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BATHONIAN AGE FOR THE SEDIMENTS IN JHURIO HILL, KACHCHH, FORAMINIFERAL EVIDENCE

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ABSTRACT

Thirteen index benthonic foraminiferal species of *Garantella, Epistomina, Pseudomarssonella, Riyadhella, Singhamina* and *Tandonina* have been obtained for the first time from the Patcham-Chari sediments exposed in Jhurio Hill, Kachchh. On the basis of these species a Bathonian age is assigned to the sequence exposed in the lower part of Jhurio Hill. An attempt has also been made to locate the Bathonian-Callovian Boundary in the exposed sequence.

INTRODUCTION

The Jurassic sequence exposed in Jhurio Hill, Kachchh is characterized by horizons yielding a rich fossil assemblage comprising megafossils, dominentaly ammonites, bivalves and brachiopods, and microfossils eg.foraminifers, ostracods, etc. The earlier workers provide a wealth of data on megafossils, especially ammonites, which have been used for chronostratigraphy and world wide correlation. Among the microfossils, the foraminifera have been studied and used for precise age determination and correlation on inter-regional scale.

In recent years papers incorporating detailed observations on Jurassic foraminifers have appeared (Ascoli, 1976; Gradstein, 1976, etc.). These authors proposed biozonation schemes of Jurassic rocks in different regions highlighting the utility of foraminifers in age determination and correlation throughout the world.

Fig. 1. Location Map of Kachchh (After Biswas, 1977).

The present paper examines the diagnostic foraminiferal assemblage from the Patcham and Chari Formations in Jhurio Hill for dating of these sediments. Samples were collected from the exposures along a nala cutting in Jhurio Hill.

STRATIGRAPHY

Lithologically, the Jurassic rocks of Kachchh have been divided into Patcham, Chari, Katrol and Umia Formations in ascending order (Table 1, Jaikrishna *et al.*, 1983).

Table 1.

Lithostratigraphic unit	Age
Umia Formation	U. Tithonian - Albian
Katrol Formation	Kimmeridgian ? - Lower to Middle Tithonian
Chari Formation	Upper Bathonian - Upper Oxfordian
Patcham Formation	Bajocian - Bathonian

Jhurio Hill, the area under investigation, falls in Kachchh mainland (Fig.1). The geology of the Jhurio Hill (Jhura Dome) has been discussed by several workers on the basis of which it is seen that there is a difference of opinion regarding the status of Patcham Formation in this particular area. Agarwal (1957) put the whole sequence of Jhura Dome into Habo Formation (= Chari Formation) and Katrol Formation, while Biswas (1977) extended the Jhurio Formation (= Patcham Formation) upto calcareous shales with golden oolite bands and assigned a Bathonian to Callovian age to this Formation. Bhalla and Talib (1985) were of the view that the whole sequence belongs to Chari and Katrol Formations. They assigned a Callovian to Oxfordian age for Chari Formation.

The present studies suggest that the Jhurio Hill sediments are broadly of Patcham, Chari and Katrol Formations. The base of the Patcham Formation is not exposed in this area. Due to lack of ammonites in the older sequence and lithological variations, it is difficult to compare the sequence worked out with

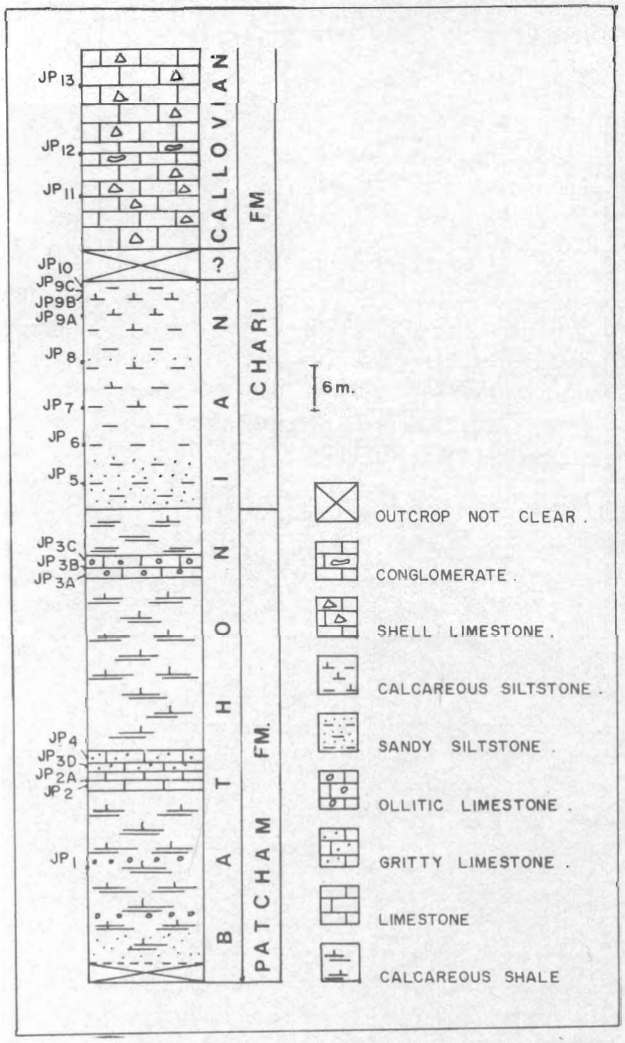

Fig. 2. Simplified Lithologic Column of lower part of Jhurio Hill, Kachchh.

the succession given by earlier workers. Present paper includes observations relating to the Patcham Formation and Lower part of Chari Formtion, exposed in Jhurio Hill (Fig. 2), where the major part of the sequence is found to be of Bathonian age.

TAXONOMY

The micropalaeontological investigation of the marine Jurassic sequence of Jhurio Hill, reveals the presence of rich and diversified microfaunal assemblage which is confined to the Patcham and Chari Formations. No foraminifera could be recorded from Katrol Formation. The microfauna is dominated by foraminifera with subordinate representation of ostracods, holothurian sclerites, echinoid fragments, bryozoans and microgastropods.

The present work describes some age-diagnostic species of foraminifera belonging to the family epistominidae, ataxophragmiidae and duostominidae, important in the dating of Jhurio Hill sediments. Their distribution is given below.

Unit JP_1 — *Garantella ornata, Garantella cf. G. stellata, Epistomina turgidula, E.nuda, E.regularis, Pseudomarssonella reflexa.*

Unit JP_6–JP_{10} — *Pseudomarssonella inflata, P. reflexa, P. primitiva, P. biangulata, Riyadhella elongata, Singhamina rajasthanensis S. jaisalmerensis* and *Tandonina paula.*

Unit JP_{11} — *Epistomina nuda, E. regularis.*

Unit JP_{13} — *Epistomina regularis, E. alveolata, E.mosquensis, E.parastelligera.*

DISCUSSION

In Kachchh, the oldest Mesozoic (Bajocian) sediments (evidence based on ammonites) have been reported from the Patcham Island by Singh *et al.* (1982). The Patcham is a part of the series of islands, separated from the mainland by the Rann. As far as the oldest Mesozoic sediments of Kachchh mainland is concerned, Waagen (1875), Oldham (1893), Vredenburg (1910) and Rajnath (1932, 1942) are of the view that the sedimentation started as early as in Middle Bathonian, while Spath (1933) gave an early Bathonian age.

The same controversial aspect exists in the Jhurio Hill section, a part of Kachchh Mainland. Spath (1933, quoted in Agarwal, 1957) suggested that *Macrocephalus* Beds of Kachchh are of Upper Bathonian age. Agarwal (1957) introduced a new name "Habo Series" in place of "Chari Formation" and correlated it with Chari Formation described by Spath (1933), according to which "*Macrocephalus* Beds" occupies Lower Habo Series and a part of Middle Habo Series i.e. Bed Nos. 18 to 12 (see Agarwal 1975, p. 125). He was of the view that these Beds belong to Callovian only. He disagreed with age assignment given by Spath (1933) as it is based on the collection of Blake, Smith, etc. However, he was also unable to assign definite Callovian age for the lower two beds i.e. Bed Nos. 17 & 18, due to lack of reliable evidence of index Callovian ammonites in these beds. Bhalla and Talib (1985) have assigned a Callovian to Oxfordian age to the Chari Formation exposed in Jhurio Hill. However, their conclusions are based on

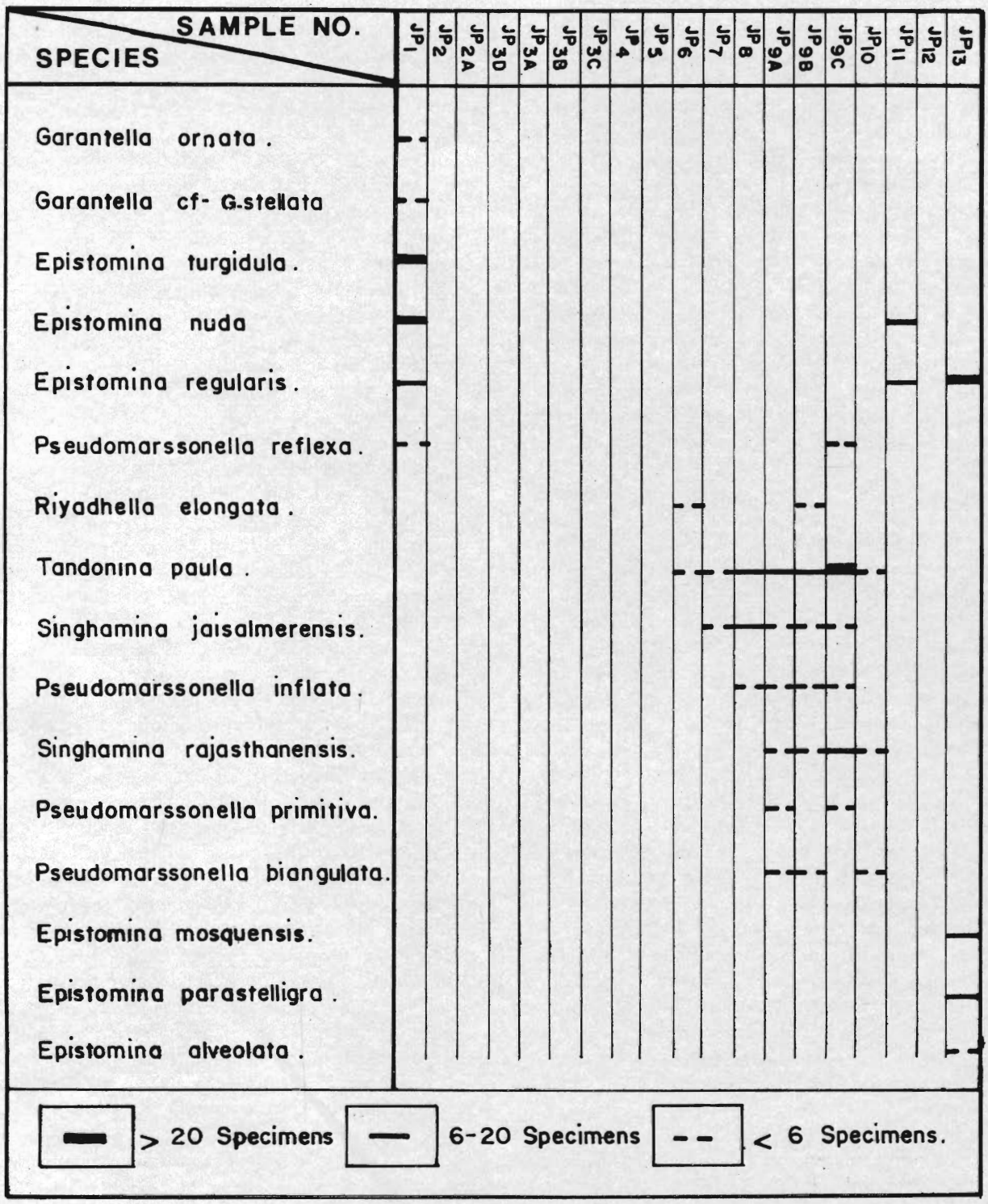

Fig. 3. Distribution of Marker Foraminiferal species in the studied sequence of Jhurio Hill.

foraminiferal assemblage consisting of mainly long ranging species. Biswas (1977) gave a new lithostratigraphic classification in which the Jhurio Formation (= Patcham Formation) takes its name from the type section exposed in Jhurio Hill. He includes a thick sequence of limestone and shales with golden oolites in Jhurio Formation and broadly assigned it a Bathonian (? Middle) to Lower Callovian age.

The foraminiferal assemblage (Fig. 3), *Garantella of. G. stellata, G.ornata, Epistomina turgidula, E. nuda, E.regularis, Pseudomarssonella inflata, P. reflexa, P. primitiva, P. biangulata, Riyadhella elongata, Singhamina rajasthanensis, S. jaisalmerensis* and *Tandonina paula*, found during present investigation is significant in that it throws light on the stratigraphic position of these sediments which is still disputed. The biostratigraphic significance of these species provides evidence in favour of Bathonian age (Fig. 4).

The geographical distribution of age-diagnostic species is as follows: *Garantella ornata*, a species ranging from Bajocian to Callovian is reported from Poland, Germany, Scotian Shelf and Grand Banks. *Garantella stellata*, another important Bajocian to Mid. Bathonian species is known from Madagascar, Poland and Grand Banks. The diagnostic Bathonian species *Epistomina turgidula* is described from Poland and India. *Epistomina regularis*, extending from Bajocian to Callovian, is known from France, Germany, Netherlands, U.S.S.R., Poland, Scotian Shelf, Grand Banks and India, while *Epistomina nuda*, a Bajocian to Callovian marker is reported from France, Poland, Germany and U.S.S.R. The diagnostic ataxophragmiids *Pseudomarssonella* and *Riyadhella*, that have been found in the present assemblage, are known from Bajocian to Mid.Bathonian of Saudi Arabia and Mid.-Up. Bathonian of Jaisalmer, India. The two Mid.-Up.Bathonian duostominids, *Singhamina*, and *Tandonina*, described recently from Rajasthan, India (Garg and Singh, 1986), occur here in abundance and appear to be restricted to the Indian region only — a conclusion valid until reports of their findings from other regions are known.

Gradstein (1976) and Ascoli (1976) studied the stratigraphic significance of *Garantella* and *Epistomina* species, on the basis of which there is now a consensus of opinion that these forms are geographically widespread and can be used as zonal markers for global correlation of coeval Jurassic sequences. Gradstein (1976) defined "*Garantella* spp. Zone" for Lr. Bathonian sequence encountered in Grand Banks which includes *Garantella ornata* and *G.stellata* among diagnostic species. Ascoli (1976) erected "*Garantella oranata* Zone" for Lr. Bathonian of Scotian Shelf and correlated this zone with the "*Garantella* spp. Zone" of Gradstein. Occurrence of these forms in the lowermost bed (Unit JP_1) strongly favours a Bathonian age assignment. Presence of another Bathonian index species *Epistomina turgidula* in the same bed increases the validity of age assignment.

Redmond (1965) has described endemic ataxophragmiids, *Pseudomarssonella biangulata, P.inflata, P.bipartita, P.reflexa, P.media, P.maxima, P.primitiva, P.plicata, P.maclurei, Riyadhella elongata, R.hemeri, R.inflata, R.intermedia, R.nana, R.regularis, R.arabica, R.rotundata* from Up. Bajocian to Lr. Callovian of Saudi Arabia. These two genera have been reported from Mid.-Up. Bathonian of Rajasthan, India (Garg and Singh, 1983). Redmond (1965) utilised these species for detailed biozonation and correlation of the various lithostratigraphic units in many areas of Saudi Arabia and suggested that these species are very helpful in biozonation and correlation. The vertical distribution of these species in Amarsagar Limestone Member of Jaisalmer Formation (Rajasthan, India) has been studied by Garg and Singh (1983) against the background of vertical distribution of similar forms in Dhurma Formation in Saudi Arabia. These workers observed that the distribution of these benthonic species in their area closely approximates the stratigraphic position of the Saudi Arabian assemblage and can be a useful guide to the precise age of Jurassic sediments in Rajasthan. Their conclusion is based on the presence of *Pseudomarssonella inflata, P.biangulata, P.primitiva, P.reflexa, P.bipartita, P.media, Riyadhella elongata, R.regularis, R.arabica, R.intermedia, R.rotundata, R.*cf.*R.nana, Pfenderina inflata, P.*cf.*P.gracilis* along with *Epistomina turgidula & E.regularis.*. The occurrence of some of these species, *Pseudomarssonella inflata, P. reflexa, P. primitiva, P. biangulata, Riyadhella elongata*, in the siltstone horizon (Unit JP_8 - JP_{10}) of Jhurio Hill sediments, important in age determination and correlation of comparable sequence of Ethiopian gulf region, provides a basis to assign a Bathonian age upto the Unit JP_{10}, that is the uppermost part of siltstone horizon. Further Garg and Singh (1986) have described two new genera *Singhamina* and *Tandonina* from the same Mid.-Up. Bathonian horizon of Rajasthan in which *Riyadhella*

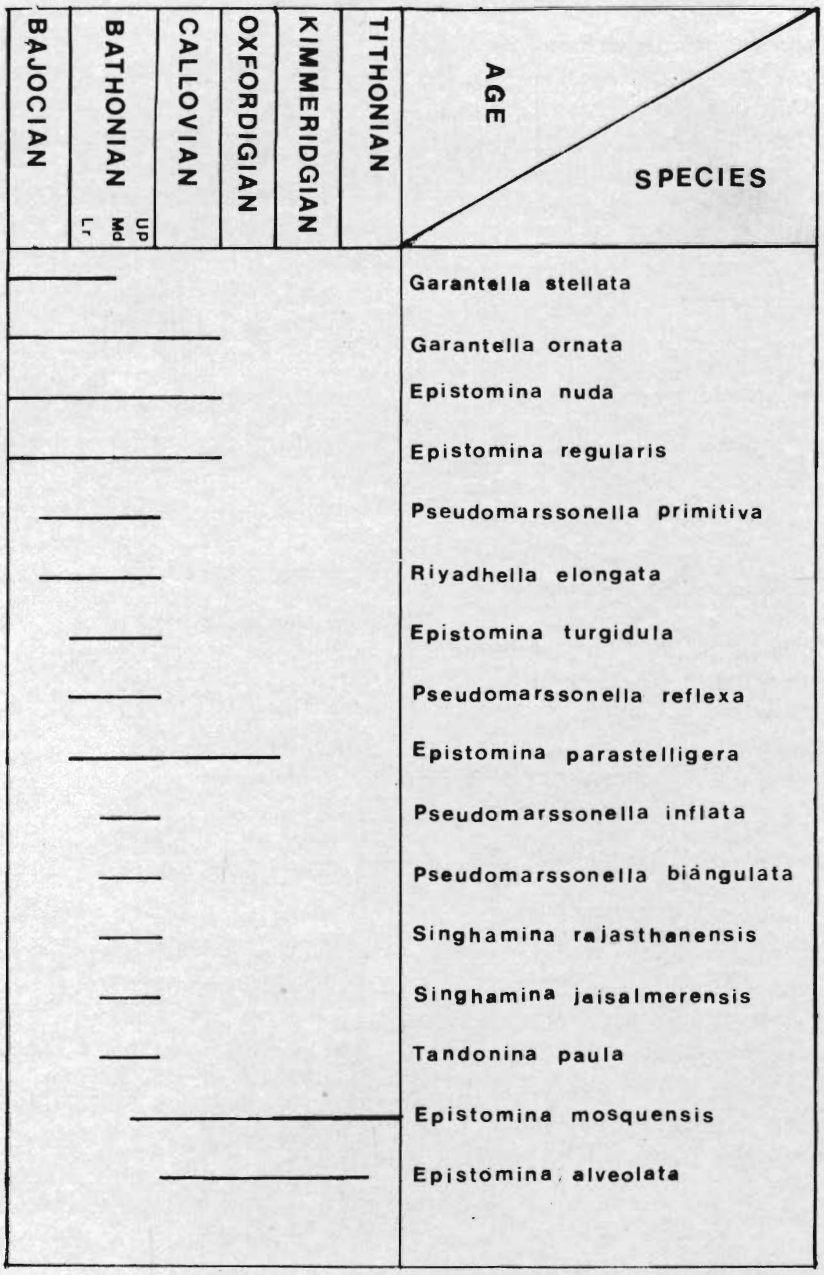

Fig. 4. Stratigraphic ranges of the marker species in the Hesozoic formation of the world.

and *Pseudomarssonella* have been found. These two genera being found in the Jhurio Hill assemblage (Unit JP_6-JP_{10}), also supports the above age assignment. However, these genera are known only from Kachchh and Rajasthan, India.

Thus in contrast to the previous ammonite evidence of Agarwal (1957) and foraminiferal evidence provided by Bhalla and Talib (1985) suggesting Callovian-Oxfordian age for the studied sequence, the present foraminiferal study suggests that the Patcham Formation and basal part of the Chari Formation in Jhurio Hill section are of definite Bathonian age. It is significant to note that Spath (1933) was also of the view that the "*Macrocephalus* Beds" of Kachchh are of Bathonian age.

BATHONIAN-CALLOVIAN BOUNDARY

Presence of *Epistomina nuda* and *E.regularis* (age discussed earlier), in the overlying fossiliferous limestone horizon (Unit JP_{11}) suggests that this horizon belongs to either Bathonian or Callovian because these species are known to occur in the sediments of Bathonian as well as Callovian ages. Few other species of *Epistomina* viz. *E.parastelligera*, *E.mosquensis* and *E.alveolata*, are present in higher horizons (appear in Unit JP_{13}). *E.parastelligera* nd *E.mosquensis* are very rare in Up.Bathonian, while abundantly reported in Callovian; however, *E.alveolata* is known to have its first appearance in Callovian. Thus, the presence of *E.alveolata* together with *E.parastelligera, E.mosquensis* in Unit JP_{13}, suggests that this horizon is definittely of Callovian age. It can therefore be suggested that Bathonian-Callovian boundary lies somewhere between Unit JP_{10} and Unit JP_{13}. However, due to lack of definite index Bathonian forminifera in Unit JP_{11} and presence of Bathonian marker species upto the Unit JP_{10}, the Bathonian–Callovian Boundary may be placed between Unit JP_{10} and Unit JP_{11}.

In the light of the present work, the authors also suggest that the earlier age assignments of different horizons of Kachchh mainland need a thorough revision.

SYSTEMATIC DESCRIPTION

Superfamily Ceratobuliminacea CUSHMAN, 1927
Family Epistominidae WEDEKIND, 1937 emend, BROTZEN, 1942
Subfamily Garantellinae GRIGELIS, 1977
Genus *Garantella* KAPTARENKO-CHERNOUSOVA, 1956

Garantella ornata (HOFKER, 1952)
(Pl.I — 8-10)

Reinholdella ornata — Hofker, 1952, p. 24, figs, 12-16.
Garentella floscula — Kaptarenko-chernousova, 1959, p. 104, pl.13, fig.4.
Garantella ornata — Hofker-Pazdro, 1969, p. 79-80,pl.10, figs.1-3, 6, pl.11, fig.2, pl.15, figs. 3-4.
— Ascoli, 1976, pl.1, fig.7.
— Gardstein, 1976, pl.4, figs.1-2.

Material: 5 specimens.

Dimensions:

Max.diameter of test	0.38 mm. to 0/50 mm.
Min.diameter of test	0.33 mm. to 0/45 mm.
Thickness of test	0.15 mm. to 0.25 mm.

Remarks: *Garantella ornata* (Hofker, 1952) is regarded as the index species of Bajocian-Bathonian. It is widely recorded from Poland, NW Germany, Upper Bajocian of Ukraine, Bathonian of Scotian Shelf and Bajocian to Lr. Bathonian of Grand Bank Wells.

Pazdro (1969) gave a detailed description of *G.ornata* from Bajocian to Lr. Bathonian of Poland. The present forms have 10-14 chambers arranged in 2-2½ whorls, single keel and few knobs and its on the chambers surface. The characters observed are within the variation range of the species.

Occurrence and Age: Yellowish calcareous shale (JP_1), Patcham Formation, Bathonian.

Garantella cf. G.stelllata KAPTARENKO CHERNOUSOVA, 1959
(Pl. I — 4-7)

Garantella stellata — Kaptarenko Chernousova, 1959, p. 105-106 pl. 13, fig. 5 a-c.
— Gradstein, 1976, pl. 4, figs. 3-4.
Garantella cf. G. stellata Kaptarenko - Espitalie and Sigal, 1963, p. 115, pl.2, fig. 7a-c.
— Pazdro, 1969, p.82-83, pl.9, fig. 5.

Material: 2 specimens.

Dimensions:

Max. diameter of test	0.38 mm.
Min. diameter of test	0.35 mm.
Thickness of test	0.23 mm.

Remarks: *Garantella stellata* is known in literature from Bajocian of Madagascar, Bajocian to Lr. Bathonian of Grand Bank Wells, Mid. Bathonian of Poland.

Only two specimens are recovered in the present assemblage. These forms are assigned to *G. stellata* on the basis of ridge like border of the aperture which is the characteristic of the type specimens. The ridge is high and thick.

Occurrence and Age: Yellowish calcareous shale (JP_1), Patcham Formation, Bathonian.

Subfamily Epistomininae WEDEKIND, 1937
Genus Epistomina TERQUEM, 1883
Epistomina turgidula PAZDRO, 1969
(Pl. I — 1-3)

Epistomina turgidula - Pazdro, 1969, p. 66, pl. 7, fig.1, pl.14, figs. 3-4, text figs. 1-2. - Garg & Singh, 1983, p. 119.

Material: 36 specimens.

Dimensions:

Max. diameter of test	0.23 mm. to 0.45 mm.
Min. diameter of test	0.18 mm. to 0.40 mm.
Thickness of test	0.13 mm. to 0.25 mm.

Remarks: The species of *Epistomina turgidula* is originally recorded from Bathonian of Poland by Pazdro (1969). This species is also known from Bathonian of Jaisalmer, India.

The forms being found in Kachchh, have oval to circular test and rough surface. Extinction of umbilical disk towards the periphery gives a false impression of presence of sutures in the studied specimens.

Occurrence and Age: Yellowish calcareous shale (JP_1), Patcham Formation, Bathonian.

Epistomina nuda TERQUEM, 1883
(Pl. I — 11-14)

Epistomina nuda — Terquem, 1883, p. 376, pl.5, fig. 1.
— Terquem, 1886, p.51, pl.5, fig. 17.
— Pazdro, 1969, p.62-64, pl.6, figs. 1-3, 6-8;pl.4, fig.6.
Epistomina stelligera REUSS - Brand & Fahrion, 1937, p.191, pl.12B, fig.20; pl.13, fig.27; pl.14B fig.21.
— Brand & Fahrion, 1962, p.152, pl.20, fig.24.

Material: 34 specimens.

Dimensions

Max. diameter of test	0.28 mm. to 0.50 mm.
Min. diameter of test	0.20 mm. to 0.40 mm.
Thickness of test	0.15 mm. to 0.25 mm.

Remarks: Epistomina nuda Terquem (1883) was originally recorded from Parkinsonia Beds of France. It is also reported in literature from Bajocian-Callovian of Poland, Middle Jurassic of Germany, and Bajocian of U.S.S.R.

The present specimens agree well with *Epistomina nuda* described from Bajocian to Callovian of Poland, except for their circular, entire outline and flush to raised sutures on umbilical side. The specimens described by Pazdro (1969) show lobulate margin and flush sutures on umbilical side.

Occurrence and Age: Yellowish calcareous shale (JP_1), shell limestone (JP_{11}); Patcham Formation, Chari Formation; Bathonian, Callovian.

Epistomina regularis TERQUEM, 1883
(Pl. II — 1-3)

Epistomina regularis — Terquem, 1883, p. 379, pl.6, figs. 1-2, non fig.3.
— Pazdro, 1969, p.44, pl.1, figs. 1-5; pl.2, figs. 1,2,4; pl.13,figs. 1-4,6,pl.14, fig.1.
— Ascoli, 1976, pl.1, fig. 8a-c.
Non-*Epistomina regularis* — Terquem, 1886, p. 55, pl.6, figs. 18-21.
Epistomina bilabiata — Terquem, 1886, p. 56, pl. 6, figs. 22-23.
Voorthuysenia praeornata Bartenstein - Hofker 1954, p. 187, fig. 21 d-e.
Epistomina decorata - Kapterenko-Chernousova, 1959, p. 108, pl.16, fig. 3.

Material: 150 specimens.

Dimensions:

Max. diameter of test	0.30 mm. to 0.35 mm.
Min. diameter of test	0.25 mm. to 0.30 mm.
Thickness of test	0.15 mm. to 0.18 mm.

Remarks: *Epistomina regularis* Terquem (1883) occurs in Mid. Jurassic of France, Germany, Netherland, U.S.A., Scotian shelf, Polland and India.

The forms under study compare well with the forms, described by Pazdro (1969) from Bajocian to Callovian of Poland, in having a lenticular, usually symmetrically biconvex test; ornamented spiral side with distinctly raised, high and pitted sutures; ornamented umbilical side with dense reticulation of prominent ribs but less frequently with bosses and pits, minute tubercles on the chamber surface.

Occurrence and Age: Yellowish calcareous shale (JP_1), shell limestone (JP_{11}, JP_{13}); Patcham Formation, Chari Formation; Bathonian, Callovian.

Superfamily Lituolacea DE BLAINVILLE, 1825
Family Ataxophragmiidae SCHWAGER, 1877
Subfamily Gobotaxtulariinae CUSHMAN, 1927
Genus Pseudomarssonella REDMOND, 1965

Pseudomarssonella inflata REDMOND, 1965
(Pl. II — 6-8)

Pseudomarssonella inflata — Redmond, 1965, p. 134-135, pl. 1, figs. 4-5.
— Garg & Singh, 1983, p. 125, pl. 1, figs. 16-17.

Material: 19 specimens.

Dimensions:

Max. length of test	0.15 mm. to 0.23 mm.
Max. diameter of test	0.13 mm. to 0.20 mm.

Remarks: The Kachchh representatives of *Pseudomarssonella inflata* Redmond (1965) are characterized by short broad test with 4 to 5 chambers in the initial portion, 5-6 whorls of chambers, increasing rapidly in size, flat to concave basal surface with a shallow umbilical area covered with raised umbilical flap, rounded peripheral margin and distinct depressed sutures. The forms reported from Bathonian of Saudi Arabia (Redmond, 1965) differ from the present specimens in having larger size, broader test and angular peripheral margin.

P.inflata Redmond, described from Jaisalmer (Garg & Singh, 1983) are somewhat different from the present specimens mainly in having lobulate periphery, only 4 chambers in their final whorl and their larger size.

Occurrence and Age: Siltstone (JP_8 JP_9), Chari Formation, Bathonian.

Pseudomarssonella primitiva REDMOND, 1965
(Pl. II — 11-12)

Pseudomarssonella primitiva — Redmond, 1965, p.136, pl.1, figs.16-18.
— Garg & Singh, 1983, p. 125-126, pl. 1, figs. 6-7.

Material: 9 specimens.

Dimensions:

Max. length of test	0.23 mm. to 0.30 mm.
Max. diameter of test	0.15 mm. to 0.20 mm.

Remarks: The specimens understudy resemble *Pseudomarssonella primitiva* Redmond (1965), described from Upper Bajocian to Bathonian of Saudi Arabia in, their elongate test, concave to flat basal surface, 4 chambers in the final whorl, bluntly angled peripheral margin. However, they slightly differ from *P.primitiva* in having smaller size and indistinct sutures.

Garg & Singh (1983) also reported *P. primitiva* from Bathonian of Jaisalmer. However, the specimens reported from Jaisalmer have larger size, lobulate periphery, distinct sutures and almost rounded peripheral margin.

Occurrence and Age: Siltsone (JP_{9a}, JP_{9c}), Chari Formation, Bothonian.

Pseudomarssonella biangulata REDMOND, 1965
(Pl. II — 9-10)

Pseudomarssonella biangulata — Redmond, 1965, p. 134, pl.1, fig.1.
— Garg & Singh, 1983, p.123-124, pl.1, figs. 1-3.

Material: 6 specimens.

Dimensions:

Max. length of test	0.20mm. to 0.30mm.
Max. diameter of test	0.15 mm. to 0.20 mm.

Remarks: The forms under study show a great affinity with *Pseudomarsonella biangulata* Redmond (1965) described from Bathonian of Saudi Arabia in having 4 chambers in their final whorl,rate of growth of chambers, depressed sutures and bluntly angled to rounded peripheral margin. However, they differ from *P.biangulata* in having smaller size, flat to depressed basal surface and distinctly depressed sutures.

The species *P.biangulata* Redmond is also reported from Bathonian of Jaisalmer (Garg & Singh, 1983). The forms, being found in Kachchh, closely resemble those of Jaisalmer, except that the present forms have smaller size distinct sutures, flat to concave basal surface and umbilical flap having less but comparatively large apertural pores.

Occurrence and Age: Siltstone (JP_{9A}, JP_{9B}, JP_{10}), Chari Formation, Bathonian.

Pseudomarssonella reflexa REDMOND, 1965
(Pl. II—4-5)

Pseudomarssonella reflexa - Redmond, 1965, p. 136, pl. 1, fig. 19a-b.
— Garg & Singh, 1983, p. 126, pl. 1, figs. 8-12.

Material: 9 specimens.

Dimensions:

Max. length of test	0.25 mm. to 0.30 mm.
Max. diameter of test	0.15 mm. to 0.23 mm.

Remarks: Except in their smaller size and larger initial chambers of the test, the specimens from Kachchh are identical to *Pseudomarssonella reflexa* Redmond described from Bathonian of Saudi Arabia (Redmond, 1965) as well as Bathonian of Jaisalmer (Garg & Singh, 1983).

Occurrence and Age: Yellowish calcareous shale (JP_1), siltstone (JP_{9C}); Patcham Formation, Chari Formation; Bathonian

Genus Riyadhella REDMOND, 1965
Riyadhella elongata REDMOND, 1965
(Pl. II — 13-15)

Riyadhella elongata — Redmond, 1965, p. 136-137, pl.1, figs. 20-21.
— Garg & Singh, 1983, p.127, pl.2, figs. 14-15.

Material: 2specimens.

Dimensions:

Max. lenghth of test	0.38 mm. to 0.43 mm.
Max. diameter of test	0.12 mm. to 0.13 mm.

Remarks: The present specimens are identical to *Riyadhella elongata* Redmond (1965), described from Bajocian to Bathonian of Saudi Arabia with the variation of distinctly depressed sutures.

This species is also reported from Bathonian of Jaisalmer (Garg & Singh, 1983) but are smaller in size and having higher and more inflated chamber in their final whorl.

Ocurrence and Age: Siltstone (JP_6, JP_{9B}), Chari Formation, Bathonian.

Superfamily Duostominacea BROTZEN, 1963
Family Duostominidae BROTZEN, 1963
Genus Singhamina GARG & SINGH, 1986

Singhamina rajasthanensis GARG & SINGH, 1986
(Pl. III — 1-3)

Singhamina rajasthanensis — Garg & Singh, 1986, p.55, pl.14, figs. 1-6, pl. 2, figs. 1-2.

Material: 15 specimens.

Dimensions:

	Specimens from Kachchh range	Specimens from Jaisalmer range
Max. diameter of test	0.25 mm to 0.35 mm.	0.35 mm. to 0.48 mm.
Min. diameter of test	0.20 mm. to 0.30 mm.	0.34 mm. to 0.40 mm.
Thickness of test	0.05 mm. to 0.08 mm.	0.11 mm. to 0.16 mm.

Remarks: The forms of Kachchh, in general, resemble *Singhamina* rajasthanensis Garg and Singh (1986), described from Jaisalmer, in their test morphology, except for few variations i.e. the present specimens differ in having smaller size and sometimes prominently lobulate periphery, much inflated last chamber on umbilical side, early chambers with prominently depressed sutures. In the type specimens the sutures are slighly depressed.

Occurrence and Age: Siltstone ($JP9_A$-$JP10$), Chari Formation, Bathonian

Singhamina jaisalmerensis GARG & SINGH, 1986
(Pl. III — 4-6)

Singhamina jaisalmerensis — Garg & Singh, 1986, p.55-56, pl. 1, figs. 7-13, pl.2, figs. 5-6.

Material- 14 specimens.

Dimensions:

	Specimens from Kachchh range	Specimens from Jaisalmer range
Max.diameter of test	0.20 mm. to 0.30 mm.	0.25 mm. o 0.30 mm.
Min.diameter of test	0.17 mm. to 0.27 mm.	0.21 mm. to 0.30 mm.
Thickness of test	0.5 mm. to 0.08 mm.	0.8 mm. to 0.12 mm.

Remarks: Kachchh representatives of *Singhamina jaisalmerensis* Garg & Singh (1986) differ from those of Jaisalmer only in having more elongate test and prominently lobulate periphery.

Occurrence and Age: Siltstone ($JP7$-$JP9$£), Chari Formation, Bathonian.

Genus Tandonina GARG & SINGH, 1986

Tandonina paula GARG & SINGH, 1986
(Pl.III — 7-9)

Tandonina paula — Garg & Singh, 1986, p.56-57, pl.1, figs. 14-18, pl.2, figs. 3-4.

Material: 75 specimens.

Dimensions:

	Specimens from Kachchh range	Specimens from Jaisalmer range
Max. length of test	0.25 mm. to 0.35 mm.	0.20 mm. to 0.26 mm.
Min. breadth of test	0.20 mm. to 0.30 mm.	0.16 mm. to 0.22 mm.
Thickness of test	0.05mm. to 0.10 mm.	0.06 mm. to 0.08 mm.

Remarks: The specimens of Kachchh are in agreement with those from Rajasthan except for variations in their size range, prominently lobulate to rounded nature of periphery, number of chambers, i.e. 19-25 chambers in 2-3 whorls against 10-22 chambers in 2-2 1/2 whorls and more convex spiral side. The present forms are highly corroded.

Occurrence and Age: Siltstone ($JP6$ -$JP10$), Chari Formation, Bathonian.

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EXPLANATION OF PLATES

PLATE I

1-3. *Epistomina turgidula* Pazdro
1. Spiral view, LUGM CF 36/02 x 115
2. Edge view, LUGM CF 36/03 x 110
3. Umbilical view, LUGM CF 36/01 x 110

4-7 *Garantella cf. G. Stellata* Kaptarenko -Chernousova
4. Spiral view, LUGM CF 28/01 x 89
5. Edge view, LUGM CF 28/01 x 85
6. Umbilical view, LUGM CF 28/01 x 89
7. Umbilical view, LUGM CF 28/02 x 88

8-10. *Garantella ornata* (Hofker)
8. Spiral view, LUGM CF 27/02 x 119
9. Edge view, LUGM CF 27/02 x 104
10. Umbilical view, LUGM CF 27/01 x 100

11-14. *Epistomina nuda* Terquem
11. Spiral view, LUGM CF 37/01 x 107
12. Edge view, LUGM CF 37/03 x 146
13 Umbilical view (showing apertural slits), LUGM CF 37/02 x 93
14. Umbilical view (showing sutures) LUGM CF 37/02 x 92

PLATE II

1-3. *Epistomina regularis* Terquem
1. Spiral view, LUGM CF 31/02 x 130
2. Edge view, LUGM CF 31/01 x 145
3. Umbilical view, LUGM CF 31/03 x 150

4-5. *Pseudomarssonella reflexa* Redmond
4. Oblique apertural view, LUGM CF 83/01 x 356.
5. Side view, LUGM CF 83/01 x 211.

6-8. *Pseudomarrsonella inflata* Redmond
6. Apertural view, LUGM CF 82/02 x 195
7. Oblique apertural view, LUGM CF 82/02 x 165
8. Side view, LUGM CF 82/01 x 170.

9-10. *Pseudomarssonella biangulata* Redmond
9. Oblique apertural viw, LUGM CF 84/01 x 200.
10. Side view, LUGM CF 84/01 x 151.

11-12. *Pseudomarssonella primitiva* Redmond
11. Oblique apertural view, LUGM CF 85/01 x 202.
12. Side view, LUGM CF 85/01 x 190

13-15. *Riyadhella elongata* Redmond
13. Side view, LUGM CF 26/02 x 123
14. Side view, LUGM CF 26/01 x 121
15. Oblique apertural view, LUGM CF 26/02 x 350.

PLATE III

1-3. *Singhamina rajasthanensis* Garg & Singh
1. Oblique umbilical view, LUGM CF 02/01 x 185.
2. Edge view, LUGM CF 02/01 x 190.
3. Spiral view, LUGM CF 02/02 x 175.

4-6. *Singhamina jaisalmerensis* Garg & Singh
4. Oblique umbilical view, LUGM CF 01/01 x 310.
5. Oblique spiral view, LUGM CF 01/01 x 300.
6. Edge view, LUGM CF 01/01 x 290

7-9. *Tandonina paula* Garg & Singh
7. Spiral view, LUGM CF 03/01 x 196.
8. Edge view, LUGM CF 03/02 x 209.
9. Umbilical view, LUGM CF 03/03 x 218.


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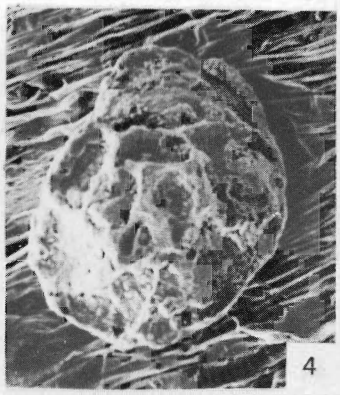
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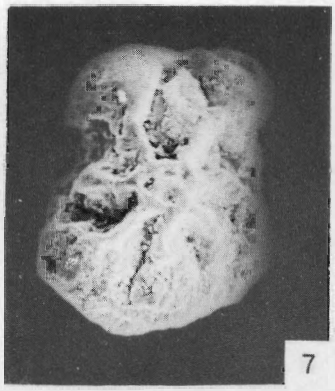
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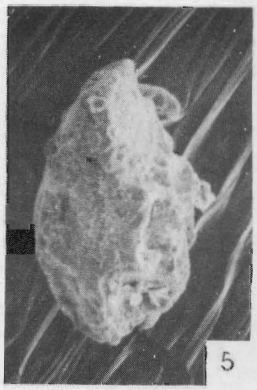
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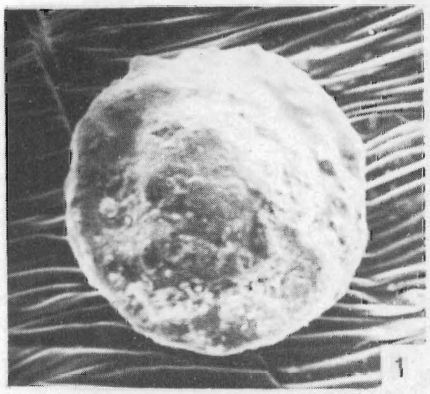
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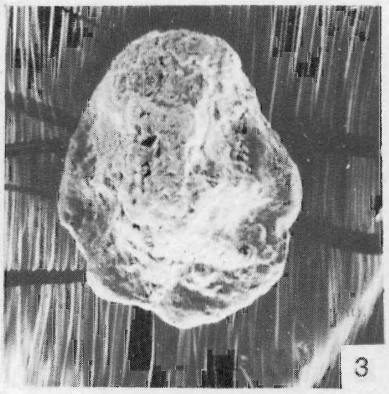
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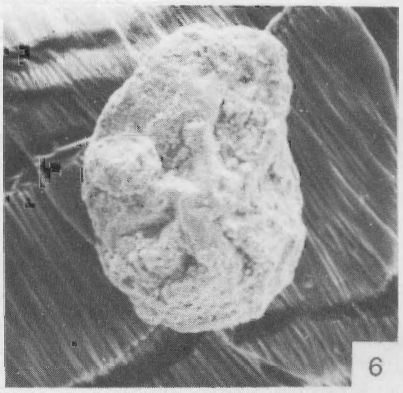
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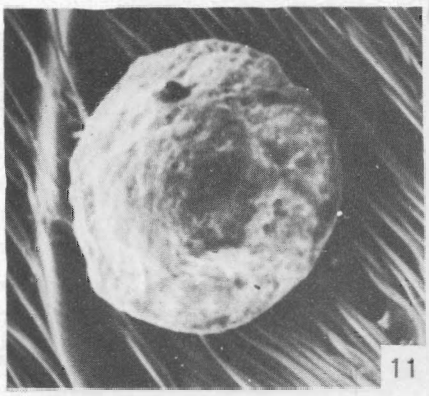
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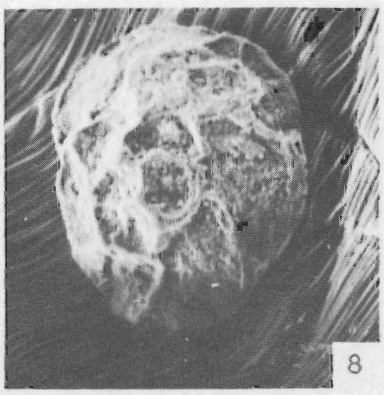
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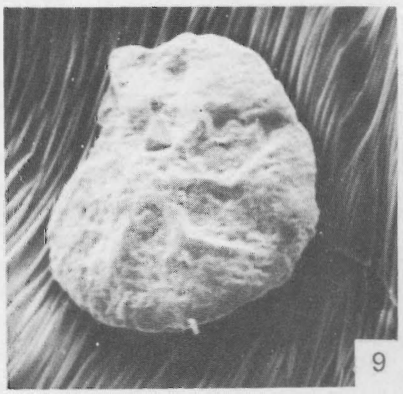
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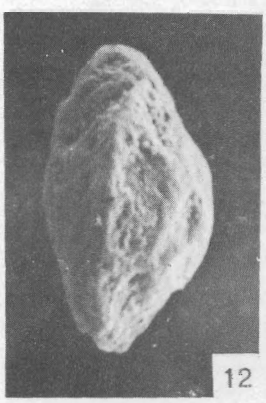
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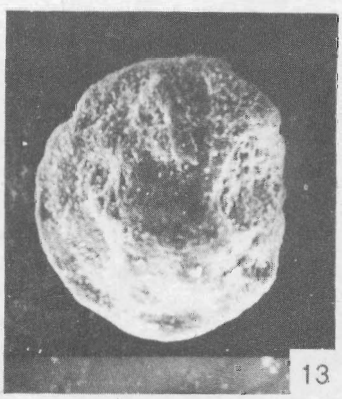
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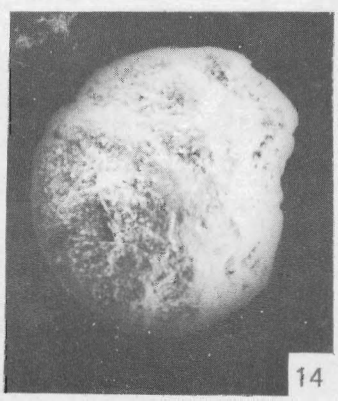
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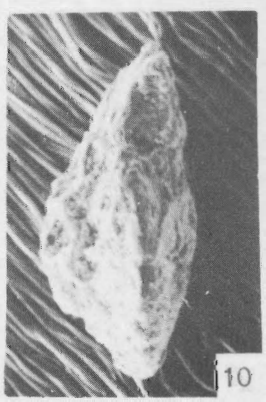
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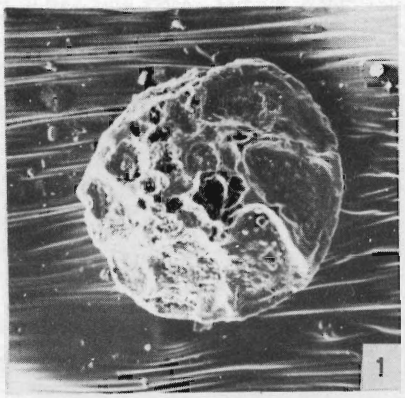
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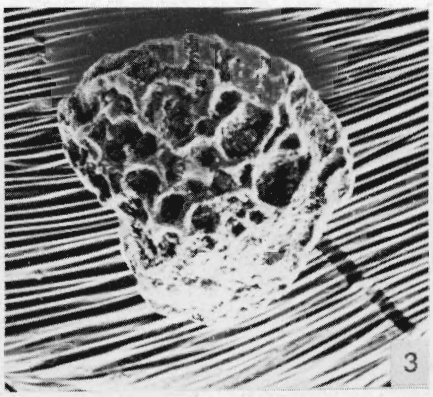
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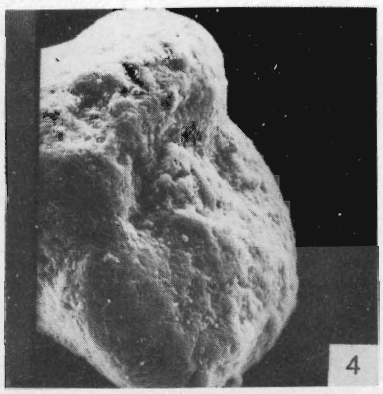
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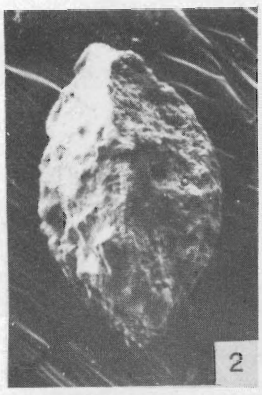
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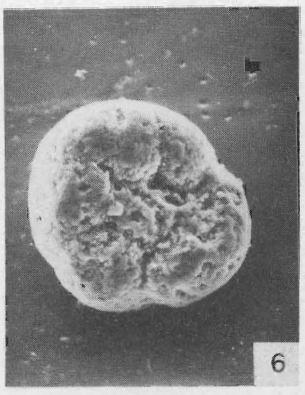
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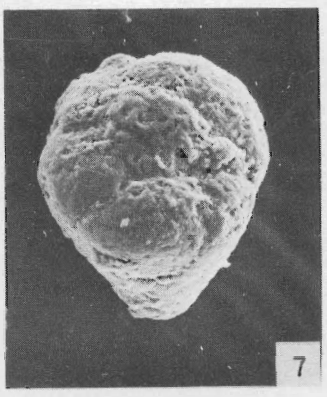
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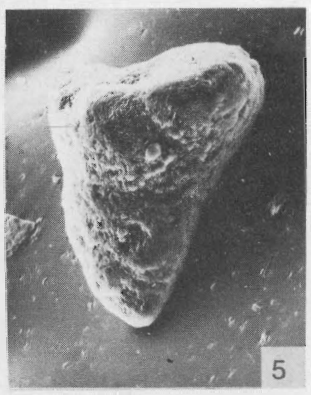
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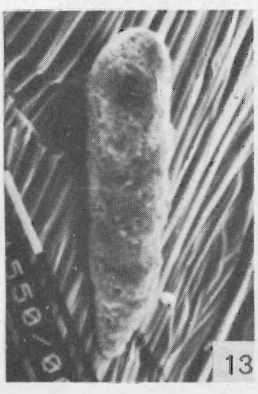
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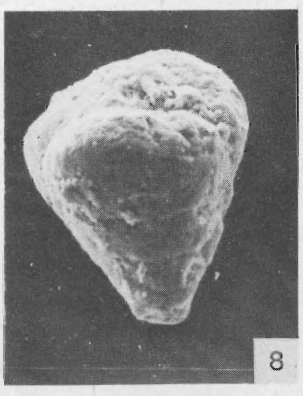
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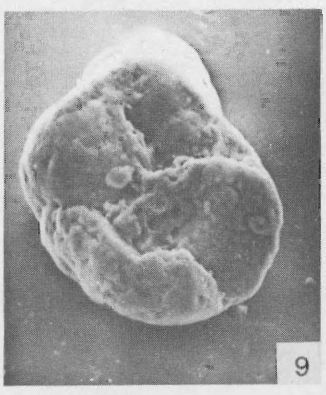
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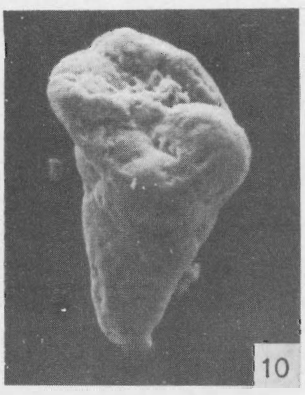
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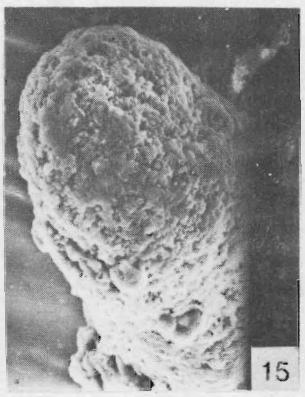
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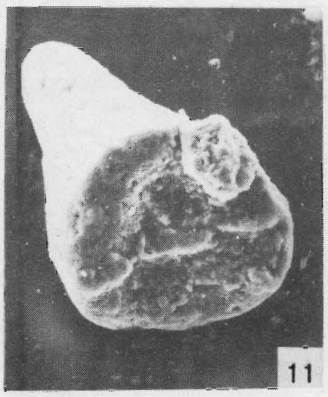
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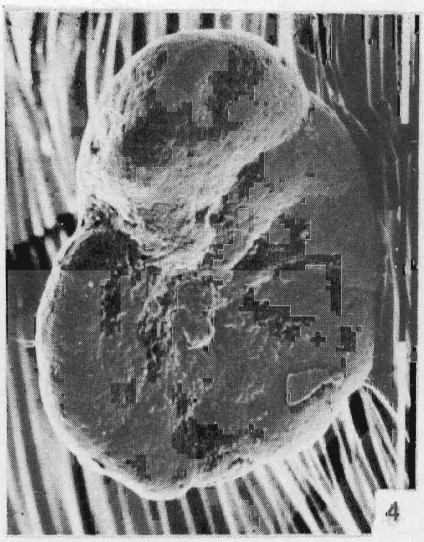
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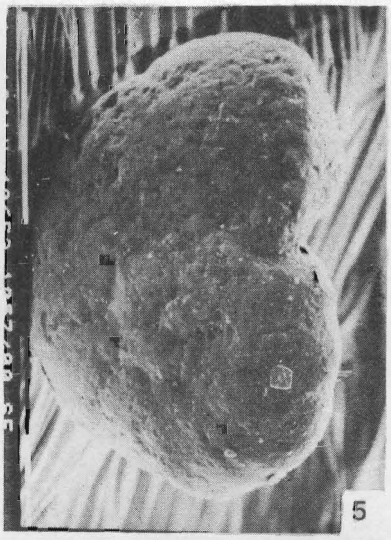
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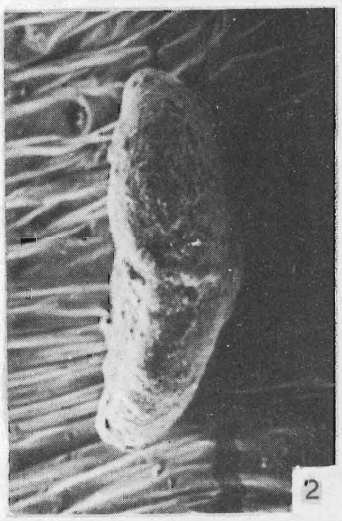
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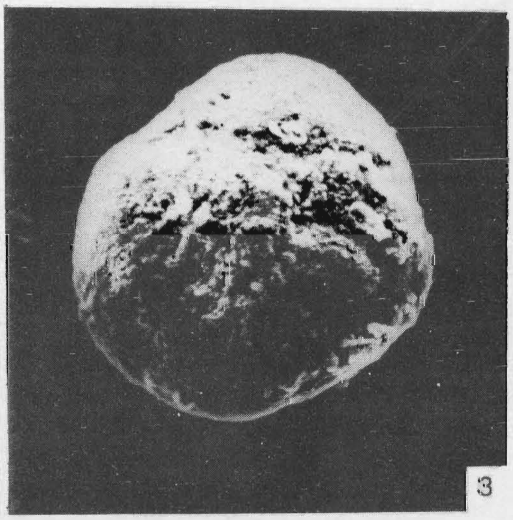
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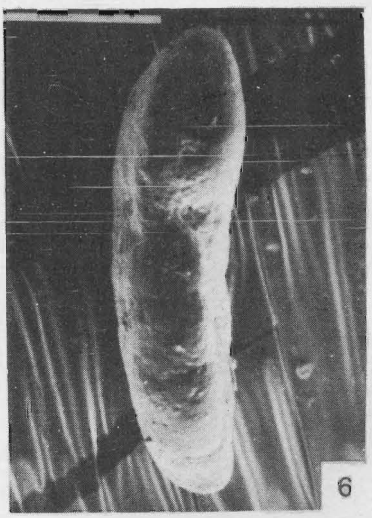
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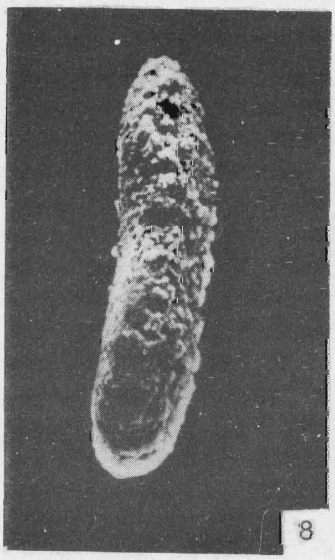
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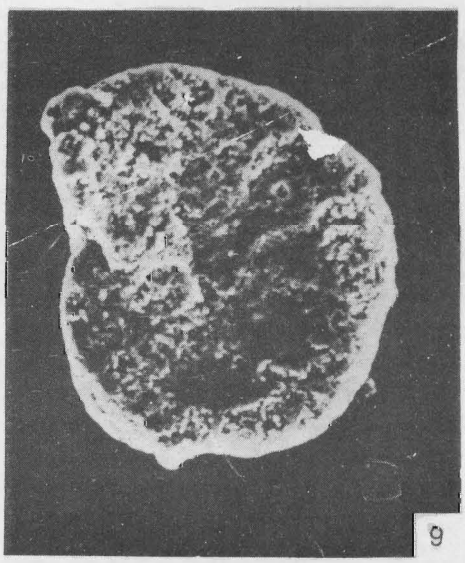
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