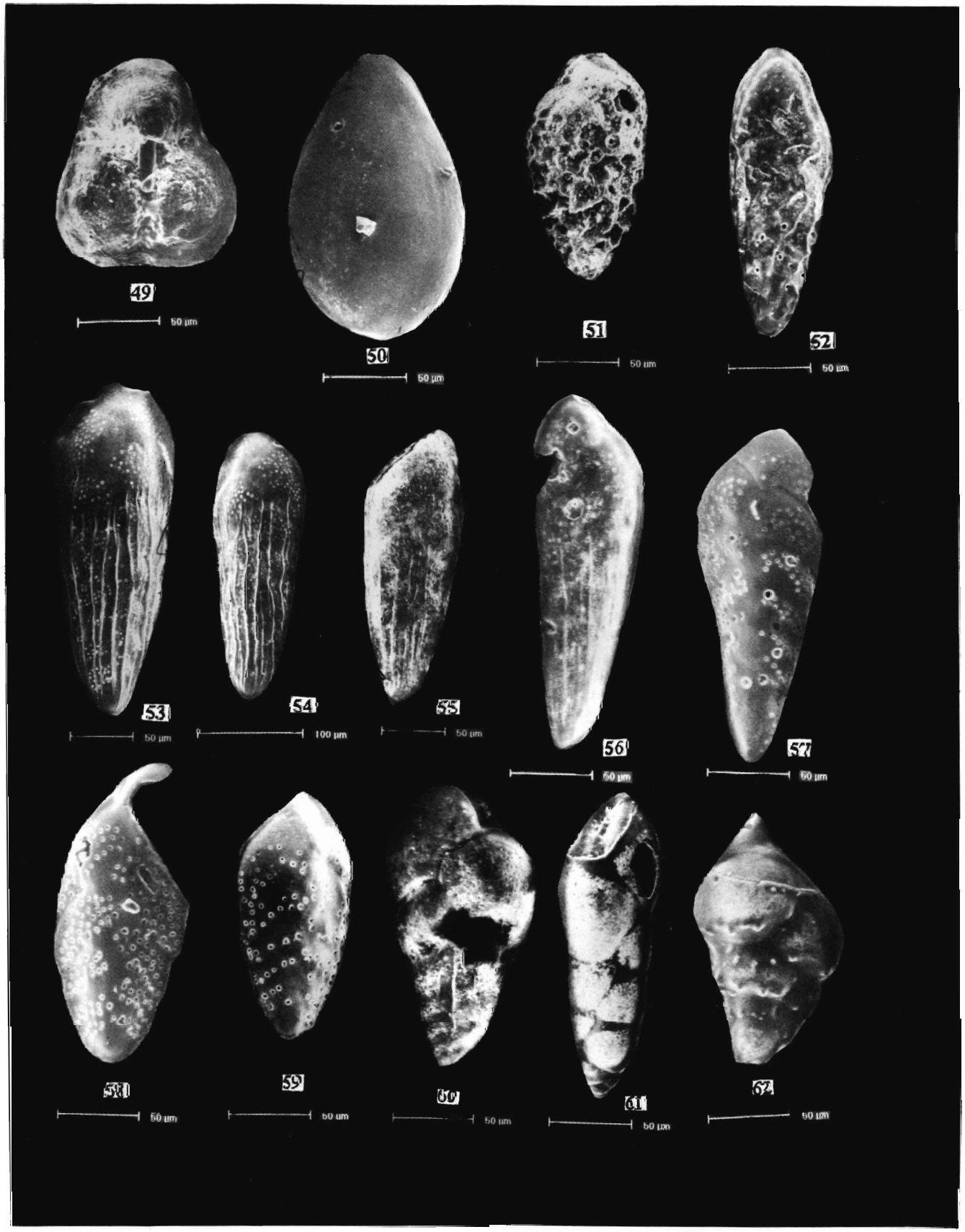
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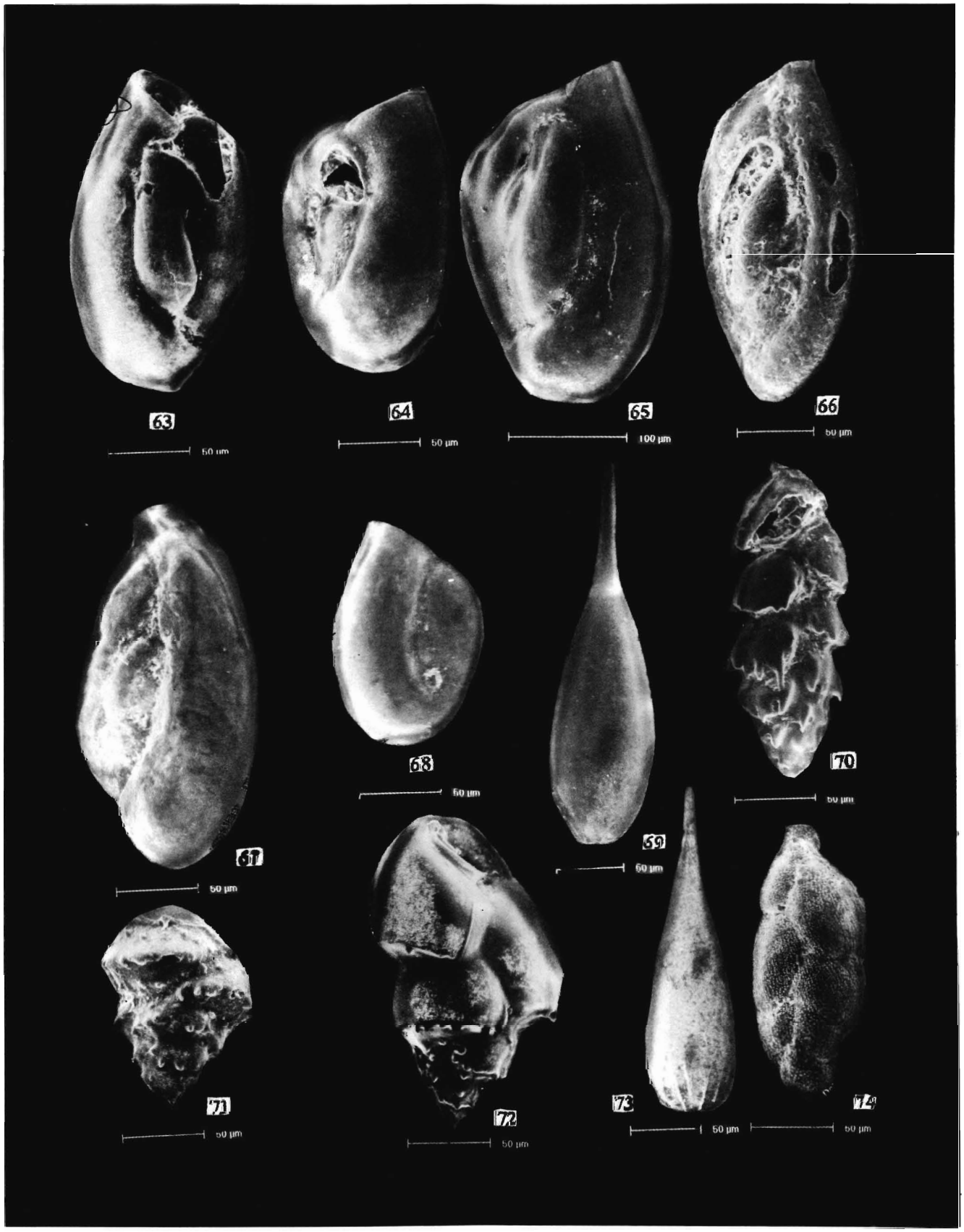
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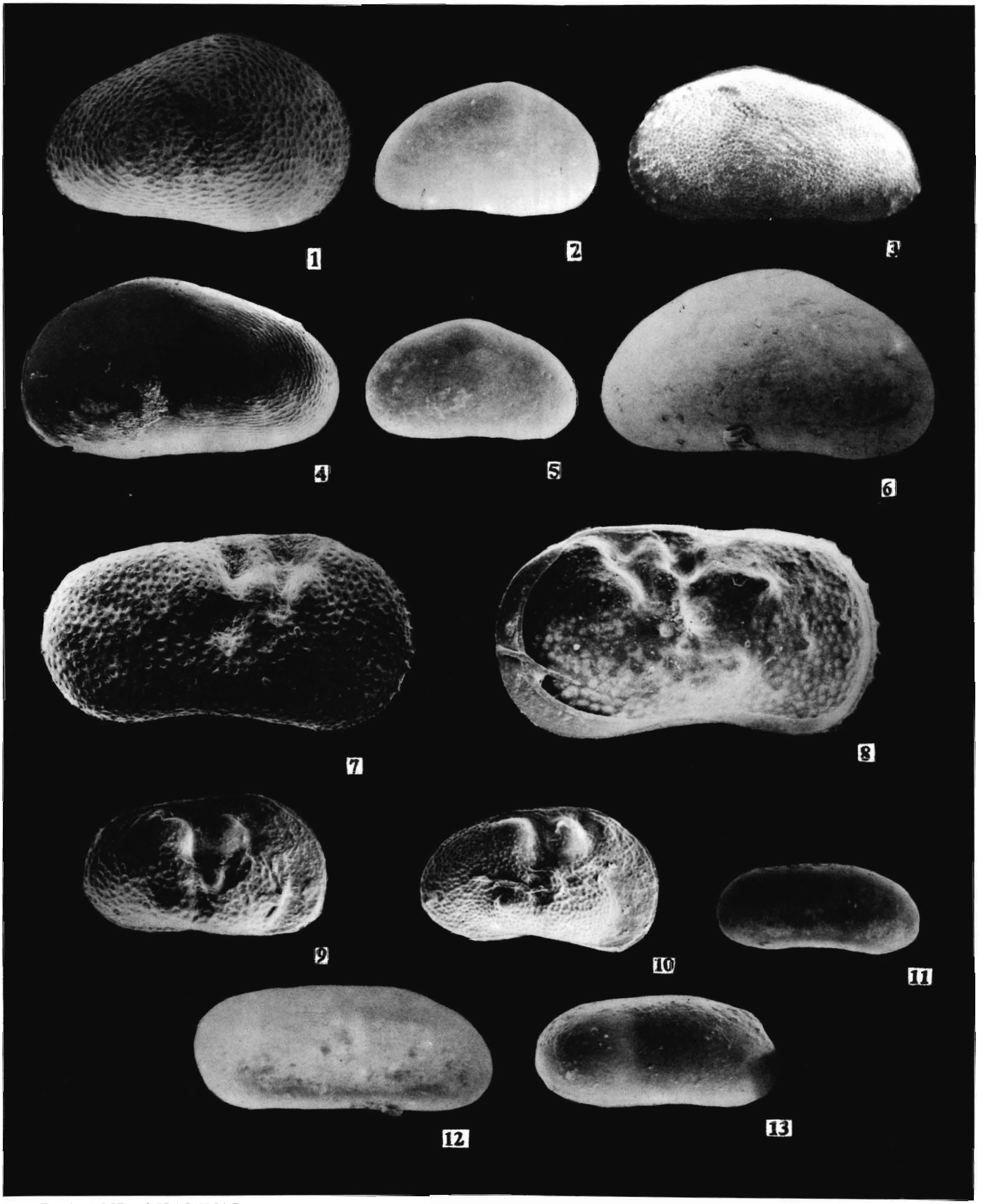
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