

SMALLER FORAMINIFERA FROM EOCENE BEDS OF JAISALMER DISTRICT, WESTERN RAJASTHAN

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ABSTRACT

Twenty-four smaller benthonic and planktonic foraminiferal taxa belonging to twelve families are recorded from the surface sequence of Khuiala (Ypresian) and Bandah (Lutetian) formations of Jaisalmer District, Western Rajasthan. Of these, *Ammobaculites bhallai* is new and *Florilus indica* (Jacob and Sastri) is being redefined with new combination and twelve taxa are recorded here for the first time from Eocene of Jaisalmer Basin. The present foraminifera have close affinity to those known from Eocene of Bikaner, Kutch, Cambay basins in India and France and Egypt.

INTRODUCTION

The Eocene rocks, known for their prolific micro-fauna, are mainly exposed around Sanu and Khuiala villages in Jaisalmer District (26°51' - 27°22' N: 70°20' - 70°58'E). The area is covered by desert sand which forms part of the Indian Thar Desert. A geological map showing the distribution of lower tertiary rocks around Sanu-huiala in Western Rajasthan and location of stratigraphic sections studied is shown in figure-1.

Perhaps the earliest publication on Tertiary foraminifera in Jaisalmer is by Chatterjee (1960), followed by Sigal *et al.* (1971), Khosla (1973) and Singh (1987). These works are only in the form of reports or notes, and no systematic and/or taxonomic work as yet published.

The stratigraphy of the Jaisalmer area is known through the works of Blanford (1877), Oldham (1886), La Touche (1902), Narayanan (1964), Das Gupta (1975), Singh (1976, 1984), Mohan (1982) and Bhatia (1985). The stratigraphic classification (Table 1) followed in the present paper is based on the earlier publications and on the extensive field work by the senior author. The location of stratigraphic sections studied are as follows:

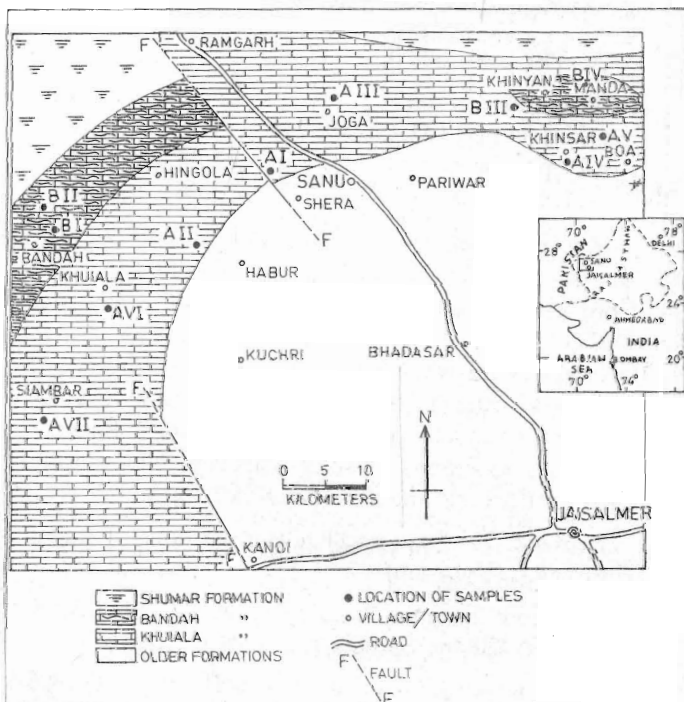


Fig. 1. Distribution of eocene rocks and locations of sections studied in Jaisalmer District, Western Rajasthan.

- Location A I About 3 km NW of Shera village.
- Location A II About 5 km NW of Habur village, along Khuiala scarp.
- Location A III 1.5 km NNE of Joga village.
- Location A IV 1 km South of Khinsar village, a type section for the Khinsar Member.
- Location A V About 3 km NW of Boa village.
- Location A VI 2 km South of Khuiala village.
- Location A VII About 2 km SW of Slambar village along low hillocks.
- Location B I About 2.5 km NE of Bandah village, a type section for the Bandah Formation.
- Location B II About 3 km NNE of Bandah village, near Sand Dunes.
- Location B III 4 km SW of Khinyan village.
- Location B IV About 1.5 km NNW of Manda village, along low hillocks.

FAUNAL ASSEMBLAGE

The twenty-four taxa of smaller benthonic and planktonic foraminifera belonging to twelve families, recorded from the formations, are being described and figured here in the present work. The present assemblage is found associated with the larger benthonic foraminifers and ostracodes (Fig. 2). The classification adopted herein is the one proposed by Loeblich and Tappan (in Moore, 1964) with slight modifications based on works on taxonomy by Bhatia and Khosla (1970) and Bhalla (1981). The holotype of a new taxon and all the hypotypes of the remaining known taxa have been deposited in the Museum,

Department of Studies in Geology, Karnatak University, Dharwad, India under numbers KUG DMF 81-107 and 123-132. The checklist of foraminifera is given below:

Bathysiphon eocenicus, *Ammobaculites bhallai* n. sp., *Textularia punjabensis*, *Clavulina* sp. cf. *C. parisiensis*, *Spiroloculina tricarinata*, *Spiroloculina* sp. A., *Quinqueloculina seminulum* Q. *crassa*, *Pyrgo subsphaerica*, *P. oblonga*, *Sigmollina* sp. c. *S. tenuis*, *Triloculina tricarinata*, *T. trigonula*, *Triloculina* sp. indet, *Globulina gibba*, *Discorbis vesicularis*, *Globorotalia imitata*, *G. thebaica*, *Cibicides aknerianus*, *Cibicides* sp., *Halkyardia minima*, *Florilus indica*, *Florilus* sp. A, *Gyroidina orbicularis*.

SYSTEMATIC DESCRIPTION

- Order Foraminiferida EICHWALD, 1830
- Suborder Textulariina DELUGE and HEROUARD, 1896
- Superfamily Astrorhizidea BRADY, 1881
- Family Rhizamminidae RHUMBLER, 1895
- Subfamily Bathysiphoninae AVNIMELECH, 1952
- Genus *Bathysiphon* SARS, 1872

Bathysiphon eocenicus CUSHMAN and HANNA (Plate I--1)

Bathysiphon eocenicus Cushman and Hanna, 1927, p. 210, pl. 13, figs. 2-3; - Avnimelech, 1952, p. 66.
Bathysiphon eocenicus Ujile and Watanabe, 1960, p. 127, pl. 1; - Bhalla, 1967, p. 354, pl. 1. fig. 1.

Dimensions in mm:	Length	Width
Hypotype 1 (KUGDMF 81)	1.85	0.32
Hypotype 2	1.24	0.32
Hypotype 3	1.06	0.30

Remarks: The present specimens though larger in size are identical to *B. eocenicus*, originally described from Eocene of California by Cushman and Hanna (1927). This is a well-known Eocene species. It has been recorded from many Lower Tertiary horizons of the world. Bhalla (1967) has recorded this species from Intertrappean beds (Lower Eocene) of Pangadi area Andhra Pradesh. The species is being recorded here for the first time from Jaisalmer region.

Horizon: Tetakkar and Khinsar members, Khuiala Formation (Ypresian).

Location: Sample 3, Locality A IV; Sample 3, Locality A VII and Sample 1, Locality B III.

- Superfamily Lituolacea DE BLAINVILLE, 1825
- Family Lituolidae DE BLAINVILLE, 1825
- Subfamily Lituolinae DE BLAINVILLE, 1825
- Genus *Ammobaculites* CUSHMAN, 1910

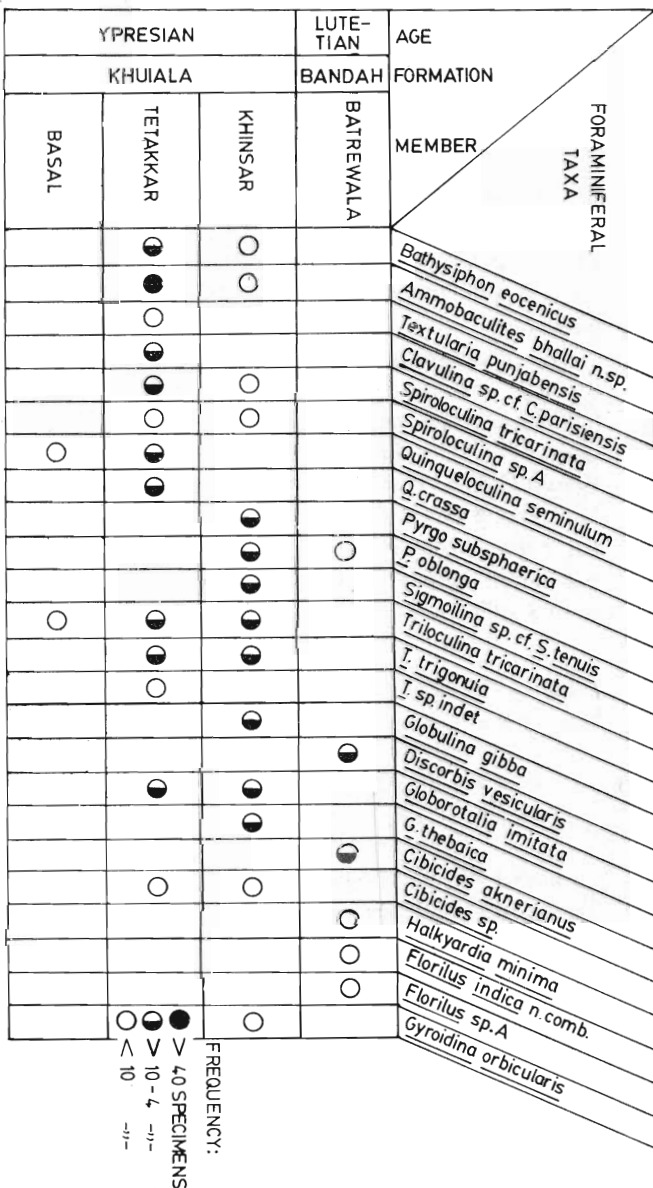


Fig. 2. Frequency distribution of Eocene smaller foraminifera.

Table I Stratigraphic Succession of Eocene Strata in Jaisalmer Basin, Western India.

PERIOD/ EPOCH	AGE	FORMATION	MEMBER	LITHOLOGY	ENVIRONMENT
Q U A T E R N A R Y	Recent			Desert sand and dunes	Arid
	Sub-Recent	Shumar		Gravel beds, coarse-grained ferruginous sandstones with kankar nodules.	Continental, Fluvial and Aeolian
Unconformity					
T E O C E N E	Lutetian	Bandah	Batrewala	Alternate beds of white, yellow friable to hard biomicrite, sparite with molluscs and giant <i>Nummulites</i> and <i>Discocyclina</i> at the top and bottom. Greenish, soft, plastic mudstone with Fuller's Earth layers at the middle.	Warm shallow water, innerneritic
			Khinsar	White to yellow hard biosparite and biomicrite, chalk/claystone with gastropods, bivalves, echinoides' worm-tubes. Yellow friable biosparite with foraminiferal band at the base.	
A E O C E N E	Ypresian	Khuijala	Tetakkar	Alternate beds of yellow to cream, hard biomicrite and gypseous biosparite with abundant internal moulds of bivalves and worm-tubes and layers of benthonic foraminiferal banks and ochreous clay at the base.	Shallow marginal marine, near shore brackish-innerneritic to open lagoonal
			Basal	Variogated gypseous clay at the top, brown coarse sandstone and massive orthoquartzite at the base	
Unconformity					
Older Formations					

Ammobaculites bhallai n. sp.
(Plate I—2.4; Fig. 3)

Diagnosis: A large, elongate, compressed, finely arenaceous species with four to five chambers in the coiled portion and eight to twelve in uniserial portion. The surface is smooth and the aperture is subrounded.

Description: Test free, elongate, straight or slightly curved, compressed, rather larger; early portion closely coiled, planispiral, evolute with four to five slightly inflated chambers, umbilicus small and

depressed; eight to twelve lobate **chambers**, broader than high in the uniserial portion, **chambers** transversely elongated. Periphery somewhat rounded, sides nearly parallel, last chamber pyriform, rounded towards apertural opening; sutures distinct, almost straight, depressed, aperture terminal and subrounded; wall arenaceous, composed of finely cemented quartz grains, surface smooth.

Remarks: The tests in the present material, though varying in size and number of chambers, do not resemble any of the known species from the Tertiary.

Dimensions in mm:	Holotype (KUGDMF 82)	Paratype 1 (KUGDMF 83)	Paratype 2 (KUGDMF 84)	Paratype 3
Length of the test	1.36	1.16	1.10	1.04
Length of uncoiled portion	1.18	0.96	0.92	0.86
Maximum width of uncoiled portion	0.28	0.26	0.24	0.30
Maximum diameter of coiled portion	0.20	0.24	0.18	0.24

Prof. S.B. Bhatia (personal communication) examined the present specimens and opined that the species is distinct and shows range of variation in size.

Type Horizon: Tetakkar Member, Khuiala Formation (Ypresian).

Type locality: A section 2 km SW of Siambar and 1.5 km NNE of Joga (Sample 3, Locality A VII; Sample 8, 9, Locality A III) villages in Jaisalmer District, Western Rajasthan.

Etymology: The species is named after Dr. S.N. Bhatta. Department of Geology, Aligarh Muslim University, Aligarh (U.P.).

Family	Textulariidae	EHRENBERG, 1825
Subfamily	Textulariinae	EHRENBERG, 1825
Genus	<i>Textularia</i>	DEFRANCE in DE BLAINVILLE, 1824

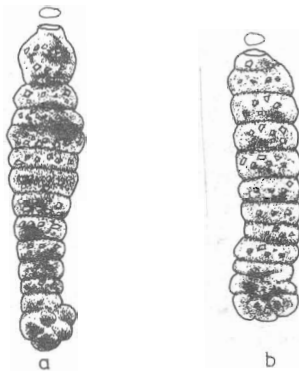


Fig. 3. *Ammobaculites bhallai* n. sp. a, microspheric form x 60; b, megalospheric form x 63.

Textularia punjabensis HAQUE
(Plate I—5-6)

Textularia punjabensis Haque, 1956, pp. 31, 32, pl. 9, figs. 12a, b, Bhatia and Khosla, 1970, p. 3, pl. 1, fig. 2.

Dimensions in mm:	Height	Width
Hypotype 1 (KUGDMF 85)	0.60	0.44
Hypotype 2 (KUGDMF 86)	0.45	0.36

Remarks: The present specimens are well within the range of variation of this species recorded by Bhatia and Khosla (1970) from the Kirthar beds near Mudh village in Bikaner District. The species was originally described by Haque (1956) from the Laki beds of Salt Range, Pakistan.

Horizon: Tetakkar Member, Khuiala Formation (Ypresian).

Locality: Sample 3, Locality A IV.

Family	Ataxophragmiidae	SCHWAGER, 1877
Subfamily	Valvulininae	BERTHELIN, 1880
Genus	<i>Clavulina</i>	D'ORBIGNY, 1826

Clavulina sp. cf. *C. parisiensis* D'ORBIGNY
(Plate I—7-8)

Clavulina parisiensis d'Orbigny, 1826, p. 268, no. 3, fig. 66; - Kaasschieter, 1961, p. 144, pl. 1, figs. 27, 28; - Bhatia and Khosla, 1970, p. 3, pl. 1, figs. 4a, b; - Khosla, 1973, p. 151.

Dimensions in mm:	Length	Width
Hypotype 1 (KUGDMF 87)	0.87	0.31
Hypotype 2 (KUGDMF 88)	0.76	0.28

Remarks: The present specimens are comparable with a well-known Eocene species *C. parisiensis* d'Orbigny (1826) originally described from France and subsequently also recorded by Kaasschieter (1961) from Eocene of Belgium, Bhatia and Khosla (1970) from Middle Eocene of Bikaner and Khosla (1973) from Middle Eocene of Rajasthan, excepting that they lack a distinct tooth (Dr.R.K. Banerji, personal communication).

Horizon: Tetakkar Member, Khuiala Formation (Ypresian).

Locality: Sample 3, Locality A VII.

<i>Suborder</i>	Miliolina	DELAGE and HEROUARD, 1896
<i>Superfamily</i>	Miliolacea	EHRENBERG, 1839
<i>Family</i>	Nubeculariidae	JONES, 1875
<i>Subfamily</i>	Spiroloculininae	WIESNER, 1920
<i>Genus</i>	<i>Spiroloculina</i>	D'ORBIGNY, 1826

Spiroloculina tricarinata TERQUEM
(Plate I—9-10)

Spiroloculina tricarinata Terquem, 1882, p. 158, pl. 16, figs. 19-21; - Cushman and Todd, 1944, p. 10, pl. 1, fig. 10; pl. 2, figs. 19-23; - Brotzen, 1948, p. 39, fig. 6(4).

<i>Dimensions in mm:</i>	Length	Width	Thickness
Hypotype 1 (KUGDMF 89)	1.02	0.52	0.25
Hypotype 2 (KUGDMF 90)	0.92	0.47	0.20
Hypotype 3	0.86	0.44	0.22

Remarks: The present specimens are similar to the figures of this species given by Brotzen (1948) recorded from Palaeocene of Sweden. The species has been originally described and figured by Terquem (1882) from Lower Eocene of France. The species is being recorded here for the first time from Jaisalmer Basin.

Horizon: Tetakkar and Khinsar Members, Khuiala Formation.

Locality: Sample 3, Locality A IV and Sample 7, Locality A III.

Spiroloculina sp. A
(Plate I—11)

Description: Test generally compressed, with ovate outline, chambers planespiral, a half coil in length, subrounded periphery, wall calcareous, imperforate, aperture simple, tooth indistinct.

<i>Dimensions in mm:</i>	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 91)	0.82	0.54	0.24
Hypotype 2	0.78	0.50	0.26

Remarks: The poorly preserved few specimens in the present material, though somewhat comparable to *Spiroloculina inflata* Terquem described and figured by Brotzen (1948) from Palaeocene of Sweden, are kept under open nomenclature for want of more details and the material.

Horizon: Tetakkar and Khinsar Members, Khuiala Formation.

Locality: Sample 7, Locality A III, and Sample 3, Locality A IV.

<i>Family</i>	Miliolidae	EHRENBERG, 1839
<i>Subfamily</i>	Quinqueloculininae	CUSHMAN, 1917
<i>Genus</i>	<i>Quinqueloculina</i>	D'ORBIGNY, 1826
<i>Quinqueloculina seminulum</i> (LINNAEUS) (Plate I—12)		

Serpula seminulum Linnaeus, 1758, systema Nature, Xed; p. 786. *Quinqueloculina seminulum* (Linnaeus) d'Orbigny, 1826, no. 44, p. 303; - Cushman, 1917, p. 44, pl. 11, fig. 2; - Bhatia and Mohan, 1959, p. 650, text-figs. 2a-c; - Mohan and Bhatt, 1968, p. 167, pl. 8, figs. 6a, b.; - Bhalla and Nigam, 1988, p. 518; - Shareef and Venkatachalapathy (1988), p. 434, fig. 9.

Quinqueloculina sp. indet. Bhatia and Khosla, 1970, p. 3, pl. 1, Fig. 7.

<i>Dimensions in mm:</i>	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 92)	0.75	0.51	0.34
Hypotype 2	0.78	0.54	0.36
Hypotype 3	0.62	0.48	0.32

Remarks: Test a little less than one and half times as long as broad, triangular in cross-section, edges rounded, sutures depressed, wall smooth, aperture indistinct. The present species in India has been recorded by Bhatia and Mohan (1959) from Miocene (Burdigalian) of Kathiawar, Western India and Mohan and Bhatt (1968) from Burdigalian of Kutch. The species has also been recorded by Bhalla and Nigam (1988) and Shareef and Venkatachalapathy (1988) from the Recent beaches of west and east coast of India. This long ranging cosmopolitan species is being recorded for the first time from Lower Eocene (Khuiala Formation) of Jaisalmer Basin. The specimens referred to as *Quinqueloculina* sp. indet by Bhatia and Khosla (1970) from Kirthar beds (Middle Eocene) of Bikaner, seem to be juveniles of *Q. seminulum* (Linnaeus).

Horizon: Basal and Tetakkar Members, Khuiala Formation (Ypresian).

Locality: Sample 2, Locality A I; Sample 3, Locality A IV and Sample 4, Locality A VII.

Quinqueloculina crassa D'ORBIGNY
(Plate I—13-14)

Quinqueloculina crassa d'Orbigny, 1850, p. 409 (Type fig. Formasini, 1905, ser. 6, vol. 2, pl. 3; fig. 5; - Mohan and Bhatt, 1968, p. 166, pl. 13, fig. 8a, b.

<i>Dimensions in mm:</i>	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 93)	0.72	0.58	0.36
Hypotype 2 (KUGDMF 94)	0.52	0.43	0.32

Remarks: The present specimens come well within the range of variation of *Q. crassa* d'Orbigny recorded by Mohan and Bhatt (1968) from Burdigalian beds of Kutch, Western India. A solitary mould specimen identified as *Quinqueloculina* sp. by Bhalla (1967) from Intertrappean (Lower Eocene) beds of Pangadi area, Andhra Pradesh, seems to be a juvenile specimen of this species. The species is being recorded here for the first time from Jaisalmer Basin, Rajasthan.

Horizon: Tetakkar Member, Khuiala Formation.

Locality: Sample 2, Locality A VI; Sample 3, Locality A IV and Sample 4, Locality A VII.

Genus *Pyrgo* DE FRANCE, 1824

Pyrgo subsphaerica (D'ORBIGNY)
(Plate II — 1-2)

Pyrgo subsphaerica (d'Orbigny) Cushman, 1929, p. 68, pl. 18, figs. 1, 2; - Mohan and Bhatt, 1968, p. 169, pl. 13, figs. 17a, b.

Dimensions in mm:	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 95)	0.44	0.46	0.40
Hypotype 2	0.42	0.44	0.38

Remarks: The specimens in the present material, though smaller in size, are similar to *P. subsphaerica* (d'Orbigny) recorded by Mohan and Bhatt (1968) from Burdigalian of Kutch. The species is being recorded here for the first time in Jaisalmer Basin, thus extending its range down into the Lower Eocene. Some larger forms referred to as *Pyrgo* sp. by Bhatia and Khosla (1970) from Middle Eocene of Bikaner seem to be close to this species.

Horizon: Khinsar Member, Khuiala Formation.

Locality: Sample 1, Locality B III.

Pyrgo oblonga (D'ORBIGNY)
(Plate II—3)

Biloculina oblonga d'Orbigny, 1826, p. 163, pl. 8, figs. 21-23.
Pyrgo oblonga (d'Orbigny) Mohan and Bhatt, 1968, p. 168, pl. 13, figs. a, b.

Dimensions in mm:	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 98)	0.42	0.35	0.37
Hypotype 2 (KUGDMF 97)	0.45	0.39	0.38

Remarks: The specimens in the present material come well within the range of variation of *P. oblonga* (d'Orbigny) recorded by Mohan and Bhatt (1968) from the Burdigalian of Kutch (Dr. R.K. Banerji, personal communication). The species is being recorded

here for the first time in Jaisalmer Basin, thus extending its range down into the Lower Eocene.

Horizon: Khinsar Member, Khuiala Formation (Ypresian) and Batrewala Member, Bandah Formation (Lutetian).

Locality: Sample 1, Locality B III and Sample 1, Locality B I.

Genus *Sigmoilina* SCHLUMBERGER, 1887

Sigmoilina sp. cf. *S. tenuis* (CZJZEK)
(Plate I — 15-16)

Cf. *Quinqueloculina tenuis* Czjzek, 1848, pl. figs. 31-34.

Cf. *Sigmoilina tenuis* (Czjzek) Cushman, 1946, p. 32, pl. 5, figs. 13-15; - Bhatia and Mohan 1959, p. 650, text-fig. 3, fig. 3; - Bhatia and Khosla, 1970, p. 4, pl. 1, fig. 8.

Dimensions in mm:	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 98)	0.62	0.30	0.28
Hypotype 2	0.64	0.29	0.27

Remarks: The present specimens are comparable with *S. cf. tenuis* (Czjzek) recorded by Bhatia and Khosla (1970) from Kirthar beds near Mudh village in Bikaner District, in general outline, except in being slightly longer in size.

Horizon: Khinsar Member, Khuiala Formation.

Locality: Sample 2, Locality B III.

Genus *Triloculina* D'ORBIGNY, 1826

Triloculina tricarinata D'ORBIGNY
(Plate II—4-5)

Triloculina tricarinata d'Orbigny, 1826, p. 229; - Cushman, 1929, pt. 6, p. 56, pl. 13, figs. 3a; - Bhatia and Mohan, 1959, p. 652, text-fig. 3, figs. 5a, b; - Mohan and Bhatt, 1968, p. 168, pl. 13, figs. 13a, b; - Bhalla and Nigam, 1988, p. 518.

Dimensions in mm:	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 99)	0.70	0.47	0.32
Hypotype 2 (KUGDMF 100)	0.72	0.43	0.30

Remarks: The present specimens resemble *T. tricarinata* d'Orbigny, recorded by Bhatia and Mohan (1959) from Miocene (Burdigalian) of Kathiawar, Western India and subsequently by Mohan and Bhatt (1968) from Burdigalian of Kutch (Dr. R.K. Banerji, personal communication). This species has been recorded by Bhalla and Nigam (1988) from the Recent beach sands of east and west coast, India. The species is being recorded here for the first time from Lower Eocene of Jaisalmer Basin, Western Rajasthan.

Horizon: Basal, Tetakkar and Khinsar Members,

Khuiala Formation (Ypresian).

Locality: Sample 2, Locality A I; Sample 3, Locality A IV and Sample 7, Locality A III.

Triloculina trigonula (LAMARCK)
Plate II—6-7)

Miliolites trigonula Lamarck, 1804, p. 351.

Triloculina trigonula (Lamarck) d'Orbigny, 1958, p. 299, pl. 16, figs. 5-9; - Mohan and Bhatt, 1968, p. 168, pl. 13, figs. 14a, b. Bhalla and Nigam, 1988, P. 518; - Shareef and Venkatachalapathy, 1988, p. 434, pl. 1, fig. 5.

<i>Dimensions in mm:</i>			
	Length	Breadth	Thickness
Hypotype 1			
(KUGDMF 101)	0.56	0.42	0.28
Hypotype 2			
(HUGDMF 102)	0.46	0.38	0.26

Remarks: The poorly preserved specimens in the present material with inflated and rounded chambers are similar to *T. trigonula* (Lamarck) from Middle Eocene (Lutetian) of France. Bhalla and Nigam (1988) and Shareef and Venkatachalapathy (1988) have recorded this species from the Recent beaches of east and west coast of India. The species is being recorded here for the first time from Jaisalmer Basin.

Horizon: Tetakkar and Khinsar Members, Khuiala Formation.

Locality: Sample 3, Locality A IV, Sample 7, Locality A III.

Triloculina sp. indet
(Plate II—8)

Description: Test elongated, nearly one and half times longer than breadth, chambers rounded, sutures distinct and depressed, aperture terminal, wall calcareous, imperforate.

<i>Dimesions in mm:</i>			
	Length	Breadth	Thickness
Hypotype 1			
(KUGDMF 103)	0.60	0.35	0.30
Hypotype 2			
	0.52	0.32	0.26

Remarks: Though a few specimens in the present collection are comparable with *T. trigonula* (Lamarck), an Eocene species, in some characters, but cannot be assigned to the species for want of more material.

Horizon: Tetakkar Member, Khuiala Formation.

Locality: Samples 1, Locality A II; Sample 3, Locality A IV.

<i>Family</i>	Polymorphinidae	D'ORBIGNY, 1838
<i>Subfamily</i>	Polymorphininae	D'ORBIGNY, 1838
<i>Genus</i>	<i>Globulina</i>	D'ORBIGNY, in DE LA SAGRA, 1839

Globulina gibba D'ORBIGNY
(Plate II — 9)

Globulina gibba d'Orbigny, 1846, p. 227, pl. 13, figs. 13-14; - Bhatia and Mohan, 1959, p. 635, text-fig. 3, fig. 10; - Mohan and Bhatt, 1968, p. 171, pl. 13, fig. 26.

<i>Dimensions in mm:</i>			
	Length	Breadth	Thickness
Hypotype 1			
(KUGDMF 104)	0.76	0.46	0.52
Hypotype 2			
(KUGDMF 105)	0.80	0.50	0.49

Remarks: The present poorly preserved specimens, though slightly larger insize, belong to this species recorded by Bhatia and Mohan (1959) from Burdigalian of Kathiawar in Western India and subsequently recorded by Mohan and Bhatt (1968) from the Burdigalian of Kutch (Dr. R.K. Banerji, personal communication). The species is also found living in the east and west coast shores of India (Shareef and Venkatachalapathy, 1988). The present forms can be easily mistaken for *Lagena* because of the shape and faint sutures and chambers in the figure. The species is being recorded here for the first time from Jaisalmer Basin.

Horizon: Khinsar Member, Khuiala Formation.

Locality: Sample 7, Locality A III.

<i>Superfamily</i>	Discorbacea	EHRENBERG, 1838
<i>Family</i>	Discorbidae	EHRENBERG, 1838
<i>Subfamily</i>	Discorbinae	EHRENBERG, 1838
<i>Genus</i>	<i>Discorbis</i>	LAMARCK, 1804

Discorbis vesicularis (LAMARCK)
(Plate II—10-12)

Discorbites vesicularis Lamarck, 1804, p. 183, pl. 62, fig. 7.

Discorbites vesicularis (Lamarck) Cushman, 1927, p. 123, pl. 24, fig. 1.

<i>Dimensions in mm:</i>			
	Length	Breadth	Thickness
Hypotype 1			
(KUGDMF 106)	0.56	0.48	0.18
Hypotype 2			
(KUGDMF 107)	0.54	0.46	0.15

Remarks: The present specimens are identical with *D. vesicularis* (Lamarck) recorded by Cushman (1927) from Middle Eocene of France. Bhatia and Khosla (1970) recorded comparable forms of this species from Kirthar beds of Bikaner in Rajasthan.

Horizon: Batrewala Member, Bandah Formation (Lutetian).

Locality: Sample 3, Locality B II.

<i>Superfamily</i>	Globigerinacea	CARPENTER, PARKER AND JONES, 1862
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Subfamily	Globorotaliidae	CUSHMAN, 1927
Subfamily	Globorotaliinae	CUSHMAN, 1927
Genus	<i>Globorotalia</i>	CUSHMAN, 1927

Globorotalia imitata SUBBOTINA
(Plate III — 1)

Globorotalia imitata Subbotina, 1953, p. 206, pl. 16, figs. 14-16; -
Loeblich and Tappan, 1957, p. 190, pl. 44, fig. 3; pl. 45, fig. 6; pl. 54,
figs. 8-9; pl. 59, fig. 5; pl. 63, fig. 3. Said, 1960, p. 283, pl. 1, fig. 6.

Dimensions in mm:	Length	Breadth	Thickness
Hypotype 1			
(KUGDMF 123)	0.51	0.38	0.24
Hypotype 2	0.48	0.36	0.22

Remarks: This species was originally described by Subbotina (1963) from Danian of USSR, and subsequently recorded by Loeblich and Tappan (1957) from the Lower Eocene beds of Gulf and Atlantic Coastan Plains in the USA, and by Said (1960) from the Lower Eocene of Egypt. The present specimens, though having somewhat less inflated chambers, agree well with the Egyptian forms described by Said (1960).

Horizon: Tetakkar and Khinsar Members, Khuiala Formation (Ypresian).

Locality: Sample 4, Locality A III; Sample 2, Locality A VI and Sample 3, Locality B III.

Globorotalia thebaica SAID
(Plate II—13-14)

Globorotalia thebaica said, 1960, p. 284, pl. 1, fig. 5.

Dimensions in mm:	Length	Breadth	Thickness
Hypotype 1			
(KUGDMF 124)	0.42	0.35	0.18
Hypotype 2	0.38	0.32	0.16

Remarks: The specimens in the present material are quite similar to *Globorotalia thebaica* described by Said (1960) from the Thebes Formation (Lower Eocene) of Luxor, Egypt.

Horizon: Khinsar Member, Khuiala Formation (Ypresian).

Locality: Sample 2, Locality B III.

Superfamily	Orbitoidacea	SCHWAGER, 1876
Family	Cibicididae	CUSHMAN, 1927
Subfamily	Cibicidinae	CUSHMAN, 1927
Genus	<i>Cibicides</i>	DE MONTFORT, 1808

Cibicides aknerianus (D'ORBIGNY)
(Plate III—2-3)

Rotalia akneriana d'Orbigny, 1846, p. 156, pl. 8, figs. 13-15.
Cibicides aknerianus (d'Orbigny) Nuttall, 1932, p. 32, pl. 9, figs. 1-3; -Bhatia and Khosla, 1970, p. 7, pl. 2, figs. 5a-c.

Dimensions in mm:	Length	Breadth	Thickness
Hypotype 1			
(KUGDMF 125)	0.52	0.43	0.16
Hypotype 2			
(KUGDMF 126)	0.50	0.46	0.16
Hypotype 3	0.50	0.44	0.18

Remarks: It is a long ranging species (Eocene to Recent). The species was recorded by Bhatia (1955) from the Palaeogene of Isle of Wight, England and Bhatia and Khosla (1970) from the Middle Eocene of Bikaner, Rajasthan. The present forms come well within the range of variation of *C. aknerianus* (d'Orbigny) recorded from Rajasthan.

Horizon: Batrewala Member, Bandah Formation (Lutetian).

Locality: Sample 3, Locality B II.

Cibicides sp.
(Plate III—4-6)

Description: Test plano-convex, low trochospiral, medium sized; spiral side flat with very weakly inflated chambers, partly evolute, last whorl with 7-8 chambers, gradually increasing in size, umbilical side convex, involute with a pseudo-umbilical knob; periphery acutely angular; sutures depressed, weakly curved, thinly limbate; aperture a low interio-marginal opening with narrow lip, extended along suture on spiral side; wall calcareous, perforate, finely pustulose.

Dimensions in mm:	Length	Breadth	Thickness
Hypotype 1			
(KUGDMF 127)	0.46	0.36	0.14
Hypotype 2	0.47	0.41	0.16
Hypotype 3	0.42	0.40	0.14

Remarks: The specimens in the present material resemble to *C. aknerianus* (d'Orbigny) recorded also herein in most of the characters, except that they have a slit like aperture and pustulose wall. They also resemble *C. lobatulus* (Walker and Jacob), a long ranging species, recorded by a number of authors from the Tertiary and Recent as suggested by Dr. R.K. Banerji (Personal communication), but differ in the absence of peripheral lobe and in having pustulose wall.

Horizon: Tetakkar and Khinsar Members, Khuiala Formation (Ypresian).

Locality: Sample 4, 9; Locality A III.

Family	Cymbaloporidae	CUSHMAN, 1927
Genus	<i>Halkyardia</i>	HERON-ALLEN AND EARLAND, 1910

Halkyardia minima (LIEBUS)

(Plate III—7)

Cumbalopora radiata var. *minima* Liebus, 1911, p. 952.*Halkyardia minima* (Liebus) Loeblich and Tappan, 1964, p. C702, fig. 575 (5).

	Longer diameter	Shorter diameter	Thickness
Hypotype 1 (KUGDMF 128)	0.40	0.36	0.28
Hypotype 2 (KUGDMF 129)	0.39	0.35	0.28

Remarks: This typical Eocene species, originally described by Liebus (1911) from Eocene of France, is represented herein with well preserved specimens in Bandah Formation in Jaisalmer Basin.

Horizon: Batrewala Member, Bandah Formation (Lutetian).

Locality: Sample 1, Locality B I.

Superfamily	Cassidulinacea	D'ORBIGNY, 1839
Family	Nonionide	SCHULTZE, 1854
Subfamily	Nonioninae	SCHULTZE, 1854
Genus	<i>Florilus</i>	DE MONTFORT, 1808

Florilus indica (JACOB and SASTRI) new combination
(Plate III — 8-10)

Nonion scapha (Fichtell and Moll) var. *indica* Jacob and Sastri, 1950, vol. 16, p. 81-83; - Tewari *et al.*, 1968, vols. 5-9, pp. 77-82; - Bhatia and Khosla, 1970, p. 8, pl. 1, fig. 18.

Description: Test free, planispiral, involute, but with broad, low chambers, increasing rapidly in breadth and thickness resulting in flaring test, peripheral margin rounded to angled, umbilical region slightly depressed, filled with fine-grained material, wall calcareous, finely perforate; aperture a narrow, interiomarginal equatorial opening.

	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 130)	0.36	0.25	0.14
Hypotype 2	0.37	0.24	0.13

Remarks: Jacob and Sastri (1950) described this species as *Nonion scapha* (Fichtell and Moll) var. *indica* from the Middle Eocene of Bikaner in Rajasthan and subsequently also recorded by Tewari *et al.* (1968) from the Middle Eocene of Kutch and Bhatia and Khosla (1970) from the Middle Eocene of Bikaner. The present specimens are identical with the Bikaner material described as var. *indica* by Jacob and Sastri (1950) and Bhatia and Khosla (1970) in overall shape, size and chambers. Further, the species *Florilus indica* (Jacob and Sastri) is dis-

tinct from *F. scapha* (Fichtell and Moll) recorded by Bhalla and Dev (1981) in the arrangement of chambers and nature of sutures (Prof. S.B. Bhatia, personal communication). Hence, on the basis of its distinct characters like broad and low chambers with flaring test, the species *indica* is transferred here to the genus *Florilus* de Montfort.

Horizon: Batrewala Member, Bandah Formation (Lutetian).

Locality: Sample 4, Locality B III; Sample 6, Locality B IV.

Florilus sp. A
(Plate III—11)

Description: Test small, planispiral, involute, umbilical region somewhat deep, periphery rounded, 8 to 9 chambers in the adult coil, last chamber inflated; sutures distinct, narrow, curved and slightly depressed, aperture a low opening at the base of the apertural face.

	Length	Breadth	Thickness
Hypotype 1 (KUGDMF 131)	0.30	0.24	0.16
Hypotype 2	0.34	0.25	0.14

Remarks: The present specimens resemble *F. indica* (Jacob and Sastri), recorded also in the present material, in general shape and size, but differ in having a deeper umbilicus and more rounded and inflated chambers. However, the specimens are kept under open nomenclature at present for want of more information.

Horizon: Batrewala Member, Bandah Formation.

Locality: Sample 4, Locality B III; Sample 6, Locality B IV.

Family	Alabaminidae	HOFKER, 1951
Genus	<i>Gyroidina</i>	D'ORBIGNY, 1826

Gyroidina sp. cf. *G. orbicularis* D'ORBIGNY
(Plate III—12-13)

Cf. *Gyroidina orbicularis* d'Orbigny, 1926, vol. 7, p. 278; - Cushman, 1927, p. 190; - Loeblich and Tappan, 1964, p. 750, fig. 614.

Dimensions in mm: Longer diameter Shorter diameter Thickness

Hypotype 1 (KUGDMF 132)	0.54	0.45	0.30
Hypotype 2	0.52	0.46	0.32

Remarks: A few specimens in the present material are comparable with *G. orbicularis* d'Orbigny, a Recent species figured by Loeblich and Tappan (in Moore, 1964) from Europe. However, more specimens are required for precise identification.

Horizon: Khinsar Member, Khuiala Formation.

Locality: Sample 2, Locality A V.

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EXPLANATION OF PLATES

PLATE I

1. *Bathysiphon eocenicus* Cushman and Hanna. X50
- 2-4. *Ammobaculites bhallai* n. sp.
 - 2 Holotype, side view, microspheric test X62
 - 3 Paratype 1, side view, megalospheric test X63
 - 4 Paratype 2, Coiled part with lateral view X74

- 5-6 *Textularia panjbensis* Haque
5 Hypotype 1, side view X96
6 Hypotype 2, side view X120
- 7-8. *Clavulina* sp. cf. *C. parisiensis* d'Orbigny
7 Hypotype 1, side view X65
8 Hypotype 2, side view X66
- 9-10. *Spiroloculina tricarinata* Terquem
9 Hypotype 1, side view X52
10 Hypotype 2, sideview X50
11. *Spiroloculina* sp. A
Hypotype, side view X72
12. *Quinqueloculina seminulum* (Linnaeus)
Hypotype, side view X52
- 13-14 *Quinqueloculina crassa* d'Orbigny
13 Hypotype 1, side view X58
14 Hypotype 2, sideview X77
- 15-16 *Sigmolina* sp. cf. *S. tenuis* (Czizek)
15 Hypotype 1, side view X70
16 Hypotype 2, sideview X76

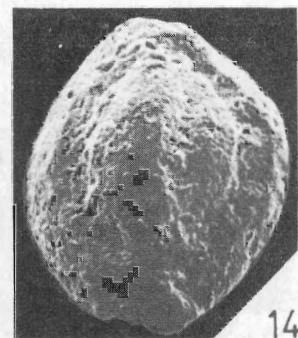
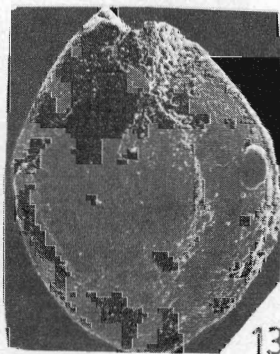
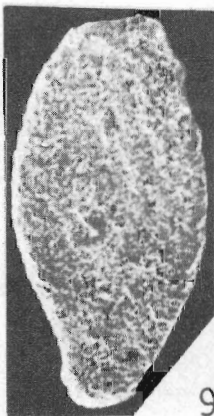
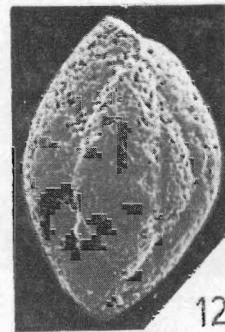
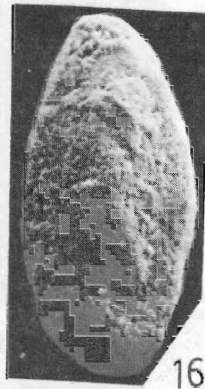
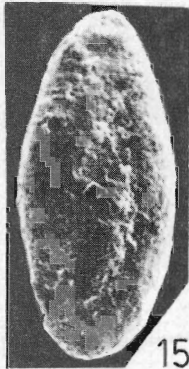
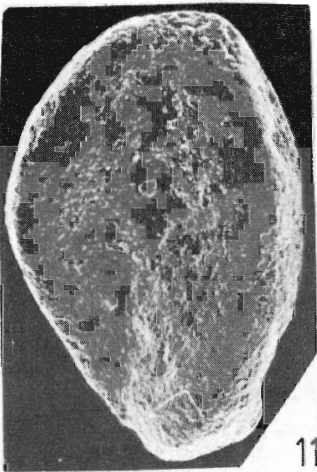
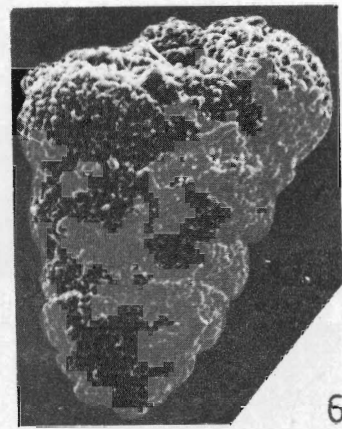
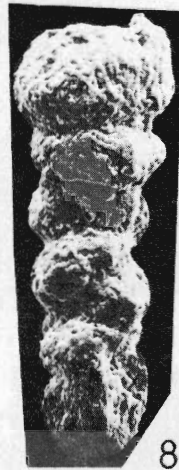
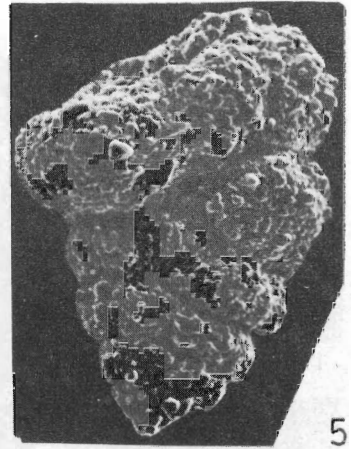
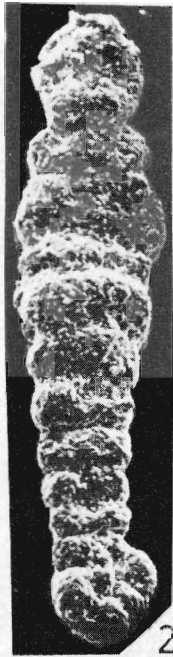
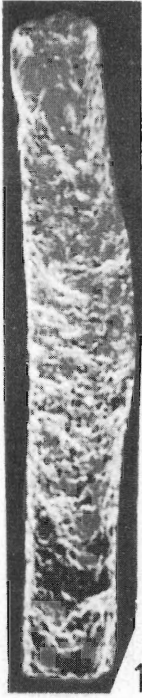
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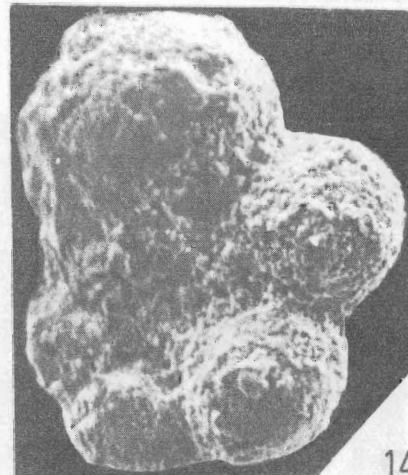
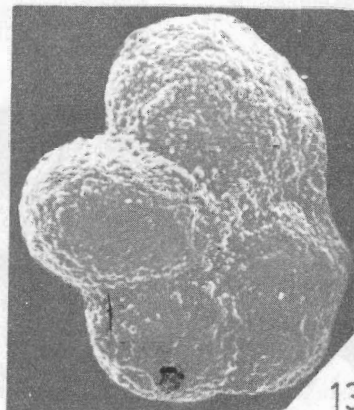
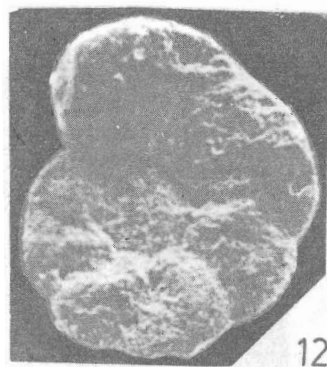
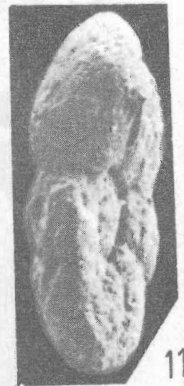
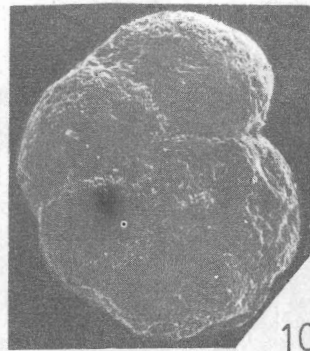
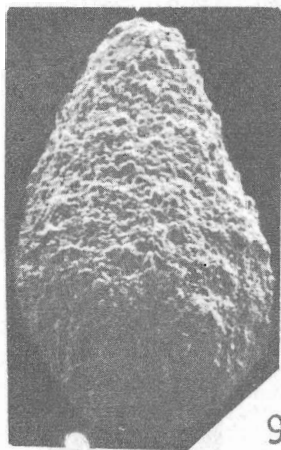
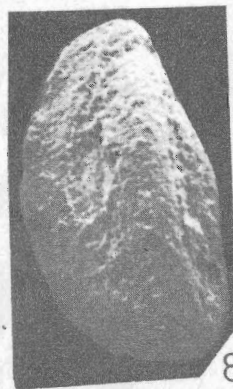
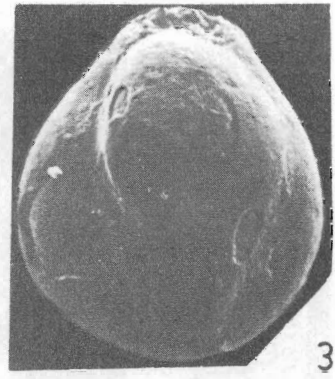
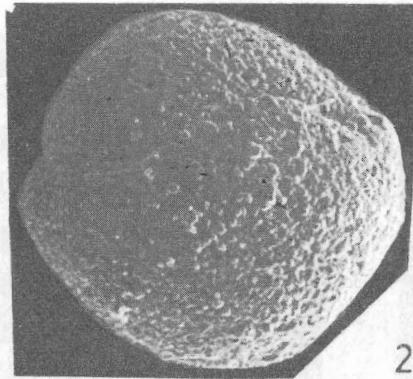
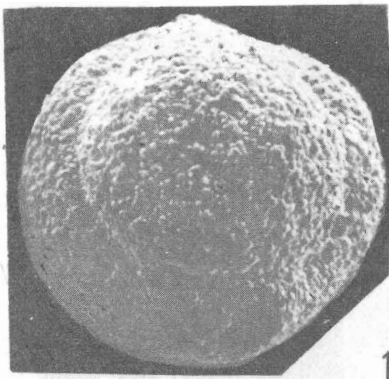
- 1-2 *Pyrgo subsphaerica* (d'Orbigny)
1 Hypotype 1, surface view X106
2 Hypotype 2, apertural view X110
3. *Pyrgo oblonga* (d'Orbigny)
Hypotype, side view X125
- 4-5. *Triloculina tricarinata* d'Orbigny
4 Hypotype 1, side view X63
5 Hypotype 2, opposite view X65
- 6-7 *Triloculina trigonula* (Lamarck)
6 Hypotype 1, side view X65
7 Hypotype 2, sideview X60
8. *Triloculina* sp. Indet.
Hypotype, side view X5
9. *Globulina gibba* d'Orbigny
Hypotype, side view X74
- 10-12. *Discorbis vesicularis* (Lamarck)
10 Hypotype 1, dorsal view X75
11 Hypotype 2, ventral view X77
12 Hypotype 3, apertural view X77
- 13-14 *Globorotalia thebaica* Said
13 Hypotype 1, dorsal view X128
14 Hypotype 2, ventral view X122

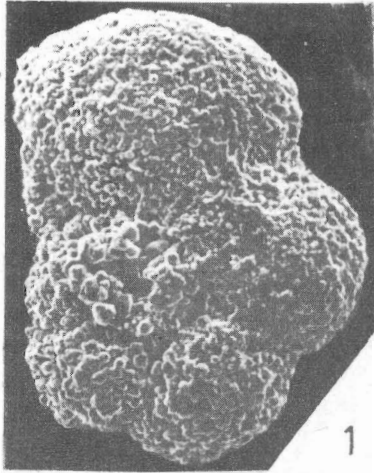
PLATE III

1. *Globorotalia imitata* Subbotina
Hypotype, ventral view X120
- 2-3 *Cibicides aknerianus* (d'Orbigny)
2 Hypotype 1, dorsal view X84
3 Hypotype 2, ventral view X92
- 4-6 *Cibicides* Sp. A
4 Hypotype 1, dorsal view X112
5, 6 Hypotype 2, ventral view X100, apertural view X132
7. *Halkyardia minima* (Liebus)
Hypotype 1, dorsal view X115

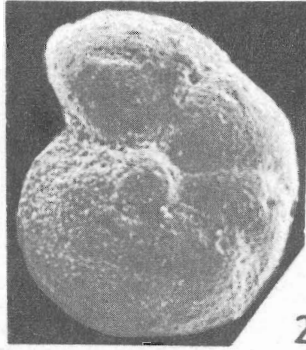
- 8-10 *Florilus indica* (Jacob and Sastri) new combination
8 Hypotype 1, dorsal view X140
9, 10 Hypotype 2, ventral view X124, apertural view X150
11. *Florilus* sp.
Hypotype 1, ventral view X132
- 12-13 *Gyroidina* sp. cf. *G. orbicularis* d'Orbigny
12 Hypotype 1, ventral view X97
13 Hypotype Apertural view X100



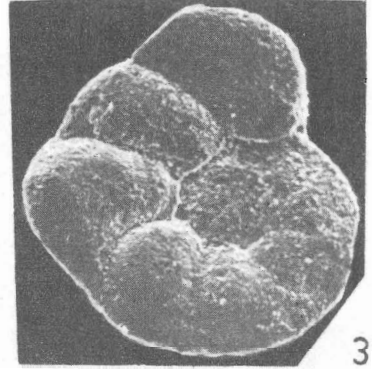




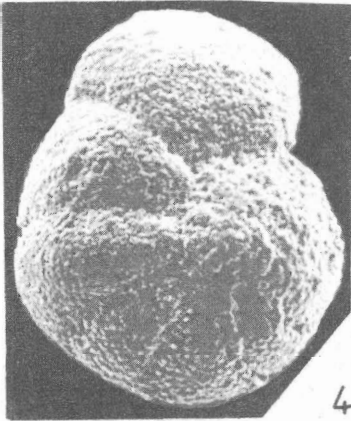
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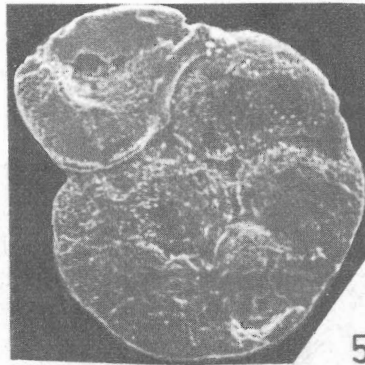
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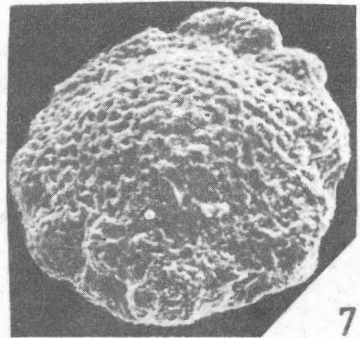
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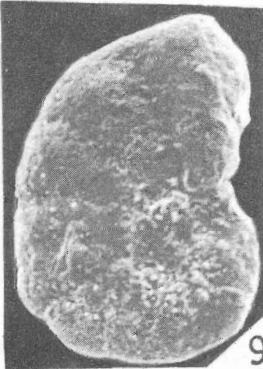
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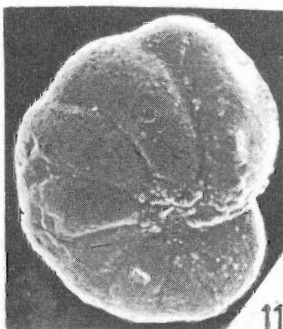
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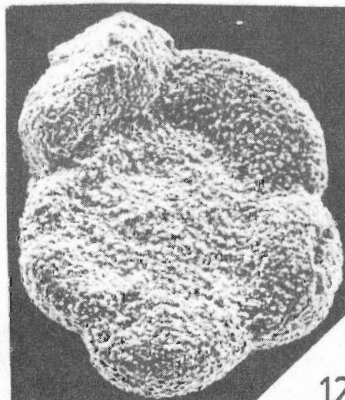
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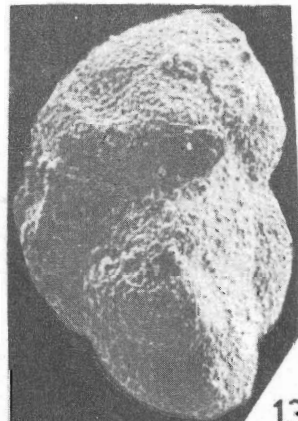
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