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MIOGYPSINIDAE FROM THE ANDAMAN BASIN, INDIA

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ABSTRACT

Eleven species of Miogypsinidae are reported from the subsurface strata in the Andaman Basin. Some of them are illustrated. They are classified and defined unambiguously according to numerical methods proposed by Drooger (1952) and Raju (1974). The *Miogypsina* species include *Miogypsina (Miogypsinoides) complanata. M. (Miogypsinoides) formosensis, M. (Miogypsinoides) bantamensis, M. (Miogypsinoides) dehaartii, M. (Miogypsina) gunteri, M. (Miogypsina) tani, M. (Miogypsina) globulina, M. (Miogypsina) antillea, M. (Lepidosemicyclina) excentrica, M. (Lepidosemicyclina) polymorpha* and *M. (Lepidosemicyclina) bifida.*

The Miogypsinidae are known to be very useful for dating shallow marine or turbiditic sediments, for well to well correlations and for interbasinal correlation in India. Following Drooger *et al.* (1986), the Oligocene/Miocene boundary is taken to be marked by the mean value of X=12.5 (see p.2) i.e. close to the first appearance of *M. (M.) gunteri*. But the presence of planktonic foraminifera such as *Globigerina sellii, G. prasaepis, G. tripartita* and *G. sastrii* at a stratigraphic level much higher than *M.(M.) gunteri* indicates that it could be marked within the *M. gunteri* zone at a level close to the X=11 at least in the Indo-Pacific Province. The *Miogypsina* succession of late Oligocene to early Miocene in well HLO is the best example known from India and one of the best from anywhere in the world. The only limitation is that the recorded assemblages are from well cuttings. The extinction of the youngest *Miogypsina* in this well, namely *M.(M.) antillea* occurs within or just above planktonic foraminiferal zone N12. A high rate of sedimentation is suggested during the Chattian *M. (M.) complanata formosensis* zone time in the area immediately south of Henry Lawrence Island in the Kwangtung Strait area.

During *M.(M.) tani* Zone (late Aquitanian) time, the centre of sedimentary deposition was in the area east of Henry Lawrence Island, near to well AN-32-1. But during the *M. (M.) antillea* Zone the rate of sedimentation was moderate to high around well AN-14-1. This suggests that the depositional centre has shifted during the Late Oligocene, Early Miocene and Middle Miocene.

INTRODUCTION

Since 1980, the Indian Oil & Natural Gas Commission has drilled 10 deep wells in the offshore area east of the Andaman Island. Some of the deep well samples yielded a considerable number of Miogypsinid species. The purpose of this study is to date the sediments and to establish a zonation based on the Miogypsindae. Interbasinal correlation of sections within India is attempted, as is interregional correlation with Europe.

PREVIOUS WORK ON MIOGYPSINIDAE FROM ANDAMAN BASIN

Since the work of Oldham (1885), outcrops of Cretaceous to Recent marine sediments have been recognised in the Andaman Islands. Different lithostratigraphic, biostratigraphic and chronostratigraphic units were proposed by the scientists of GSI, ONGC and Banaras Hindu University, but a full discussion of all previous work is beyond the scope of this paper.

Sastri and Bedi (1962) first reported the occurrence of *Miogypsina,* namely *M. cf. irregularis* from the Andaman Islands. Chatterjee (1964) subsequently reported *Miogypsinoides dehaartii* and *Miogypsina irregularis* from the lower Arenaceous stage of the Archipelago Series. Mohan and Pandey (1971) listed *M. dehaartii, M. globulina* and *Miogypsina antillea* in their fig. 2 and Raju and Chidambaram (1986) have reported five species of Miogypsinidae from deep wells drilled by ONGC in the offshore area east of the Andaman Islands. The two additional species reported by Raju and Chidambaram (1986), but not by previous authors, are *Miogypsina (Miogypsina) tani* and *M. (Lepidosemicyclina) excentrica*. Unfortunately, none of these workers described the *Miogypsina* species or explained their methodology. It is, therefore, unclear how far quantitative methods were employed in studying the Miogypsinidae of the Andaman Basin.

METHODS OF INVESTIGATION

Individual specimens of the Miogypsinidae were sorted from the washed residues, obtained by conventional methods of preparation. Most samples mainly about 20 gms in weight yielded lower than 20 *Miogypsina* specimens. Well preserved specimens were usually obtained.

Drooger (1952, 1963) and Raju (1974) have introduced and explained a number of biometric parameters. However, only those used in species definition are considered in this report. The relevant

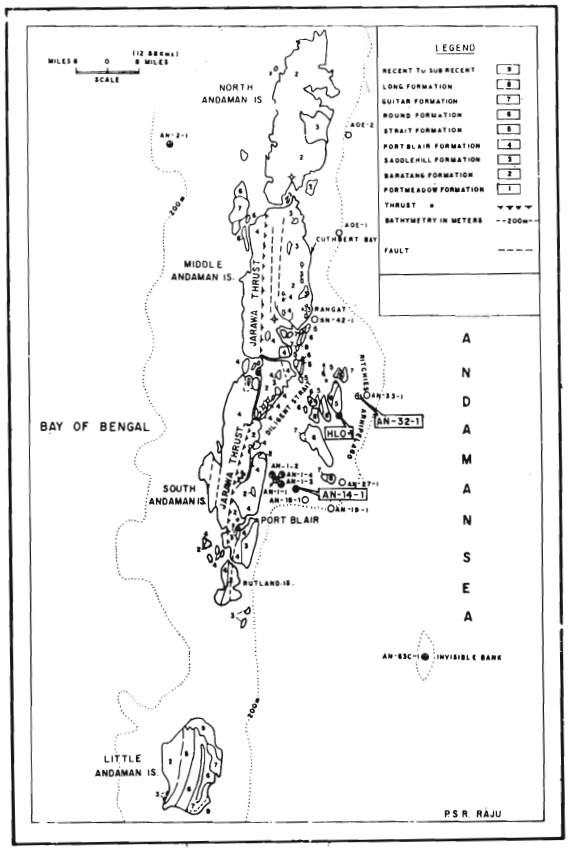

Fig. 1. Location and Geological Map

symbols and definitions are given below:

X = The total number of spirally coiled nepionic chambers excluding both embryonic chambers.

Y = the number of spirally coiled nepionic chambers up to, and including the first one with a distal stoloniferous opening and excluding the embryonic chambers; hence up to the beginning of equatorial growth ascertained from the first distinct equatorial chamber.

V = $200\,\alpha/\beta$ gives the degree of symmetry of the protoconchal nepionic spirals. The scale ranges from zero to 100.

α = the arc length of the circumference of protoconch section underlying the smaller spiral.

β = the arc length of the circumference of protoconch underlying both protoconch spirals.

DI = diameter of the protoconch, and

DII = diameter of the deutroconch, both diameters including half of the thickness of the walls and both taken at right angles to the line connecting the centres of these embryonic chambers. Both diameters are measured in microns.

γ = Angle, lying in the median section and formed by the apical - frontal line through the centre of the protoconch and the line connecting the centre of the embryonic chambers.

All the *Miogypsina* species are determined on the basis of numerical classification of Drooger (1952) and Raju (1974).

TAXONOMY

A short review of pertinent data will be given on the species recognised from Andaman Basin. All the slides were deposited in the Regional Laboratory, ONGC, Madras.

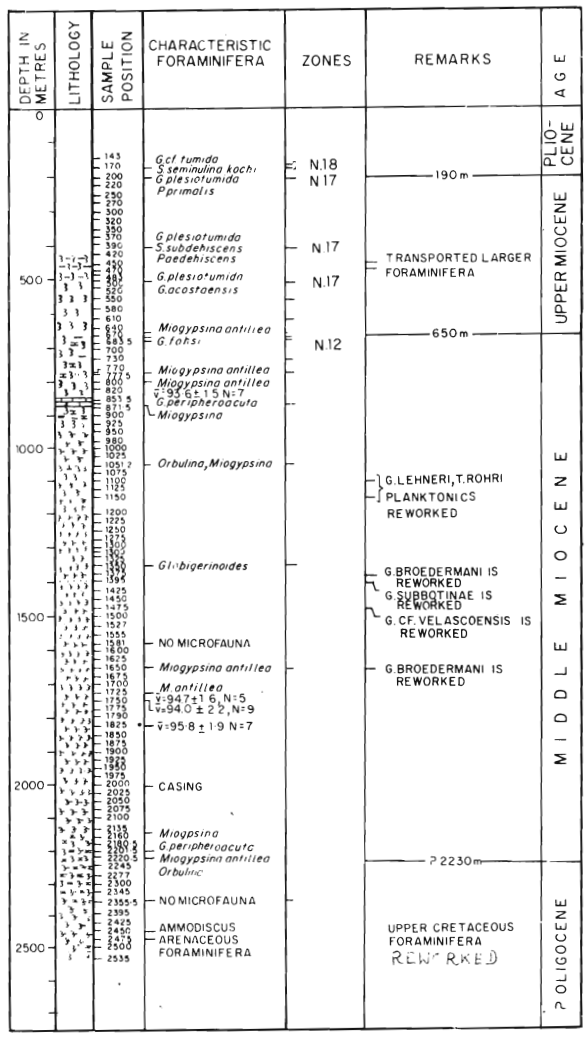

Fig. 2. The Oligocene–Pliocene succession in the well an–14–1, Andaman Basin.

Miogypsina (Miogypsinoides) complanata SCHLUMBERGER
(Plate I — 6, Plate II — 7,8)

Miogypsina complanata Schlumberger, 1900, p. 330, pl.2 figs. 13- 16; pl.3, figs. 18-21
Miogypsina (Miogypsinoides) complanata Schlumberger, Raju, 1974, p.78-79, pl.1, figs. 6-9; pl.3, figs. 3-9

Location and samples : Cutting samples at 1300m, 1275m 1105m, 1075m, and 1055m; Well HLO, Andaman Basin.

Diagnosis : Populations of *Miogypsinoides* with value of $\overline{X}$ greater than 17.

Distribution in India : Kutch, Bombay Offshore, Cauvery Basin, Krishna-Godavari Basin and the Andaman Basin.

Miogypsina (Miogypsinoides) formosensis YABE AND HANZAWA
(Plate I — 9)

Miogypsina (Miogypsinoides) dehaartii Van der Vlerk var. formosensis Yabe and Hanzawa, 1928, p.534, figs. la-b.
Miogypsina (Miogypsinoides) formosensis Yabe and Hanzawa, Raju, 1974, p.79, pl.4 fig.1.

Locality and Samples : Cutting samples at 1325 m, 1250 m, 1200 m, 1180m, 1100m; Well HLO, Andaman Basin.

Diagnosis : Population of *Miogypsinoides* with value of $\overline{X}$ between 17 and 13.

Distribution in India : Kutch, Cauvery Basin and Andaman Basin.

Miogypsina (Miogypsinoides) bantamensis (TAN SIN HOK)
(Plate II — 5,6,9; Plate IV — 3,4,5,6; Plate VI —7,8)

Miogypsinoides complanata forma bantamensis Tan Sin Hok, 1936, p.48-50. pl.1, fig. 13.
Miogypsina (Miogypsinoides) bantamensis (Tan Sin Hok), Raju, 1974, p.79-80, pl.1, figs. 10-13, pl.5, fig. 4

Locality and Samples : Cuttings between 975 and 700 m in Well HLO, Andaman Basin.

Diagnosis : Population of *Miogypsinoides* with values of X between 13 and 10.

Remarks: The samples from Well HLO contain both *Miogypsina (Miogypsinoides) bantamensis* and *Miogypsina (Miogypsina) gunteri*. However, no clear distinction is made between the two species.

Distribution in India : Cauvery Basin and Andaman Basin.

Miogypsina (Miogypsina) gunteri COLE
(Plate I — 3)

Miogypsina gunteri Cole, 1938, p.42, figs. 10-12; 14; pl.8, figs. 1-9
Miogypsina (Miogypsina) gunteri Cole, Raju, 1974, p.81-82, pl.1, figs. 14-18

Locality and samples : Cuttings between 975 m and 700 m in Well HLO, Andaman Basin.

Diagnosis : Population of *Miogypsina* s.s with values of X between 12.5 and 9.

Distribution in India : Cauvery and Andaman basins.

Miogypsina (Miogypsina) tani DROOGER
(Plate V — 5,7,8; Plate VI — 7)

Miogypsina (Miogypsina) tani Drooger, 1952, p.26-27, 51-52; pl.2, figs. 20-24, pl. 3, figs. 2a-b.
Miogypsina (Miogypsina) tani Drooger, Raju, 1974, p.82, pl.1 figs. 26-30; pls. 5, fig. 5.

Locality and samples : Cutting samples at 650 m and 605 m from Well HLO and cuttings at 2500m, 2070m, 1550m from AN-32-1.

Diagnosis : Populations of *Miogypsina* s.s. with values of $\overline{X}$ between 9 and negative value of $\bar{r}$.

Distribution in India : Kutch, Bombay Offshore, Kerala Basin, Cauvery Basin, Krishna-Godavari Basin and Andaman Basin.

Miogypsina (Miogypsina) globulina (MICHELOTTI)
(Plate I — 4,5; Plate V — 6)

Nummulites globulina Michelotti, 1841, p.297, pl.3, fig. 6
Nummulites irregularis Michelotti, 1941, p.297, pl.3, fig. 5
Miogypsina (Miogypsina) globulina (Michelotti) Drooger and Socin, 1959, p. 420, pl.1 figs. 5-6.
Miogypsina (Miogypsina) globulina (Michelotti), Raju, 1974, p.82-83, pl.2, figs. 1-4; pl.5, figs. 6-7; pl.6, fig.1

Locality and samples : Cuttings at 780 and 1000m in Well AN-32-1, Andaman Basin.

Diagnosis : Populations of *Miogypsina* s.s. with $\overline{V}$ values between zero and 45 and values of $\bar{r}$ positive. An additional feature is that more than 50% of specimens per sample have a second principal auxiliary chamber.

Distribution in India : Kutch, Saurashtra, Bombay Offshore, Kerala Basin, Cauvery Basin, Krishna-

Godavari Basin, Mahanadi Basin, Bengal Basin and Andaman Basin.

Miogypsina (Miogypsina) antillea (CUSHMAN)
(Plate I — 1,2; Plate V — 1,2,3,4)

Heterosteginoides antillea Cushman, 1919, pl.5, figs. 5-6.
Miogypsina antillea (Cushman), Drooger, 1952, p.42, 56, pl.2, figs. 45-49
Miogypsina (Miogypsina) antillea (Cushman), Raju, 1974, p.84, pl.2, figs. 23-29 pl.5, fig.9,; pl.6, figs. 7-8.

Locality and samples : Cutting samples at 2220.5 m, 1825m, 1800m, 1750m, 1725m, 1650m, 810m and 800m from Well AN-14-1.

Diagnosis : Population of *Miogypsina* s.s. with values of $\overline{V}$ between 70 and 100, usually greater than 90. In more than 50% of the specimens per sample, the value of V should be greater than 90.

Distribution in India : Cauvery, K.G. and Andaman basins.

Miogypsina (Lepidosemicyclina) excentrica
(TAN SIN HOK)

Miolepidocyclina excentrica Tan Sin Hok, 1937, p.40-42, pl.1, fig. 12; pl.II, figs 1-7,8,9; pl.III, figs. 1-9
Miogypsina (Lepidosemicyclina) excentrica (Tan Sin Hok), Raju, 1974, p.86-87; pl.2, figs. 12-22; pl.4, figs 8,9; pl.7, figs. 1- 10

Locality and samples : Cutting sample at 830 m in AN-32-1

Diagnosis : Population of *Lepidosemicyclina* with distinct accessory auxillary chambers around the deuteroconch, at least more than 50% of the specimens per sample. Value of $\overline{V}$ are usually greater than 90.

Distribution in India : Kutch, Bombay Offshore, Cauvery Basin, KG Basin, Mahanadi Basin and Andaman Basin.

Miogypsina (Miogypsinoides) dehaartii
(VAN DER VLERK)
(Plate I — 7,8; Plate II — 1,2,3; Plate VI — 4,5)

Miogypsina dehaartii Van der Vlerk, 1924, p.429-432, text figs. 1-3, Drooger 1953, p.110-114, pl.1, figs. 15-19, 20-26. Van der Vlerk, 1966, p.422-423 pl.1, figs. 7-10, pl.2, fig.1
Miogypsinoides dehaartii Van der Vlerk var. *pustulosa* Hanzawa, 1940, p, 780-782, pl.40, figs.9-29; pl. 42, fig.13.

Locality and samples : Cutting samples 2080-2085 m from Well AN- 32-1

Diagnosis : Population of *Miogypsinoides* with values of $\overline{X}$ below 10 and negative values of $\bar{r}$. An additional feature is that the values of Y are greater than 0.75. Conical variants may be present.

Distribution in India : Cauvery and Andaman basins.

Miogypsina (Lepidosemicyclina) polymorpha
(RUTTEN)
(Plate III — 1,2,3,4; Plate VI — 1,2,3)

Miogypsina (Lepidosemicyclina) polymorpha Rutten, 1911, p 1143- 1161, van Vessem, 1977, p.421-428.

Locality and samples : Cutting samples at 857m. 1750m, 2220.5m and 2500m from Well AN-14-1.

Diagnosis : Following the work of van Vassem (1977) and our observations, the characteristic features of *M.(L.) polymorpha* appear to be: 1) More than 2 stolons are present in Chamber III; 2) presence of small accessory auxillary chambers on Character II and 3) presence of elongate hexagonal equatorial chambers immediately after the embryonic-nepionic stage.

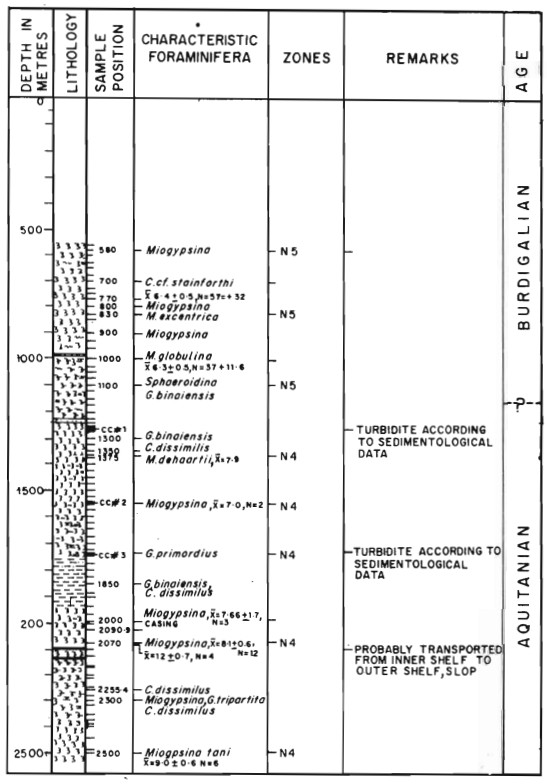

Fig. 3. Miocene Succession in the Well AN-32-1, Andaman Basin

Distribution in India : Cauvery and Andaman basins.

Miogypsina (Lepidosemicyclina) bifida (RUTTEN)
(Plate III — 5,6; Plate VI — 6)

Miogypsina (Lepidosemicyclina) bifida Rutten, p.1143-1161, van Vessem 1977, p.421 to 428.

Locality and samples: Cutting samples at 770-780 m in AN-32-1 Well.

Diagnosis : In equatorial sections, protoconch circular, and deuteroconch semilunar and larger than the protoconch which it practically embraces. The third and fourth nepionic chambers are also large and the fourth nepionic chamber is triangular and points towards the frontal margin.

Remarks : As very few perfect sections were obtained, biometric methods could not be applied. According to van Vessem (1977), Drooger (1953) examined specimens of both *M.(L.) polymorpha* and *M.(L.) bifida* and stated that biometric differences. in V, D and Y were insufficient to distinguish them.

Distribution in India : Cauvery and Andaman basins.

REMARKS ON PHYLOGENY

Raju (1973, 1974) has discussed in detail the evolutionary trends in Indian Miogypsinidae. Later, Drooger and Raju (1978) proposed four evolutionary models based on investigations of larger foraminifera, which include the Miogypsinidae.

The succession of *M. (Miogypsinoides) complanata* and *M. (Miogypsinoides) formosensis* with fluctuating values of $\overline{X}$ in the interval between 1600 and 1000m in Well HLO suggests pulsating evolution.

The succession of *M.(M.) gunteri/bantamensis* and *M. (Miogypsina) tani* in the interval from 975 to 605 m in Well HLO and the data on M. tani from 2500 to 1550 m in Well AN-32-1 suggest a gradual evolution.

On the other hand, the data of $\overline{V}$ on *M.(Miogypsina) antillea* from 2220.5 to 670 m in Well AN-14-1 suggest near arrested evolution (stasis).

BIOSTRATIGRAPHY

The evolutionary trends in the Miogypsinidae were fairly well reconstructed (Drooger, 1952, 1963 and Raju, 1974). The limits of all the *Miogypsina* species were defined numerically so that there can be little ambiguity. This increases precision. The following zones are defined below:

1. *Miogypsina (Miogypsinoides) complanata-formosensis* Range Zone

Definition : Equivalent to the combined ranges of *M.(M.) complanata* and *M.(M.) formosensis*

Reference section : This zone is well developed in the interval from 1600 to 1000 m in the Well HLO. The mean values of X fluctuate within this interval.

Remarks : This zone was recognised in the type section of the Waiorian stage, Kutch; and in the Cauvery, Bombay Offshore and K.G. basins.

Age : Drooger (several publications), Raju (1974), Drooger and Raju (1978) and Drooger and Lagland (1986) have equated this zone with the Chattian stage, Late Oligocene. The duration of this zone according to Drooger and Lagland (1986) is 2 million years (24 to 26 m years).

2. *Miogypsina (Miogypsina) gunteri* Range Zone

Definition : Equivalent to the total range of *M.(M.) gunteri*.

Reference section : This zone is well developed in the interval from 975 to 700 m in the Well HLO. *Miogypsina (Miogypsinoides) bantamensis* also occurs in this interval.

Remarks : Earlier recognised in the Cauvery Basin (Raju, 1974).

Age : Equivalent to the lower part of the Aquitanian Stage in France.

3. *Miogypsina (Miogypsina) tani* Range Zone

Definition : Equivalent to the total range of the nominate zonal marker.

Reference section : Well developed in the interval from 2500 to 1550 m in the Well AN-32-1.

Remarks : Also recognised in the Well HLO. *M.(M.) tani* zone was recognised in Kutch, Bombay Offshore, Kerala, Cauvery and the K.G. basins.

Age : Equivalent to the middle and upper parts of the Aquitanian Stage in France.

4. *Miogypsina (Miogypsina) globulina* Interbiohorizon Zone

Definition : Lower limit defined by the last occurrence of *M.(M.) tani* and the upper limit by the first

occurrence of *Miogypsina (Lepidosemicyclina) droogeri*.

Reference section : Not designated

Remarks: This zone has been recognised in Well AN-14-1 and in Kutch, Saurashtra, Bombay Offshore, Kerala Basin, Cauvery Basin and Bengal Basin.

Age: Equivalent to the lower part of the Burdigalian stage.

5. *Miogypsina (Lepidosemicyclina) droogeri-excentrica* Range Zone

Definition : The combined ranges of *M.(L.) droogeri* and *M.(L.) excentrica*.

Reference section : Well AN-32-1.

Remarks : This zone is well established and has proved useful in the correlation of sections in Kutch, Bombay Offshore, Kerala Basin, Cauvery Basin, K.G. Basin and Mahanadi Basin.

Age : Equated with planktonic foraminiferal zone N6 and lower N7, and thus equivalent to the upper part of Burdigalian Stage.

6. *Miogypsina (Lepidosemicyclina) polymorpha* Interbiohorizon Zone:

Definition : Lower limit defined by the extinction of *M.(L.) excentrica*, and the upper limit by the first appearance by of *M. (Miogypsina) cushmani*.

Reference section : Thirupundi Deep Well, Cauvery Basin.

Remarks : So far this zone has been recognised in the Cauvery and Andaman basins but its status in the latter area is unclear.

Age : Indirectly correlated with the uppermost Burdigalian Stage and the lower part of the Langhian Stage.

7. *Miogypsina (Miogypsina) antillea* Range Zone:

Definition : Equivalent to the total range of *M.(M.) antillea*.

Reference section : 2220.5 to 670 m in Well AN-14-1.

Age : Middle Miocene

OLIOGENE-MIOCENE BOUNDARY

The *Miogypsina* succession of late Oligocene to early Miocene age from Well HLO is the best example known from India and one of the best from anywhere in the world. The only limitation is that all assemblages are recorded from cuttings.

In the interval from 1600 to 1000m *M. (Miogyp-*

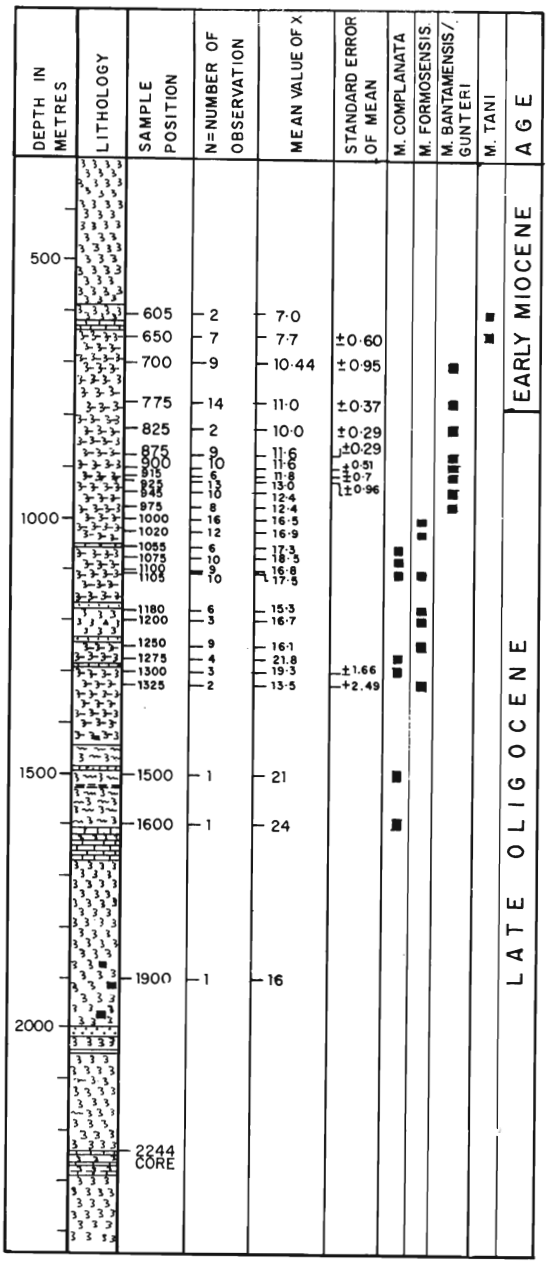

Fig. 4. The Late Oligocene – Early Miocene Succession in the Well HLO Andaman Basin

sinoides) complanata and *M.(M.) formosensis* are found (Fig.4). The fluctuating trend in the mean values of X may be due to pulsating evolution (Drooger and Raju, 1978; M. Drooger *et.al.*, 1979) to occasional contamination through cavings from higher strata in the well, or to thrust faulting. Our present interpretation is that the probable cause is pulsating evolution.

In the interval from 975 to 700 m, *M. (Miogypsina) gunteri* and *M. (Miogypsinoides) bantamensis* are found. In the higher part, from 650 to 605 m, *M. (Miogypsina) tani* and *M. (Miogypsinoides) dehaartii* occurs.

All these species are defined numerically following Drooger (1952) and Raju (1974). The section containing *M. complanata* and *M. formosensis* is correlated with the Chattian, while the section with *M. gunteri* and *M. tani* is referred to the Aquitanian.

The sharp fall in the mean values of X from 15.5 to 12.4 at depths between 1000 and 975 m is remarkable. *Miogypsina* s.s. probably appears close to this change in $\overline{X}$ values. Following the proposal of Drooger *et. al.* (1986) and the sharp change in $\overline{X}$, the Oligocene-Miocene boundary can be marked at 975 m in HLO. *However Globigerina sastrii, G. selli, G. cf. tripartita, G. rohri and G prasaepis* occur at depths between 650 m and 775m in HLO Well. These species are known to disappear in Zone N3 and their association suggests an Oligocene age. *Miogypsina tani* is associated with them. If, however, planktonic foraminifera are taken into account, the Oligocene-Miocene boundary falls within the *Miogypsina tani* Zone at a mean value of X around 7.5. On the basis of Nannofossil assemblages and Miogypsinidae Raju *et al.* (MS) marked this boundary at the level of the mean value of X=11 in *Miogypsina* scale. Thus, there are three alternatives for marking Oligocene-Miocene boundary. It may be noted that Late Oligocene (Chattian) sediments are about 1275 m thick in Well HLO.

CONCLUSIONS

Eleven species of miogypsinidae are recorded from the Andaman Basin, nine of them having been previously defined unambiguously by Raju (1974). Consistency in defining species has helped in dating the subsurface sediments, in well to well correlation and in interbasinal correlation. Since the European stratotypes of the Chattian, Aquitanian and Burdigalian stages contain Miogypsinids and as similar numerical methods are used for discriminating between species, direct correlation between the two regions is possible.

The Oligocene-Miocene boundary in India may be drawn at the transition from *M. formosensis* to *M. bantamensis* at $\overline{X}$ = 12.5, or within *M. tani* zone or at the mean value of X=11. The extinction of *M.(L.) excentrica* has been found to be a Burdigalian datum horizon for interbasinal correlation. The extinction of the youngest species, *M. antillea*, is found to be at a level of Zone N12 or lower part of Zone N13 of Blow's (1969) planktonic foraminiferal zonal scheme.

The present study demonstrates that the Miogypsinidae from deep well cutting samples with control from a few side wall cores can be successfully used in dating and correlation.

Miogypsinid data suggest that the centre of deposition during *M. complanata-formosensis* Zone and *M. gunteri* Zone time (Late Oilogocene to earliest Early Miocene) was in an area immediately south of Henry Lawrence Island. A moderate to high rate of sedimentation is indicated. During *M. tani* Zone (Late Aquitanian) time, the depositional centre was in an area east of Henry Lawrence Island, near to well AN-32-1. The rate of sedimentation was high. During *M. antillea* Zone time, the rate of sedimentation was moderate to high around Well AN-14-1.

These data suggest that the centre of deposition shifted continuously from Late Ologocene, to Middle Miocene time.

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EXPLANATION OF PLATES

PLATE I

1 & 2 *Miogypsina (Miogypsina) antillea* (Cushman) x 62, specimen from the cutting samples at 1750-1755m AN-14-1, Well.

3 *Miogypsina (Miogypsina) gunteri* Cole, x 50; specimen from the cutting samples at 875-88m, HLO Well.

4 & 5 *Miogypsina (Miogypsina) globulina* (Michelotti), x 27, 5:x 46 specimen from the cutting samples at 820-830m, An-32-1 Well.

6 *Miogypsina (Miogypsinoides) complanata* Schlumberger, *X 41, specimen from the cutting samples at 1150-1110m HLO Well.*

7 & 8 *Miogypsina (Miogypsinoides) dehaartii cupuleaformis* Vander Vlerk X 58, specimen from the cutting samples at 1820-30m, An-32-1 Well.

9 *Miogypsina (Miogypsinoides) formosensis,* Yabe and Hanzawa X 65, specimen from the cutting samples at 1050-55m, HLO Well.

PLATE II

1,2,3 *Miogypsina (Miogypsinoides) dehaartii* Vander Vlerk X 53,specimen from the cutting samples at 650-655m HLO Well. 2 & 3 X 46, specimen from the cutting samples at 680-685m HLO Well.

4 *Miogypsina (Miogypsina) tani* Drooger, X 55, specimen from the cutting samples at 650-655m, HLO Well.

5 & 6 *Miogypsina (Miogypsinoides) bantamensis* (Tan Sin Hok), 5: X 53, specimen from the cutting samples at 925-930m, HLO Well. 6: X 61, specimen from the cutting samples 950-955m HLO Well.

7 & 8 *Miogypsina (Miogypsina) complanata*, Schlumberger, showing pararotalia stage, 7: Enlargement X 64, specimen from the cutting samples at 1525-1530m, HLO Well. 8: X 73, specimen from the cutting samples at 1525-1530m.

9 *Miogypsina (Miogypsinoides) bantamensis* (Tan Sin Hok), Enlargement X 78, specimen from the cutting samples at 925-930m, HLO Well.

PLATE III

1,2, 3,4 *Miogypsina (Lepidosemicyclina) polymorpha* Rutten 1: X 43, 2: X 39, 3: X 33, 4: X 30, specimens from the cutting samples at 2220- 2225m, An-14-1 Well.

5 & 6 *Miogypsina (Lepidosemicyclina) bifida* Rutten 5: X 33, 6: X 21, specimens from the cutting samples at 770-780m, An-32-1 Well.

PLATE IV

(Median Sections)

1 & 2 *Miogypsina (Miogypsinoides) complanata* Schlumberger.

1: Enlargement X 100, Microspheric, specimen from the cutting samples at 1250-1255m, HLO Well.

2: Enlargement X 76, specimen from the cutting samples at 1095-1100m, HLO Well.

3,4,5, 6,7,8 *Miogypsina (Miogypsinoides) bantamensis* (Tan Sin Hok).

3: X 43, specimen from the cutting samples at 825-830m, HLO Well (Mean value of X is 10).

4: X 72, specimen from the cutting samples at 775-780m, HLO Well (Mean value of X is 11)

5: X 46,
6: X 69, specimens from the cutting samples at 870-875f m, HLO Well (Mean value of X is 11.6)

7: X 72,
8: X 59, specimens from the cutting samples at 775-780m, HLO Well (Mean value of X is 11)

PLATE V

(Median Sections)

1,2, 3,4 *Miogypsina (Miogypsina) antillea* (Cushman) 1: X 49, 4: 85, specimens from the cutting samples at 1825-1830m, An-14-1 Well (Mean value of V is 95.81)

2: X 103, 3: X 75, specimens from the cutting samples at 1750- 1755m, An-14-1 Well (Mean value of V is 93.95)

5 *Miogypsina (Miogypsina) tani* Drooger, X 50, specimen from the cutting samples at 650-655m, HLO Well (Mean value of X is 7.71)

6 *Miogypsina (Miogypsina) globulina* (Michelotti), X 41, specimen from the cutting samples at 770-80m, An-32-1 Well (mean value of X is 6.4, and mean value of δ is + 32).

7 & 8 *Miogypsina (Miogypsina) tani* Drooger, 7: X 69, specimen from the cutting samples at 2070-2075m, An-32-1 Well (Mean value of X is 8.1) 8: X 61, specimen from the cutting samples at 2495-2500m, An-32-1 Well, (Mean value of X is 9)

PLATE VI

(Median Sections)

1,2,3 *Miogypsina (Lepidosemicyclina) polymorpha* Rutten 1: X 74, specimen from the cutting sample at 1795-1800m, An-14-1 Well. 2: X 58, 3: X 66, specimens from the cutting samples at 1750-1755m, An-14-1 Well.

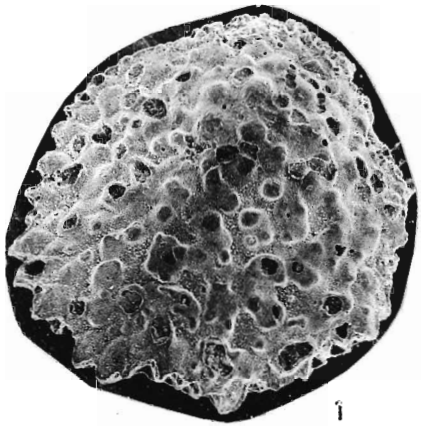
4, 5 *Miogypsina (Miogypsinoides) dehaartii* Vander Vlerk 4: X 78, specimen from the cutting samples at 750-760 An-32-1 Well. (Mean value of X is 7)

5: X 41, specimen from the cutting samples at 770-780m An-32-1, Well. (Mean value of X is 6.4)

6 *Miogypsina (Lepidosemicyclina) bifida* Rutten. X 62, specimen from the cutting samples at 770-780m, An-32-1 Well. (may be from contaminations).

7 *Miogypsina (Miogypsina) tani* Drooger, X 70, specimen from the cutting samples at 650-655m, HLO Well (Mean value of X is 7.71).

8 *Miogypsina (Miogypsinoides) bantamensis* (Tan Sin Hok) X 58, specimen from the cutting samples at 775-780m, HLO Well (Mean value of X is 11).



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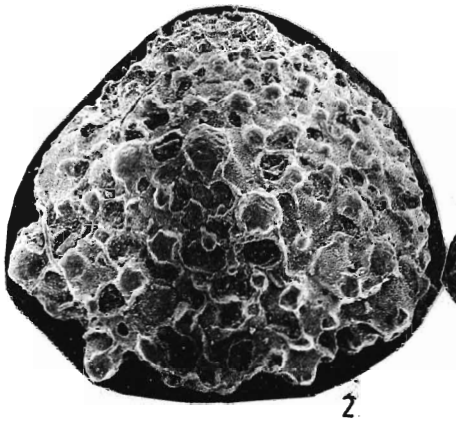

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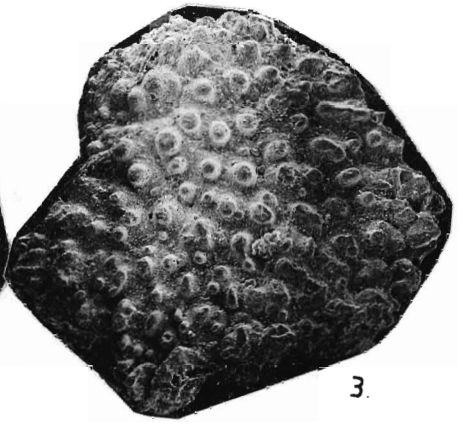

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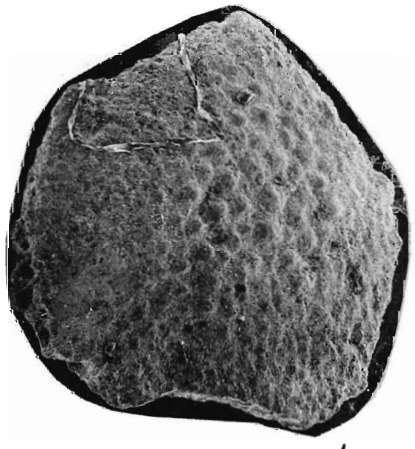

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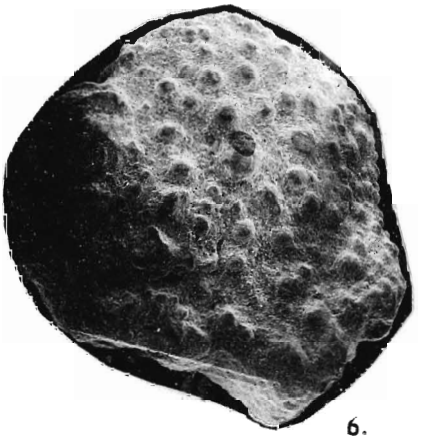

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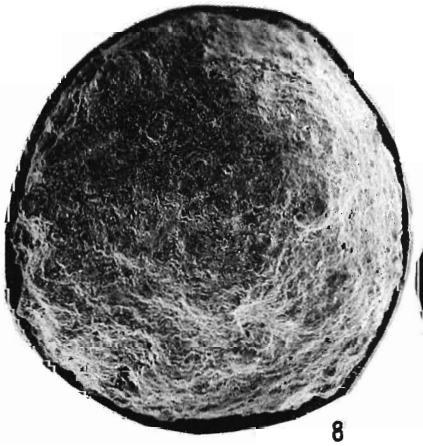

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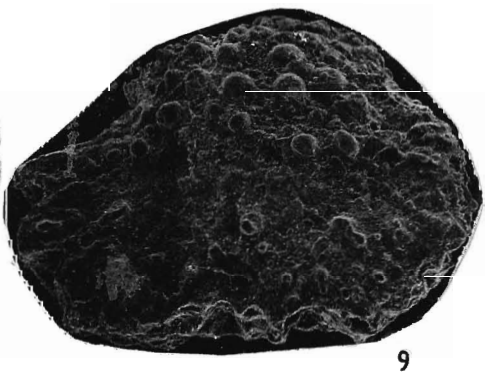

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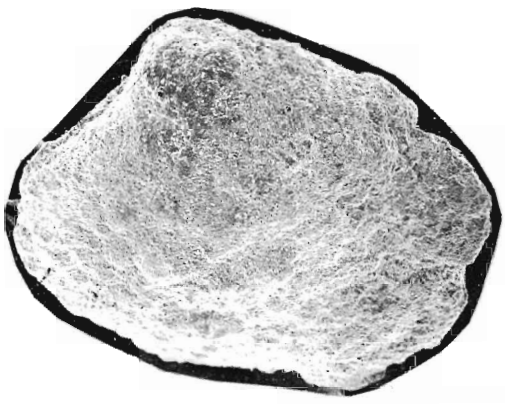

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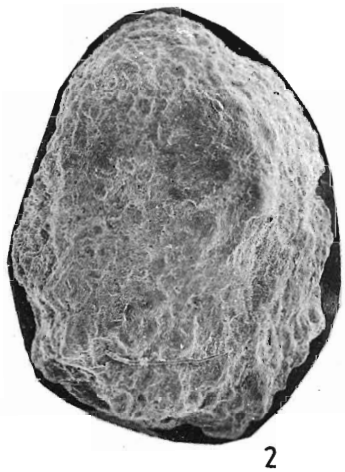

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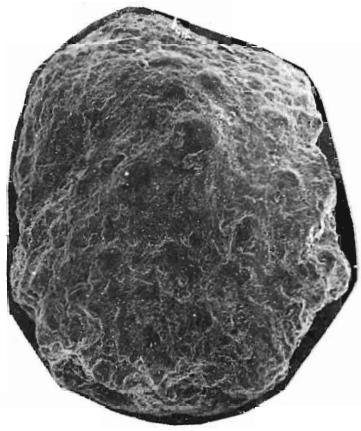

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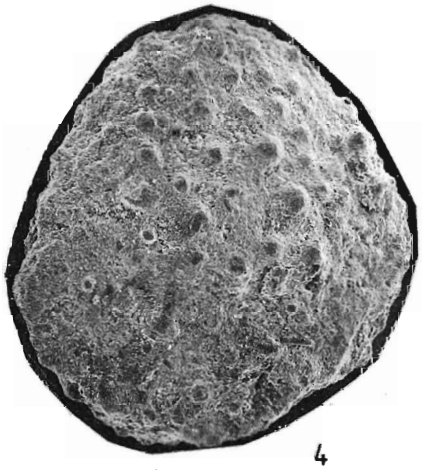

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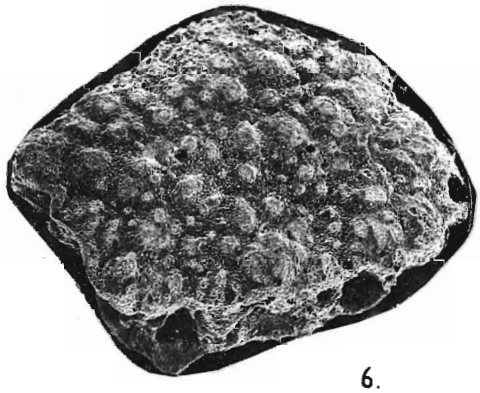

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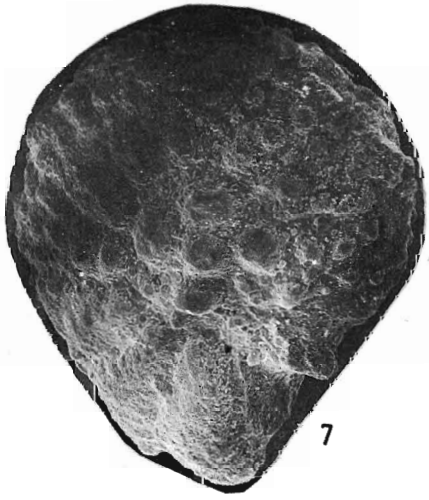

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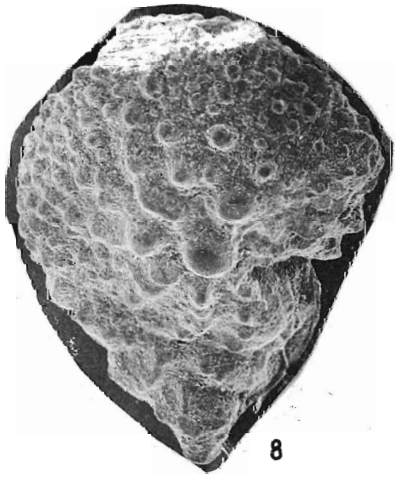

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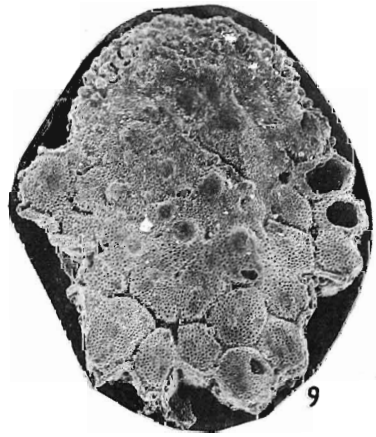

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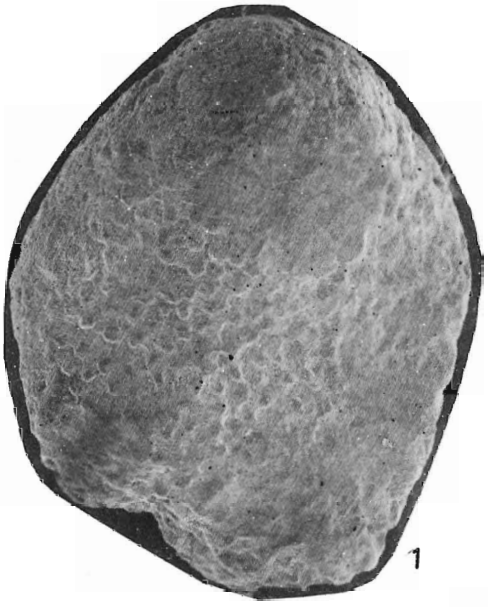
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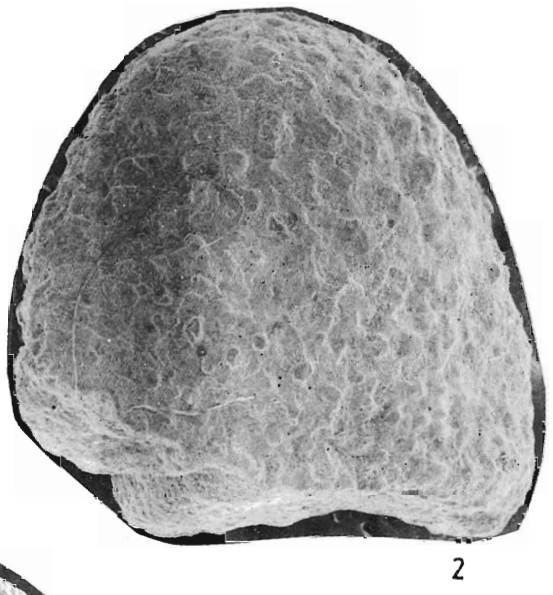
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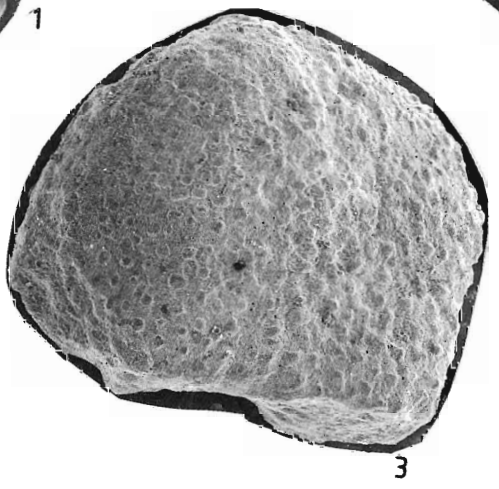
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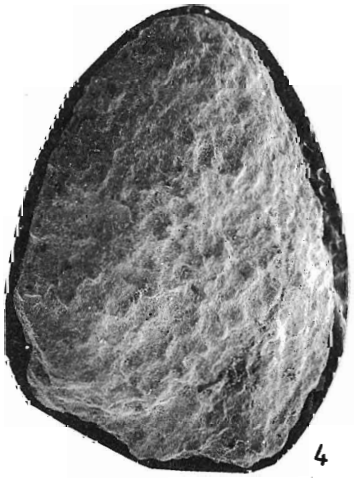
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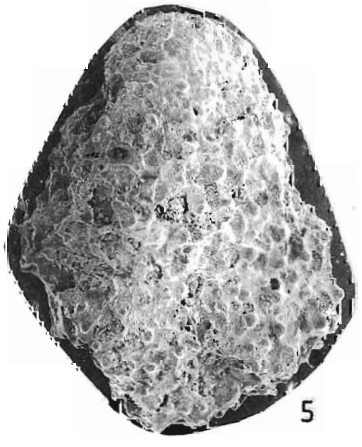
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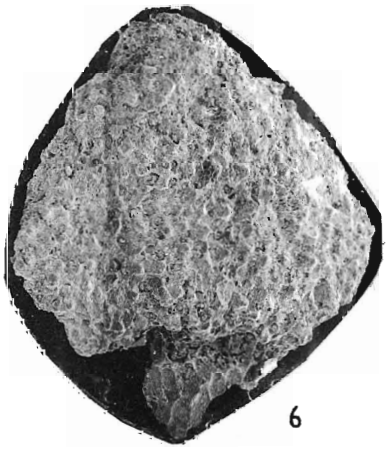
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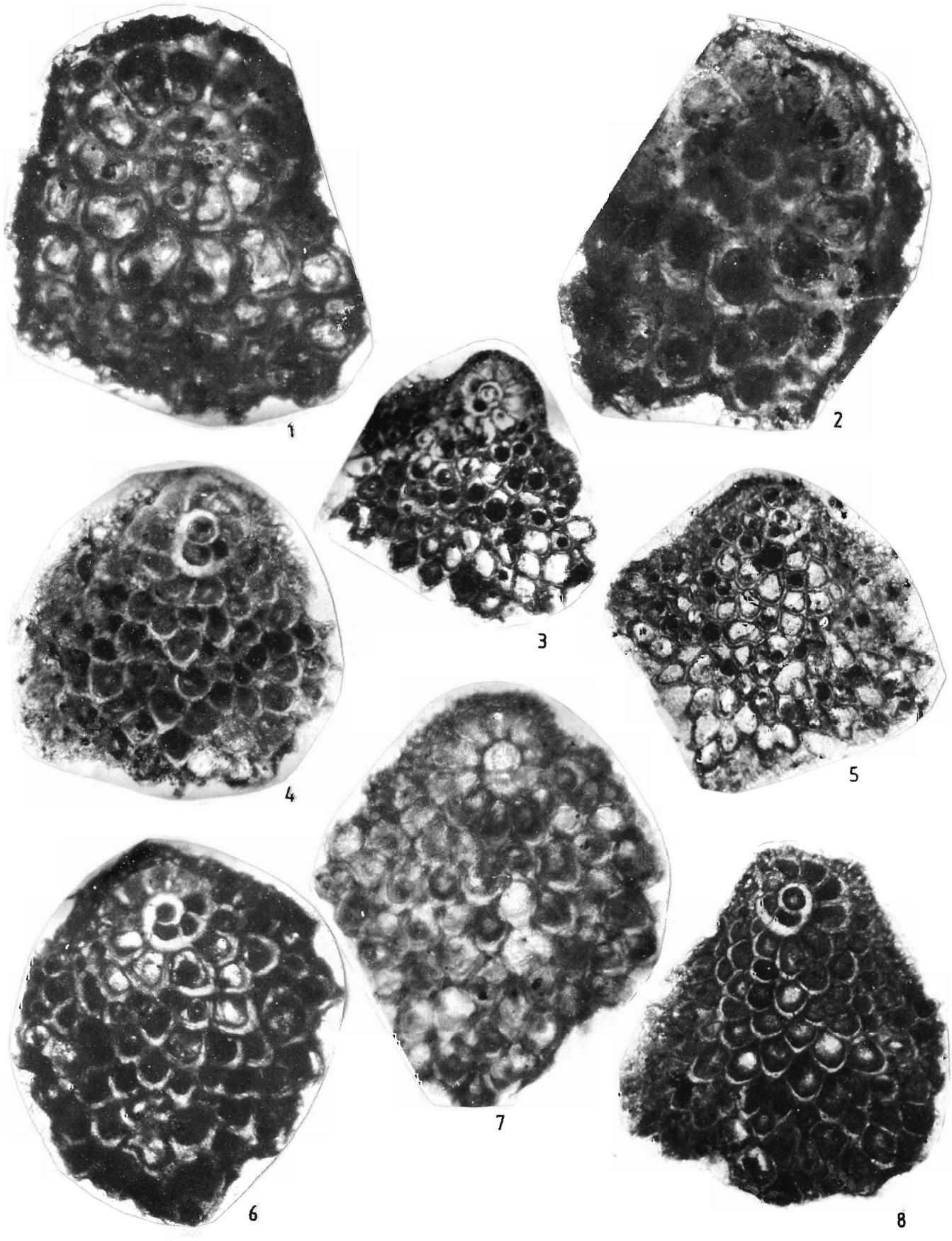
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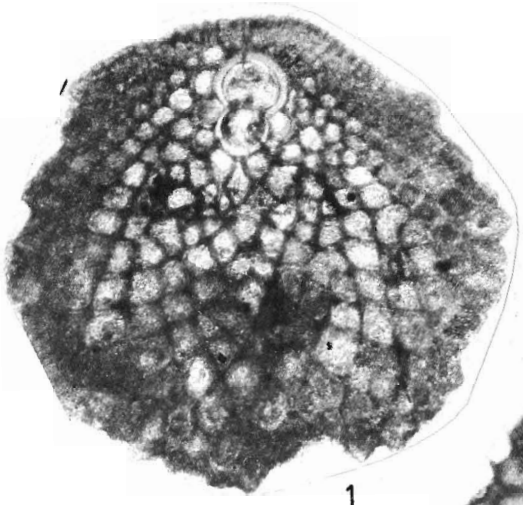

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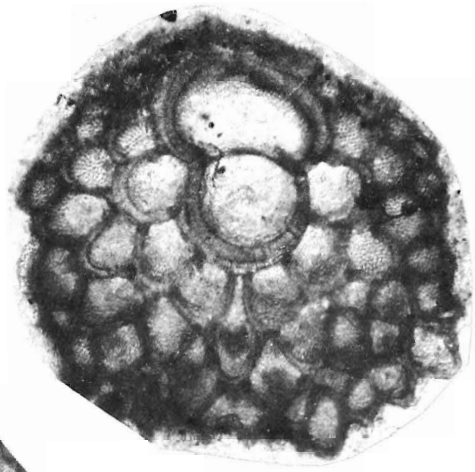

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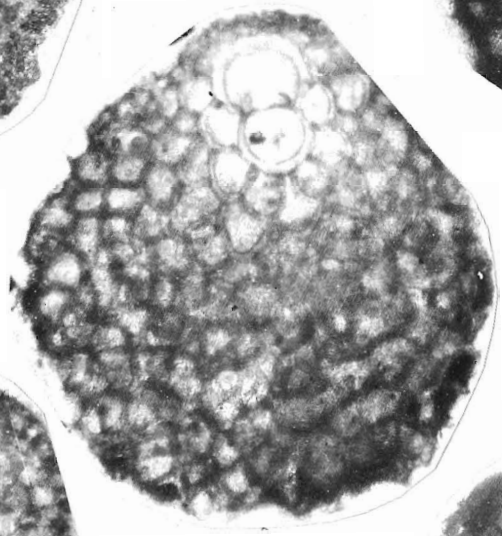

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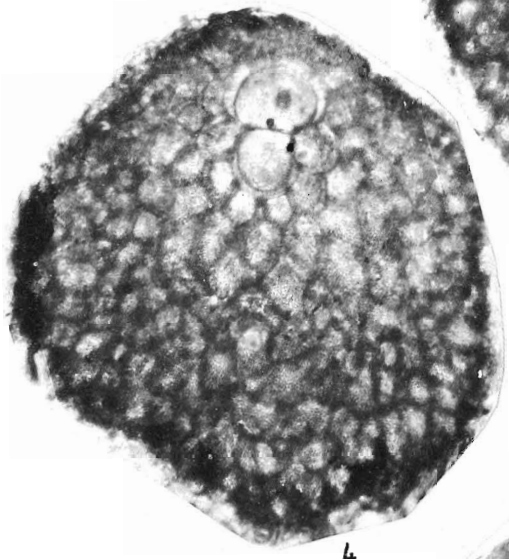

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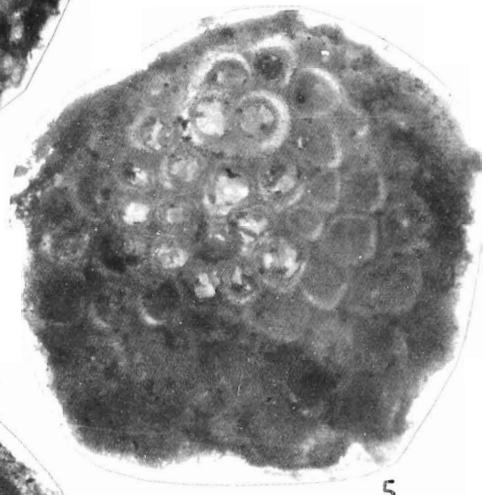

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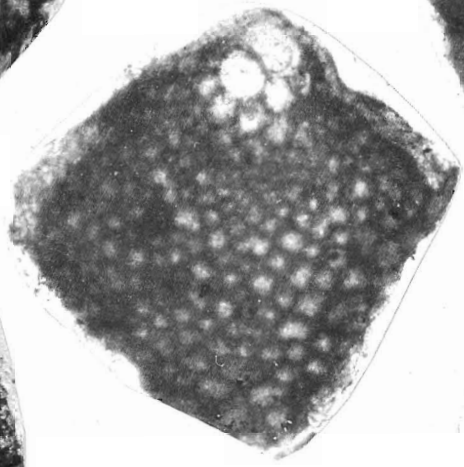

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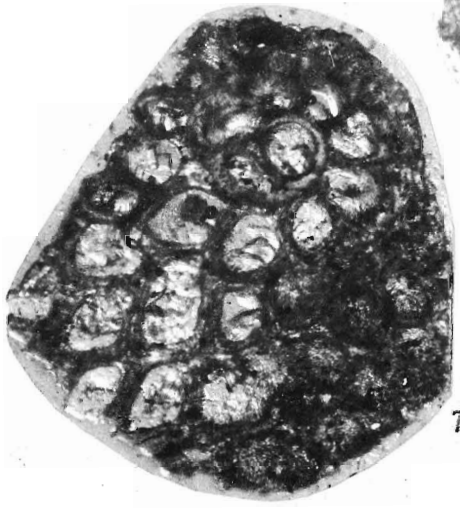

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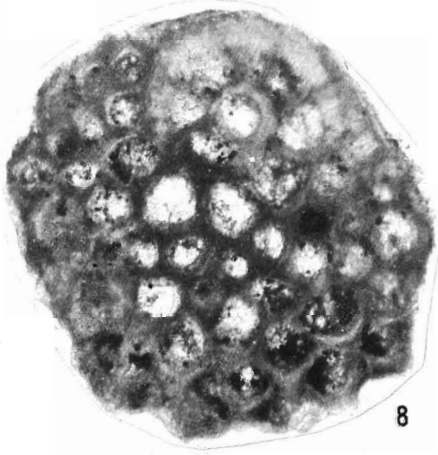

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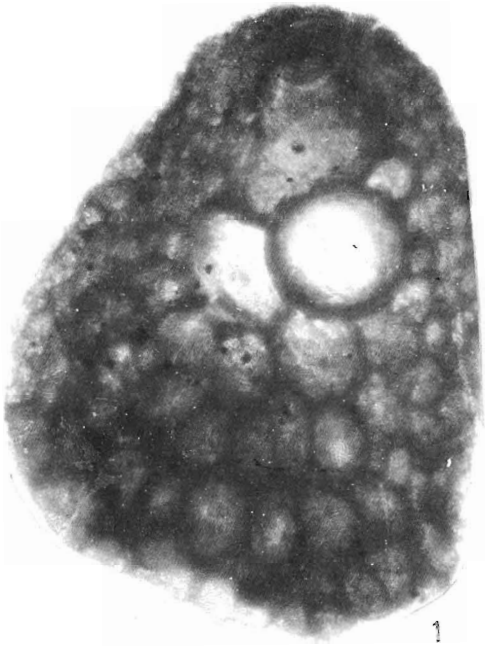
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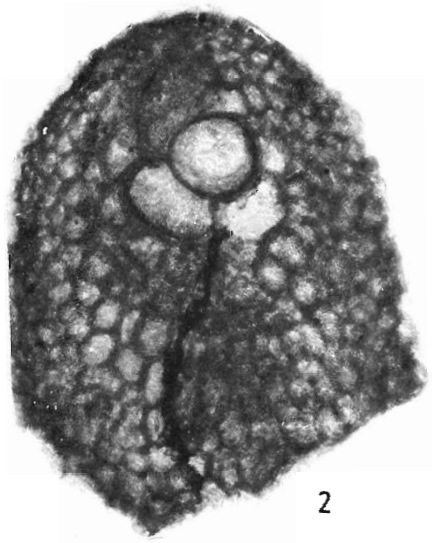
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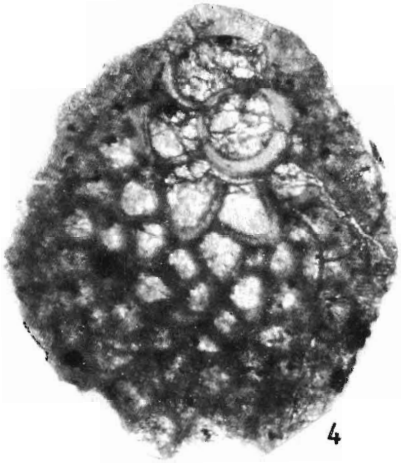
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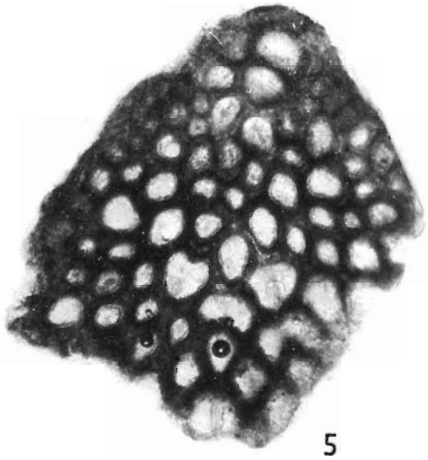
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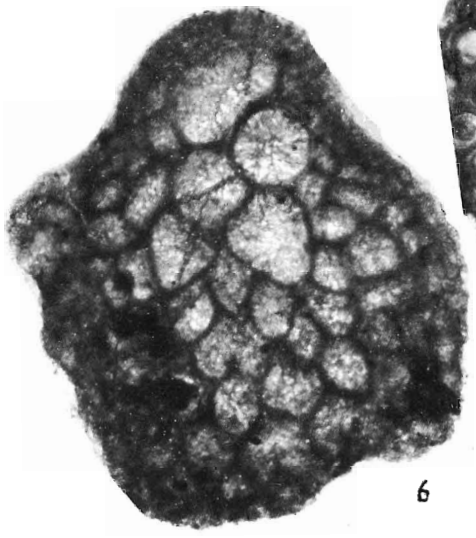
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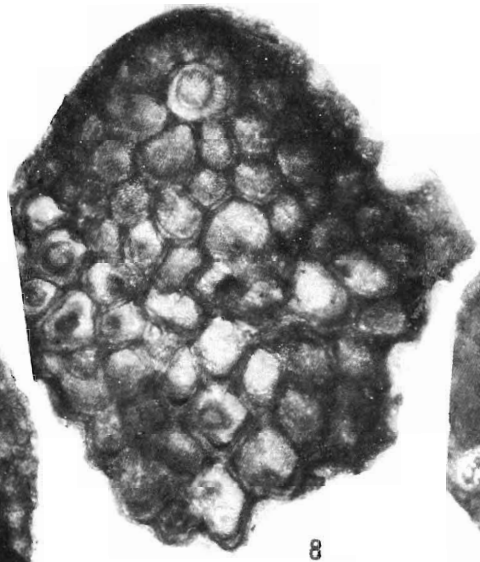
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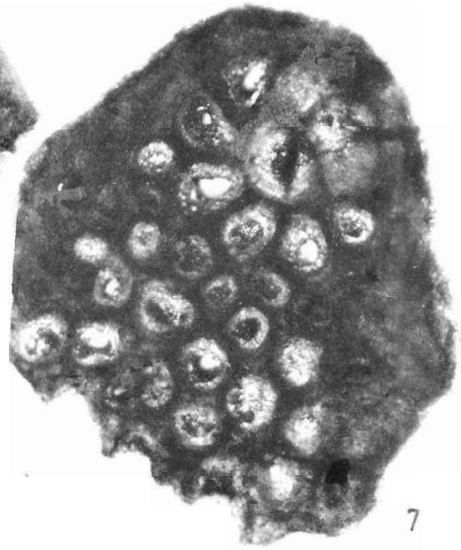
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