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SMALLER BENTHONIC FORAMINIFERA FROM LATE OLIGOCENE ROCKS OF THE VINJHAN-MIANI AREA OF KUTCH, GUJARAT.

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ABSTRACT

The paper incorporates the systematic description of 31 species of smaller benthonic foraminifera recorded from the Late Oligocene rocks occurring around Vinjhan-Miani area. By the aid of recorded fauna, the environment of deposition has also been discussed here. The interpretations suggest neritic shallow water, tropical conditions of deposition for these rocks.

INTRODUCTION

Vinjhan-Miani (23°6′ : 69°1′30″- 23°7′ : 69°6′) which falls in the survey of India Toposheet No.41 E is situated at the southwestern corner of Kutch, western India. Srivastava (1970) first recognised this thinly exposed patch of yellowish brown, fossiliferous marls in the present area and assigned Middle Oligocene (Rupelian) age to it on the basis of ostracoda. However, in the present study, they have been dated as Late Oligocene on the basis of foraminiferal fauna. These marls are found here directly overlying the Middle Eocene rocks. The exposures are observed 1 km ENE of Khirasra village (Jauhari, 1976) and are described here as below :

Table 1

Late Oligocene	Soft, yellow fossiliferous marl Hard, brown fossiliferous marl	1 m
.....	Disconformity	
Middle Eocene	Dirty white and yellow soft marl ; yellow, hard limestone ; unfossiliterous khaki shales	

Earlier, Tandon (1970) proposed a biostratigraphic classification of the Oligocene rocks exposed around Jhadwa, Maniara and Bermoti areas of southwestern Kutch on the basis of larger foraminifera and macroinvertebrates.

FAUNAL ASSEMBLAGE

The overlying marls show the presence of a peculiar type of lamellibranch shells which express affinity with *Pecten*. Thin sections of the marls have revealed the presence of *Spiroclypeus ranjanae* in abundance along with rare forms of *Lepidocyclina* (*Lepidocyclina*) sp. and frequently occurring *Miogypsinoides complanata*. In addition to the above larger foraminifera, the present assemblage consists of thirty one species of smaller foraminifera which are given below :

Spiroloculina sp., *Quinqueloculina barkhana*, *Quinqueloculina* aff. *Q. panamensis*, *Triloculina* sp., A., *Triloculina* B., *Triloculina* sp., *Pyrgo bulloides*, *Miliola* sp., *Globulina inflata*, *Globulina* aff. *G. tropicale*, *Eoeponidella hemisphaerica*, *Discorbis* aff. *D. propinqua*, *Discorbis* sp., *Rotalia* sp., *Elphidium* cf. *E. chilenum*, *Cibicidina* aff. *C. abnormis*, *Cibicides blowi* n. sp. *Cibicides brahmai* n. sp., *Cibicides* sp. A., *Cibicides* sp., B., *Cibicides* sp. C, *Cibicides* sp. D, *Cibicides carinatus*, *cibicides lobatulus*, *Cibicides lobatulus constricta* n. sub sp., *Cibicides megaloperforatus*, *Cibicides* aff. *C. molacus*, *Sphaerogypsina globulus*, *Florilus* sp., *Anomalinella kutchensis*, and *Anomalinella* sp.

This assemblage has been assigned a Late Oligocene age (Chattian/Bormidian) on the basis of foraminiferal form like *Miogypsinoides complanata*. The age of the assemblage has been separately discussed by the writer (Jauhari, Ms.). As a result, the strata yielding above assemblage belong to the latest part (Chattian/Bormidian) of Oligocene and may be put at par with *Eupatagus rostratus* zone (Bermota Stage, Chattian) of Tandon (*op.cit.*) ; see Table 2.

TIME UNITS		AREAS / Indian Equivalents	KUTCH BASIN: BERANDA-BERNANA (MOHAN & SESHAN, 1970)	VINJHAN-MIANI (PRESENT WORK)	RAMANIA AREA (RAJU ET AL., 1970)	JHADWA, MANIARA, BERMOTI (TANDON, 1970)	
OLIGOCENE	CHATTIAN-BORMIDIAN	LOWER NARI	NUMMULITES FICHTELI ZONE	SPIROCLYPEUS RANJANAE ZONE (P.22)	MIOGYPSINOIDES COMPLANATA-SPIROCLYPEUS RANJANAE ZONE	BERMOTA STAGE	EUPATAGUS ROSTRATUS ZONE
				MIOGYPSINOIDES COMPLANATA ZONE (P.21)			
	RUPELIAN			NOT EXPOSED	NUMMULITES FICHTELI-INTERMEDIUS-EULEPIDINA-NEPHROLEPIDINA ZONE	BERNANI STAGE	NUMMULITES SUBCLIPEUS ZONE
							LEPIDOCYCLINA (EULEPIDINA) ZONE
	LATTORFIAN				NUMMULITES FICHTELI-INTERMEDIUS ZONE	MANIARA STAGE	NUMMULITES FICHTELI ZONE

Table 2. Showing biostratigraphic correlation of oligocene rocks in Kutch.

Moreover, they are correlatable with *Miogypsinoides complanata-Spiroclypeus ranjanae* zone of Raju *et al.* (1970) in Ramania area of Kutch and *Spiroclypeus ranjanae* bed (a part of the basal Gaj Formation—Waior Stage of Biswas, 1970) of Tewari and Singh (1974) in Waior, Kutch.

PALAEOECOLOGIC CONSIDERATIONS

The rocks referred to as Late Oligocene (Bormidian) in the present area are poorly exposed and show little thickness. As compared to the Middle Eocene, the faunal recovery is poor. The planktonic species could not be seen in the samples studied. This signifies a change in environment. Possibly a very shallow depositional environment, in which planktonics were not able to sustain themselves, could be inferred. Such a shallow-water environment was probably due to the shallow nature of Oligocene sea in western India (Sahni and Kumar, 1974). The following faunal analysis clearly illustrates this fact in the area.

Despite the poor occurrence of fauna, the samples reveal fairly good representation of certain benthonic forms which can be used to deduce the environmental relationships. Among the larger foraminifera, *Spiroclypeus ranjanae* is dominant. The presence of rare *Lepidocyclina* (*Lepidocyclina*) sp. and frequently occurring *Miogypsinoides complanata* is also noticed. In addition to these, thirty one species of smaller foraminifera represented by *Spiroloculina*, *Quinqueloculina*, *Triloculina*, *Pyrgo*, *Miliola*, *Globulina*, *Discorbis*, *Rotalia*, *Elphidium*, *Cibicidina*, *Cibicides*, *Sphaerogypsina*, *Anomalinella*, and *Florilus* are recorded here. Molluscs and bryozoa also occur in these rocks. The bivalve shells referable to Pectinid group are a common feature of these rock units.

The abundance of *Spiroclypeus* points to a shallow bathymetric position in the continental shelf environment. Cole (1975) suggests that *Heterostegina*, a living genus and structurally similar to *Spiroclypeus*, is well suited to warm, shallow, protected conditions. In Bandy's (1964) opinion, *Heterostegina* shows positive responses to a bathymetry from 20 m. to 30 m. and is often recorded from these depths in abundance. The remarkable morphologic similarity of *Spiroclypeus* and *Heterostegina*, therefore, suggests similar biologic preferences for *Spiroclypeus*.

The diverse species of porcelaneous foraminifera, e.g., Miliolidae (esp. *Quinqueloculina*, *Triloculina*, etc.)which "....are usually excellent indices of near-shore conditions" (Bandy, 1960) frequently occur in these horizons. *Rotalia* and *Elphidium* which also make their appearance here in sufficient numbers have been considered by Lowman (1949) to be characteristic of inner neritic environment (strongly brackish and near-shore marine environments). *Discorbis* cf. *D. propinqua* present here is comparable with *D. dimidiatus* (Hedley, Hurdle, and Burdett, as quoted in Wright, 1973) which lives "in shallow (0.18 m.), subtropical to tropical conditions (18—26°C) with salinities of 39-56°/00" (Wright, 1973). *Florilus* which is structurally similar to *Nonionella* is present in appreciably large numbers in the present area. Bandy and Arnal (1960) opine that *Nonionella* group is a dominant constituent of inner shelf biofacies. *Cibicides*, a euryhaline, eurythermal, typically inner shelf genus, is represented by several species. The common occurrence of miogypsinids is again a pointer to shallow-water, near-shore environment. Tropical conditions are indicated by *Miogypsinoides* and *Miogypsina* populations and the great abundance of *Spiroclypeus*.

Other shallow-water elements present in the assemblage include the broken pieces of echinoid spines, bryozoans, and molluscs. Srivastava (1970) recorded *Gisortia* (gastropod), *Astarte*, and *Pecten labadyei* Sowerby (Bivalves) from these horizons. The shells are complete and do not show the marks of abrasion, thereby indicating the deposition in quiet waters of possibly protected, shallow shelf region. *Astarte* suggests warm water conditions. Though it mainly inhabits arctic and subarctic regions of the present-day world, its representatives were commonly distributed in the tropical waters of the geologic past. It is a common belief among the palaeontologists that it migrated to the cold waters in younger geologic times (Woodring, 1960 ; Boekschoten, 1967).

When viewed in terms of palaeoecology, the commonly occurring pectinids assume far greater importance because of their varied mode of existence. Their morphologic structures are suited to their living attached to the substratum by a byssus, to resting on the sea bottom by a side, and to swimming. Roger (1939) suggests that they are sparsely distributed in littoral zone, more common in the 30 to 72 m. zone, and abundant in central to outer shelf regions. The forms inhabiting deeper portions of modern seas are usually small in size and occurrence. It seems that large-sized and relatively less common (than more common of 30 to 72 m. zone) pectinids in the present area suggest shallow, neritic environment.

The shallow-water substrates appear to be in agreement with the pectinids' life habits, shape, and other morphologic features. Pectinids which live on the substratum attached to some object become good swimmers during their adult stage. Kauffman (1969, pp. 160-61) and Stanley (1970, pp. 37-43) established correspondence between the shell form of pectinids and their life habits in the adult stage. These workers suggest that the smooth streamlined shape, a light weight shell, an equivalve shell, a large umbonal area angle, the presence of a straight hinge line having well-developed ears, etc. are among the trends developed in relation to the audlt mode of existence of Pectinids i.e. swimming. Though all the trends are

not present in a single genus, the presence of even few of these is sufficient to fulfil the requirements of the swimming habit. Kaufman (1969) proposes a well-meaning hypothesis that light shell and the swimming habit of Pectinids are efficient adaptations to the fine-grained, soft substrates, and do not allow the organisms to sink into the substrate. The soft-mud habitats which host the majority of Pectinids most probably occur commonly in the shallow parts of inner neritic zone.

The occurrence of shallow water foraminifera, lamellibranchs (mainly Pectinids), bryozoa, and echinoid spines together indicates that the deposition of the late Oligocene rocks in the area under study took place in an inner neritic (shallow-water) environment characterized by tropical, well-protected, if not exactly lagoonal, conditions.

SYSTEMATIC DESCRIPTION

Superfamily Miliolacea Ehrenberg, 1839
Family Nubeculariidae Jone, 1875
Subfamily Spiroloculininae Wiesner, 1920
Genus *Spiroloculina* d'Orbigny, 1826

Spiroloculina sp.

(Plate I—1)

Description : Test lanceolate, strongly compressed, having flattened sides, longer than broad, with slightly depressed central area, raised at the peripheral parts, periphery truncated and acute angled ; chambers regularly increase in size as added, sides flattened, basal end of the final chamber broadened, apertural end tapering, without neck ; sutures distinct, depressed ; wall calcareous, smooth, porcelaneous, imperforate ; aperture at the open end of the final chamber, in the form of a rounded opening, not very clear in the present specimen.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./LU./858	0.70	0.35	4.67	2	4.67

Remarks : The present form is represented by a single specimen in the material. It appears very close to *Spiroloculina lancea* Ehrenberg, a recent species recorded from Graubrauner sand, Florida, U.S.A., but is distinguished from the latter by the absence of an elongate apertural end.

Horizon : Hard, dark brown marl unit, and soft, yellow marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Family Miliolidae Ehrenberg, 1839
Subfamily Quinqueloculininae Cushman, 1917
Genus *Quinqueloculina* d'Orbigny, 1826

Quinqueloculina barkhana Mohan and Bhatt

(Plate I—2-3)

Quinqueloculina barkhana Mohan and Bhatt, 1968, *Natl. Inst. Sci.* India, Proc. Calcutta, India, vol. 34, pt. 3, no. 4, p. 166, pl. 13, Fig. 5a-c.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./859	0.67	0.50	0.35	1.3	1.9
Geol./L.U./860	0.65	0.35	0.20	1.8	3.2

Remarks : The present forms compare favourably with *Quinqueloculina barkhana* Mohan and Bhatt recorded from the Miocene (Burdigalian)beds of Chadopadi—Sansora area of southwestern Kutch. This species is rare in the material.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Quinqueloculina aff. *Q. panamensis* Cushman

(Plate I—4-5)

Quinqueloculina panamensis Cushman, 1918, *U.S. Nat. Mus. Bull.* Washington, D.C., U.S.A., no. 103, p. 80, pl. 31, fig. 1a-c.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./861	0.35	0.30	0.15	1.16	2.3
Geol./L.U./862	0.45	0.35	0.20	1.28	2.25

Remarks: Expressing affinity with *Quinqueloculina panamensis* Cushman known from the Gatun Formation (Miocene) of Panama canal zone, the present ill-preserved specimens are characterized by the test having equal length and width, loosely coiled chambers of later stage, free apertural end, slightly flattened chambers, rounded periphery, and partially agglutinated wall. The last chamber of these specimens, tending to become loosely coiled, has much resemblance with the type species which is, however, distinguished by its smooth wall.

Horizon : Hard, dark brown marl unit.

Localit : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Genus *Triloculina* d'Orbigny, 1826

Triloculina sp. A

(Plate I—6-7)

Description : Test oval, longer than broad, angular at the edges, chambers rapidly increasing in size, loose, last chamber broad at the basal end and narrow at the apertural end which is produced into a short neck ; sutures distinct, depressed ; wall procelaneous, imperforate with fine striae at places ; aperture situated at the tip of the apertural end, filled.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./863	0.45	0.25	0.20	1.8	2.25

Remarks : The present form can be compared with *Triloculina architectura* Todd reported from the Middle Oligocene of Burke Greek, Rankin County, Mississippi but markedly differs from the latter in its loosely arranged chambers and more angular margins. In view of single specimen, the detailed study is not possible.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Triloculina sp. B

(Plate I—8-9)

Description : Test medium-sized, length and breadth unequal, periphery rounded ; chambers inflated, embracing, loosely coiled ; last chamber occupying the major portion of the test ; sutures distinct, strongly depressed ; wall calcareous, rough due to weathered surface and the presence of some foreign particles, thick, opaque ; aperture terminal, not clear.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./864	0.65	0.45	0.35	1.8	1.8

Remarks : In general appearance, the present form is close to *Triloculina globosa* Jauhari recorded from the Middle Eocene of the present area but seems to be distinct in its loosely coiled chambers.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Triloculina sp. C.

(Plate I—10-11)

Description : Test small, length and breadth equal, periphery subrounded, chambers strongly inflated, 3 visible to the exterior ; sutures distinct, depressed ; wall calcareous, imperforate ; aperture terminal, somewhat rounded, bifid tooth present, triangular in cross-section.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./865	0.30	0.30	0.25	1	1.2

Remarks : A single specimen in the collection precludes the writer from designating a definite specific status to it.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Genus *Pyrgo* Defrance, 1824

Pyrgo bulloides (d'Orbigny)

(Plate II—3-4)

Biloculina bulloides d' Orbigny, 1826, Ann. Sci. Nat, vol. 7, p. 297, pl. 16, figs. 1-4.

Pyrgo bulloides (d'Orbigny) Marks, 1951, *Contr. Cushman Found. Foram. Res.*, vol. 2, pt. 2, p. 41 ; Bhatia and Mohan, 1959, *Jour. Pal.*, vol. 33, no. 4, pp. 652 ; Tewari and Bhargava, 1966, *Jour. Pal. Soc.* India, vol. 11, p. 27, pl. 10, fig. 14a-b.

Dimensions (in mm.)

Specimen number	Diameter	Thickness	D/T
Geol./L.U./866	0.50	0.45	1.11
Geol./L.U./867	0.25	0.20	1.25
Geol./L.U./868	0.45	0.35	1.28
Geol./L.U./869	0.40	0.30	1.33

Remarks : The present specimens which are referable to *Pyrgo bulloides* (d'Orbigny) are characterized by nearly spherical test, two externally visible chambers, distinct depressed sutures, rounded edges, porcelaneous, imperforate wall with rough external surface, and a terminal, rounded aperture with an indistinct tooth.

Horizon : Hard, dark brown marl unit, and soft, yellow marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Subfamily Miliolininae Ehrenberg, 1839

Genus *Miliola* Lamarck, 1804

Miliola sp.

(Plate II—5-6)

Description : Test elongate, tapering at both ends, longer than broad, elliptical in shape ; chambers compressed, with broadly angular edges, gradually increasing in size, quinqueloculine in arrangement, last chamber broadest at the basal end but narrow towards the apertural end, neck absent ; sutures distinct, depressed ; pentagonal in cross section ; wall porcelaneous, imperforate, with a covering of agglutinated particles ; aperture not distinct, a small rounded opening with a trematophore, bordered by a thin rim-like structure.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./870	0.60	0.35	0.15	1.71	4

Remarks : The present form is a distinct species in itself and can be easily differentiated from *Miliola robusta* Le Calvez by its rather elongate test, depressed apertural

end covered by last but one chamber, and somewhat less flattened chambers. Because of a solitary specimen, it cannot be described as a new species.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Superfamily Nodosariacea Ehrenberg, 1838
Family Polymorphinidae d'Orbigny, 1838
Subfamily Polymorphininae d'Orbigny, 1838
Genus *Globulina* d'Orbigny in de la Sagra, 1839

Globulina inflata Reuss

(Plate II—2)

Globulina inflata Reuss, 1851, Geol. Ges. Zeitschr., Berlin, *Dentschland*, Bd., 3, p. 81.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./871	0.45	0.35	0.30	1.28	1.16

Remarks : In its slightly compressed globular test, 3 strongly overlapping chambers, highly enlarged last chamber, and small, terminal, radiate aperture with fistulose growth, the present form closely resembles *Globulina inflata* Reuss. The aperture is raised above the surface.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Globulina aff. *G. tropicale* Petri

(Plate III—7-8)

Globulina tropicale Petri, 1957, Foraminiferos miocenicos da formacao Pirabas (Portuguese with English Summary) Sao paulo *Univ. Fac. Filos, Cien, Letras, Bol.* Sao Paulo, Brazil, no. 216 (Geol. no. 16), p. 50, pl. 4, fig. Za-c.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./872	0.90	0.65	0.50	1.38	1.8
Geol./L.U./873	0.75	0.625	0.45	1.2	1.69

Remarks: The present specimens seem allied to *Globulina tropicale* Petri in their elongate oval test, oblique, distinct sutures, and radiate aperture. However, the differences from the type species are expressed in deeply incised sutures and a high degree of inflation of the chambers.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Superfamily Discorbacea Ehrenberg, 1838
Family Discorbidae Ehrenberg, 1838
Subfamily Discorbinae Ehrenberg, 1838
Genus *Eoeponidella* Wickenden, 1949

Eoeponidella hemisphaerica (Cushman)

(Plate III—1-2)

Discorbis hemisphaerica Cushman, 1931, *Contr. Cushman Lab. Foram. Res.*, Sharon, Mass, U.S.A., vol. 7, pt. 3, p. 59, pl. 7, fig. 14a-c.

Dimensions (in mm.)

Specimen number	Diameter	Thikcness	D/T
Geol./L.U./874	0.325	0.15	0.25

Remarks : In its planoconvex, trochospiral test, convex spiral side, flattened to concave umbilical side, more than 4 inflated chambers in the last whorl, and an interiomarginal, extraumbilical aperture, the present specimen is in accord with *Eoeponidella hemisphaeriaca* Cushman recorded from the Jackson formation (upper Eocene) of Jackson, Mississippi, U.S.A. But the type species is characterized by subacute to slightly rounded periphery, in contradistinction with the acute periphery of the present form.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Genus *Discorbis* Lamarck, 1804

Discorbis aff. *Discorbis propinqua* (Terquem) emend Le Calvez

(Plate III—3-5)

Discorbis propinqua (Terquem), emend Le Calvez, 1949 Revision des foraminifers lutetiens du Bassin de Paris ; II-Rotaliidae et familles affines. *France, Service Carte, Geol., Mem. Paris*, p. 17, pl. 1, figs. 12-14.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./875	0.45	0.40	0.30	1.12	1.5

Remarks : Being closely allied to a Middle Eocene species, *Discorbis propinqua* (Terquem), the present form is characterized by strongly convex umbilical side, high umbonal boss, subacute, carinate periphery, six chambers in the last whorl, deeply excavated sutures on umbilical side, limbate, flush sutures on spiral side, and a slightly high-arched, extraumbilical aperture with a thin lip.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Discorbis sp.

(Plate III—6-7)

Description: Test trochospiral, planoconvex, umbilical side flattened, involute, spiral side strongly convex, evolute, equatorial profile nearly circular, equatorial periphery entire and distinct from rest of the test, axial profile broadly conical, axial periphery acute and carinate ; chambers numerous, increasing gradually in size, triangular in shape on umbilical side, elongate, narrow, arcuate on spiral side, about six in the last-formed whorl; on umbilical side, chambers broad and fused at their peripheral ends, but narrow and well separated near their umbilical ends ; they are all ultimately joined to a solid umbonal boss which is quite prominent and raised above the surface of the test ; sutures arcuate, flush on spiral side, straight, radial, thickened, and deeply excavated on umbilical side (visible only to about half-way to the periphery). Umbilicus filled with a plug appearing as a high umbonal boss formed as a result of the fusion of umbilical ends of the chambers. Wall smooth, calcareous, coarsely perforate. Aperture an elongate, extra-umbilical slit at the base of the final chamber.

Dimensions (in mm.)

Specimen number	Max. Diam.	Min. Diam.	Thick-ness	Mx.d. mn.d.	Mx.d. T
Geol./L.U./876	0.35	0.275	0.15	1.27	2.33

Remarks : Because of solitary specimen, the present form cannot be studied in detail.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Superfamily Rotaliacea Ehrenberg, 1839
Family Rotaliidae Ehrenberg, 1839
Subfamily Rotaliinae Ehrenberg, 1839
Genus *Rotalia* Lamarck, 1804

Rotalia sp.

(Plate III—9-10)

Description—Test medium-sized, trochospiral, compressed, planoconvex, spiral side flattened, umbilical side strongly convex, equatorial profile circular to slightly oblong, equatorial periphery lobulate and strongly corrugated, axial periphery acute with an irregular, corrugated keel ; spiral side irregularly sprinkled with small, thick papillae and very much rugged near peripheral region, umbilical side, with a prominent square-shaped plug surrounded by a deep groove (very close in shape to that of *Rotalia canalis* Todd and Post); chambers, on spiral side obscured by the ornamentation, on umbilical side uniform in shape and size, longer than broad, about eight in the last whorl, broader at periphery but narrower towards umbilical region ; sutures obscured on spiral side, distinct, radial, deeply incised on umbilical side. Wall calcareous, perforate, surface roughened due to indentations, covered with sparsely scattered papillae on spiral side. Umbilicus closed with a plug. Aperture on umbilical side, a short opening at the base of the last chamber.

Dimensions (in mm.)

Specimen number	Max. diam.	Min. diam	Thick-ness	Mx.d mn d	Mx.d. T
Geol./L.U./877	0.60	0.50	0.35	1.2	1.8
Geol./L.U./878	0.70	0.65	0.45	1.47	1.01
Geol./L.U./879	0.60	0.50	0.40	1.25	1.2

Remarks : These forms, although very close to *Rotalia canalis* Todd and Post recorded from the Oligo/Miocene Strata of Bikini Island, Bikini Atoll, Marshall Islands, are differentiated as a plano-convex, trochospiral species having larger dimensions and acute periphery and lacking peripheral spines of *R. canalis* (regarded by Todd and Post (1954) in *R. canalis* as extensions of the angular chambers). Superficially resembling *Rotalia alabamensis* Cushman and McGlamery, which is known from the Oligocene Bram marl, Chickasawhay marl of Clarke county, Alabama, U.S.A., the present species markedly differs in its plano-convex test, liberal distribution of papillae on spiral side, and umbilical plug much bigger than that seen in *R. alabamensis*. It is rare in occurrence.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Family Elphidiidae Galloway, 1933
Subfamily Elphidiinae Galloway, 1933
Genus *Elphidium* de Montfort, 1808

Elphidium cf. *Elphidium chilenum* Todd and Kniker

(Plate III—8, 11-13)

Elphidium chilenum Todd and Kniker, 1952, *Cushman Found : Foram* Res. Spec. Publ. Washington, D. C. No. 1, p. 19, pl. 3, fig. 37a-b.

Dimensions (in mm.)

Specimen number	Diameter	Thickness	D/T
Geol./L.U./880	0.20	0.125	1.6
Geol./L.U./881	0.25	0.15	1.66

Remarks : The present specimens are referable to *Elphidium chilenum* Todd and Kniker recorded from the Late Eocene of southwestern Chile (Magallares Province). They, however, differ from *E. chilenum* in their large umbilici, highly inflated last chamber hanging over the umbilicus on both sides, small size, and peculiar apertural face forming a hood over the peripheral aperture.

Horizon: Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Superfamily Orbitoidacea Schwager, 1876

Family Cibicididae Cushman, 1927

Subfamily Planulininae Bermudez, 1952

Genus *Cibicidina* Bandy, 1949

Cibidina aff. *Cibicidina abnormis* (Pishvanova)

(Plate IV—1-3)

Cibicides (*Cibicidoides*) *abnormis* Pishvanova, 1964. In Vasilenko, V. P. (Anomalinidae) (Russian) Leningrad: *Vses Neft. Nauchno Issled. Geol. Razved. Inst.* (VNIGRI) (All union Petrolem Scientific Research Geological Prospecting Institute), Fossil foraminifera of the U.S.S.R., Trudy, n.s., vypusk, 80, p. 183, pl. 32, fig. 5a-c.

Dimensions (*in mm.*)

Specimen number	Length	Breadth	Thickness	L/B	L/T
Geol./L.U./882	0.35	0.30	0.15	1.17	2.33

Remarks : In its flat, partially involute spiral side, strongly convex, involute umbilical side with a truncated top, limbate sutures, depressed umbilical region, tri angular, flattened apertural face, and arcuate, peripheral aperture, the present specimen closely resembles *Cibicidina abnormis* (Pishvanova) originally known from the Miocene of Transcarpathian Mountains, Ukrainian S.S.R. However, the present form differs in its narrower umbilical depression and lesser number of chamber in the last whorl. The reason for assigning this form to the genus *Cibicidina* is its partially involute spiral side, coarsely perforate, calcareous wall, and bluntly angular carinate periphery. The form is rare in the present material.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan Miani area, southwestern Kutch, Gujarat.

Subfamily Cibicidinae Cushman, 1927

Genus *Cibicides* de Montfort, 1804

Cibicides blowi sp. nov.

(Plate IV—4-10)

Description : Test trochospiral plano-convex, spiral side flattened to slightly concave, evolute, umbilical side strongly convex, involute ; equatorial profile nearly circular, equatorial periphery lobulate, axial outline conical, axial periphery acute with thin keel ; chambers on umbilical side distinct, inflated, triangular in shape, about 7-8 in the last-formed whorl, gradually increasing in size in early portion, enlargement rapid in later ontogenetic stages, last chamber considerably enlarged and covering the umbilical region almost completely, chambers on spiral side flush with the surface ; sutures curved, distinct, radial, depressed on umbilical side, thickened, raised on spiral side ; wall finely perforate, calcareous, smooth ; umbilicus very narrow, almost closed by the large final chamber. Aperture at the base of the last-formed chamber on the umbilical side, a high-arched opening that extends to the umbilicus, with a thin, distinct lip throughout apertural length.

Dimensions (*in mm.*)

Specimen number	Length	Breadth	Thickness	L/B	L/T
Geol./L.U./Holotype/883	0.30	0.20	0.15	1.5	2
Geol./L.U./Paratype/884	0.30	0.20	0.10	1.5	3
Geol./L.U./Paratype/885	0.35	0.27	0.15	1.3	2.33
Geol./L.U./Paratype/886	0.325	0.25	0.15	1.3	2.16

Remarks : Its high-arched aperture extending to umbilical side, large last chamber covering most of the umbilical depression with its thin triangular flap, conical axial profile, and very narrow umbilical opening make it distinct from *Cibicides cuvilleri browni* Kline. Lack of more spreading, irregular later chambers and large umbilical knob, and the presence of typical aperture again distinguish it from *Cibicides pseudoungerianus antilleana* Drooger.

Horizon : Hard, dark brown marl unit, and soft, yellow marl unit.

Type Locality : ENE of Khirasra village of the Vinjhan-Miani area of southwestern Kutch, Gujarat.

Etymology : The species is named in honour of the late Dr. W. H. Blow for his outstanding contribution to the study of planktonic foraminifera and their applicability in Biostratigraphic zonation.

Cibicides brahmai sp. nov.

(Plate IV—13-16)

Description : Test trochospiral, planoconvex, spiral side flattened and evolute, umbilical side convex, involute, equatorial profile elongate oval, equatorial periphery almost entire, very weakly lobulate, axial profile vaulted, axial periphery acute, with thin keel ; chambers numerous, gradually increasing in size, about 8 to 9 in the last-formed whorl, last chamber much enlarged, chambers flush on the spiral side, excepting few early ones ; sutures curved, limbate, flush on the spiral side, radial, depressed, less curved on umbilical side ; umbilicus closed ; wall calcareous, coarsely perforate on spiral side, less so on umbilical side. Aperture elongate, high-arched slit at the base of the last-formed chamber, provided with a distinct, thin lip throughout the apertural length, extending from near umbilicus to periphery,

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./Holotype/887	0.40	0.30	0.15	1.30	2.66
Geol./L.U./Paratype/888	0.40	0.275	0.15	1.46	2.66
Geol./L.U./Paratype/889	0.30	0.225	0.10	1.33	0.3

Remarks : *Cibicides brahmai* n. sp., which is close to *Cibicides kleinpelli* Smith known from the Middle Eocene of Contra Costa County, California, is differentiated from the latter by its characteristic high-arched aperture, highly incised sutures on umbilical side, and convex umbilical side. The present species can also be distinguished from *Cibicides carinatus* (Terquem) emend. Le Calvez by its peculiar aperture, thin carina, and large number of chambers in the last whorl. Aperture in the present species shows some variation in its width and may extend either from midway between umbilicus and periphery, or from near umbilicus itself.

Type Horizon : Hard, dark brown marl unit, and soft, yellow marl unit.

Type Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Etymology : The species is named after Dr. Brahma Swaroop Tewari, Professor and Head of Geology, Punjab University, Chandigarh in recognition of his invaluable contribution to Indian Micropaleontology and Geology.

Cibicides sp. A

(Plate IV—11)

Description : Test trochospiral, planoconvex, spiral side flattened, evolute, umbilical side convex, involute, equatorial profile nearly circular, equatorial periphery lobulate, axial profile vaulted, axial periphery acute, carinate ; chambers numerous, gradually increasing in size except for last 3 rapidly enlarging chambers, about 6 in the last-formed whorl, flush with the surface on spiral side, inflated on umbilical side ; sutures curved, slightly limbate, flush with the surface on spiral side, curved, limbate, depressed, radial on umbilical side. Wall calcareous, coarsely perforate ; umbilicus with an umbonal boss. Aperture an elongate slit with distinct lip, extending from near umbilicus to periphery and also continuing on spiral side along spiral suture.

Dimensions (in mm.)

Specimen number	Max . diam.	D/T	Thickness
Geol./L.U./890	0.45	3	0.15

Remarks : The present form is a distinct species, but due to insufficient number of specimens, it cannot be studied in detail.

Horizon : Hard, dark brown unit.

Locality : ENE of Khirasra village of the Vinjhan Miani area, southwestern Kutch, Gujarat.

Cibicides sp. B

(Plate IV—14)

Description : Test concavo-convex, spiral side concave, umbilical side strongly convex,periphery lobulate, acute, with thin keel in the earlier part of the test ; chambers irregular in shape, in early portion gradually increasing in size, but in later stages increasing rapidly in size, about 7 in the last-formed whorl, flush with the surface on spiral side ; sutures indistinct on spiral side, curved, radial, depressed on umbilical side ; umbilicus deep, narrow ; wall calcareous, perforate ; Aperture an elongate narrow slit with a lip, extending from periphery to midway between umbilicus and periphery.

Dimensions (in mm.)

Specimen number	Max. diam.	Min. diam.	Thick-ness	Mx. d T	Mx. d mn.d
Geol./L.U./891	0.45	0.425	0.25	1.8	1.06

Remarks : The presence of a single specimen in material makes it difficult to study it in detail.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Cibicides sp. C

(Plate V—1-3)

Description : Test trochospiral, planoconvex, spiral side flattened, umbilical side convex, equatorial outline, nearly circular, equatorial periphery weakly lobulate, axial profile roughly ellipsoidal, axial periphery subacute, noncarinate ; chambers on umbilical side elongate in earlier portion, becoming broader in later ontogenetic stages, flush on spiral side, gradually increasing in size, about nine in the last-formed whorl ; sutures curved, limbate, flush on spiral side, less curved, less limbate, depressed on umbilical side ; wall calcareous, perforate ; aperture elongate, arched opening at the base of the last chamber, extending from across periphery to umbilicus, bordered by a distinct lip ; umbilicus reduced to a very narrow opening.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./892	0.25	0.225	0.15	1.11	1.66

Remarks : Because of single specimen, it cannot be worked out in detail.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Cibicides sp. D

(Plate V—5-6)

Description : Test planoconvex, compressed, trochospiral, spiral side flat and partially evolute, umbilical side strongly convex, involute, with a small central boss, equatorial profile nearly oval, equatorial periphery lobulate, axial periphery acute with a thin nonporous keel ; chambers flush on spiral side, distinct on umbilical side, not uniform in shape, longer than broad, gradually increasing in size, about 8 in the last whorl ; sutures limbate strongly curved, flush on spiral side, distinct, arcuate, depressed on umbilical side ; wall calcareous, coarsely perforate. Aperture an arched, equatorial opening that extends along the spiral suture to spiral side and also slightly to umbilical side.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./893	0.50	0.45	0.15	1.28	3.33

Remarks : As there is only one specimen of this form, it is not possible to describe it in detail.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Cibicides carinatus (Terquem) emend. Le Calvez

(Plate V—8-9, 11)

Truncatulina carinata Terquem, 1882, Mem. Soc. Geol. France, Ser. vol. 2, p. 94, pl. 10, figs. 1-2.

Cibicides carinatus (Terquem) emend Le Calvez, 1949, Mem. Service Carte Geol., Paris, France, p. 45, pl. 4, figs. 72-74.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./893	0.45	0.40	0.10	1.128	4.5
Geol./L.U./894	0.45	0.40	0.10	1.128	4.5
Geol./L.U./895	0.35	0.25	0.10	1.4	2.5

Remarks : The present specimens are referable to *Cibicides carinatus* (Terquem) emend. Le Calvez recorded previously from the Lutetian stage of Paris basin. The last chamber is considerably enlarged and shows rapid increase in size. The wall perforations on spiral side are coarser than those on umbilical side. Aperture varies in length ; in some it is extended, while in others it is restricted to periphery only.

Horizon : Hard, dark brown marl unit, and soft, yellow marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Cibicides lobatulus (Walker and Jones)

(Plate V—4, 7, 10, 12)

Nautilus lobatulus Walker and Jacob, 1798, Adams Essays, Karm. Ed. p. 642, pl. 42, fig. 36.

Cibicides lobatulus (Walker and Jacob)—Kaasschieter, 1955, Vesh. Kon. Nederl. Akad. Wetensch, afd. Natuurk, Ser. 1, vol. 21, no. 2, p. 94, pl. 11, fig. 5,- Butt. 1966, Late Oligocene foraminifera from Escornebeou, SW France, Schotanus Jens-Utrecht, N. V., Utrecht (Nederland), p. 67, pl. 4, fig. 5-7.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./896	0.60	0.50	0.25	1.2	2.4
Geol./L.U./897	0.40	0.30	0.15	1.303	1.66
Geol./L.U./898	0.55	0.45	0.20	1.22	2.85

Remarks : The present specimens are supposed to be the variants of *Cibicides lobatulus*. They are characterized by compressed, thin, oval test, large last chamber, inflated chambers on umbilical side, acute, thinly carinate periphery, slightly curved, radial sutures, narrow, deep umbilicus, and a high-arched peripheral aperture with a distinct lip, extending to spiral side.

Horizon : Hard, dark brown marl unit, and soft, yellow marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Cibicides lobatulus constricta subsp. nov.

(Plate V—13, Plate VI—1-8)

Description : Test trochospiral, longer than broad, planoconvex, with flat, evolute spiral side and strongly convex, involute umbilical side, equatorial profile nearly circular to oval, equatorial periphery lobulate and strongly constricted at the last two chambers, axial profile conical to hemispherical, axial periphery acute with thin keel ; chambers distinct, flush on spiral side, raised and inflated on umbilical side, about eight to ten in the last whorl, gradually increasing in size, last 2-3 chambers increasing rapidly in size, last chamber deeply notched at the margins ; sutures, on spiral side distinct, curved, limbate, on umbilical side depressed, radial ; umbilicus, on spiral side covered with secondary shell material, on umbilical side narrow and shallow. Wall calcareous, perforate, surface smooth. Aperture an arched slit at the base of the last chamber, peripheral in position, slightly extended to spiral side, bordered with a distinct lip.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./Holotype/ 899	0.35	0.25	0.15	1.4	2.33

Geol./L.U./Paratype/ 900	0.35	0.25	0.15	1.4	2.33
Geol./L.U./Paratype 901	0.40	0.30	0.15	1.33	2.66
Geol./L.U./Paratype 902	0.40	0.30	0.15	1.33	2.66

Remarks : The proposed species is very much allied to *Cibicides lobatulus* (Walker and Jacob) but can be easily distinguished by its carinate periphery and thickening of the spiral sutures of the early portion. It markedly differs from *Cibicides lobatulus patalensis* Haque known from the Palaeocene (Ranikot Series) of the Nammal gorge, Salt Range, Western Pakistan in its completely involute umbilical side, large last chamber, and aperture that extends across the periphery on both sides.

Type Horizon : Hard, dark brown marl unit.

Type Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Etymology : The species is named on its characteristic feature of peripheral constriction.

Cibicides megaloperforatus Said and Kenawy

(Plate VI—9-10)

Cibicides megaloperforatus Said and Kenawy, 1956, *Micropaleontology*, vol. 2, no. 2, p. 155, pl. 7, fig. 13a-c.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./903	0.35	0.25	0.15	1.4	2.33

Remarks : In its buckled test, acute, lobulate periphery, 6 chambers in the last whorl, considerably large last chamber, narrow umbilicus, and slit-like aperture, the present specimen accords well with *Cibicides megaloperforatus* Said and Kenawy recorded from the Palaeocene of northern Sinai, Egypt. The aperture in the present specimen is a high-arched opening, proivded with a distinct lip, and is seen extending from across periphery to near umbilicus.

Horizon : Hard, dark brown marl unit.

Locality—ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Cibicides molacus Poag

(Plate VI—11-14)

Cibicides molacus Poag, 1966, *Micropaleontology*, vol. 12, no. 4, p. 418, pl. 48, figs. 13-15.

Dimensions (in mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./904	0.30	0.275	0.15	1.09	2
Geol./L.U./905	0.30	0.25	0.15	1.2	2

Remarks : In their keeled periphery, 10-12 chambers in the last-formed whorl, clear shell material in the umbilical depression, coarsely perforate spiral side, finely perforate umbilical side, and a low-arched, slit-like aperture extending from across periphery to spiral side along spiral suture, these specimens are comparable with *Cibicides molacus* Poag recorded from the Lower Miocene ? Paynes Hammock formation but differ in having acute periphery, less thickened sutures, and a central area of clear shell material on umbilical side.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Superfamily Orbitoidacea Schwager, 1876

Family Acervulinidae Schultze, 1854

Genus *Sphaerogypsina* Galloway, 1933

Sphaerogypsina globulus (Reuss)

(Plate VI—16)

Sphaerogypsina globulus (Reuss)—Galloway, 1933, A manual of foraminifera : Principia Press, Indiana, U.S.A., p. 309.

Dimensions (in mm.)

Specimen number	Max. Diameter
Geol./L.U./906	0.95

Remarks : The form referable to *Sphaerogypsina globulus* is represented by a single specimen. It is characterized by a large globular test with roughly circular to polygonal chambers, each having several large pores. Tewari and Bhargava (1966) reported it from the Oligocene rocks of Waghopadar, southwestern Kutch.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Superfamily Cassidulinacea d'Orbigny, 1839

Family Nonionidae Schultze, 1854

Subfamily Nonioninae Schultze, 1854

Genus *Florilus* de Montfort, 1808

Florilus sp.

(Plate VII—1-3)

Description : Test large, planispiral, involute on both sides, longer than broad ; chambers low, gradually increasing in length, about 8-10 in the last-formed whorl ; last chamber triangular in apertural view ; the pointed ends of all the chambers seen projecting into the umbilicus; sutures slightly curved, radial, depressed ; umbilicus depressed, with granular shell material extending into the depressed sutures ; wall calcareous, perforate ; aperture peripheral, a small slit present at the base of the last-formed, large chamber.

Dimensions (mm.)

Specimen number	Length	Breadth	Thick-ness	L/B	L/T
Geol./L.U./907	0.50	0.40	0.30	1.25	1.66
Geol./L.U./908	0.45	0.35	0.25	1.28	1.8

Remarks : The above specimens seem allied to *Florilus microumbilicus* (Le Roy) in the shape of the test, large last chamber and number of chambers in the last whorl, but differ in smooth periphery, depressed sutures, and papillate umbilicus. They seem to represent a distinct species, but lack of sufficient specimens rules out describing them as a new species.

Horizon : Hard, dark brown marl unit, and soft, yellow marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Family Anomalinidae Cushman, 1927

Subfamily Almaeninae Myatlyiuck, 1959

Genus *Anomalinella* Cushman, 1927

Anomalinella kutchensis Singh and Saxena

(Plate VII—7-8)

Anomalinella kutchensis Singh and Saxena, 1976 Jour. Pal. Soc. India, vol. 19, p. 38, pl. 2, figs. 1-4, pl. 3, figs. 4-6.

Dimensions (in mm.)

Specimen number	Max. diam.	Min. d.	Thick-ness	Mx.d. Md.d.	Mx.d. T.
Geol./L.U./909	0.70	0.60	0.35	1.16	2
Geol./L.U./910	0.80	0.70	0.45	1.14	1.77
Geol./L.U./911	0.65	0.55	0.30	1.18	2.16

Remarks : The present forms, which are in close agreement with *Anomalinella kutchensis* Singh and Saxena recorded from the Lakhpat Series (Oligocene) of Bermota village, Kutch, differ from the type species in having exceptionally high dimensions, more thickened sutures and peripheral keel, and almost symmetrical primary aperture extending equally to both sides.

Anomalinella Kutchensis in the present study has been recorded from the latest part of Oligocene. Its nearly symmetrical nature of aperture suggests that the present representatives of the species are closer to *Anomalinella* (*Anomalinella*) and possibly represent an advanced stage of evolutionary change from *Preanomalinella* to *Anomalinella*. See Singh and Saxena, 1976.

Horizon : Hard, dark brown marl unit, and soft, yellow marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

Anomalinella sp.

(Plate VII—9-14)

Description : Test planispiral, completely involute, inequally biconvex, biumbonate, circular to slightly oblong in equatorial profile, equatorial periphery entire, thickened, imperforate, raised above the surface, in axial profile elliptical, axial periphery acute, with thick keel ; chambers gradually enlarging, 11-12 in the last whorl, slender, longer than broad ; sutures non-perforate, distinct, radial, slightly curved, considerably thickened, raised above the surface, occupying the major portion of the test. Umbonal region on both sides much enlarged and extensive, made up of clear shell material, imperforate ; wall calcareous, granular in appearance, coarsely perforate ; primary aperture interiomarginal, low-arched, peripheral, bordered with a distinct lip, slightly extending across the periphery, almost symmetrical ; supplementary aperture situated in the last chamber, an elongate narrow slit, running parallel to the keel.

Dimensions (in mm.)

Specimen number	Max. diam.	Min. diam.	Thick-ness	Mxd. Mnd.	Mxd. T
Geol./L.U./912	0.375	0.35	0.20	1.07	1.87
Geol./L.U./913	0.35	0.30	0.15	1.16	2.15

Remares : Anomalinella sp. is different from the rest of the known species in its smaller dimensions, large number of chambers in the final whorl, and exceptionally thickened, extensive sutural and umbonal areas. In *Anomalinella kutchensis*, from which these specimens markedly differ, the sutural and umbonal areas are not as thickened and extensive as in the latter. Lack of sufficient number of specimens does not favour creating a new species.

Horizon : Hard, dark brown marl unit.

Locality : ENE of Khirasra village of the Vinjhan-Miani area, southwestern Kutch, Gujarat.

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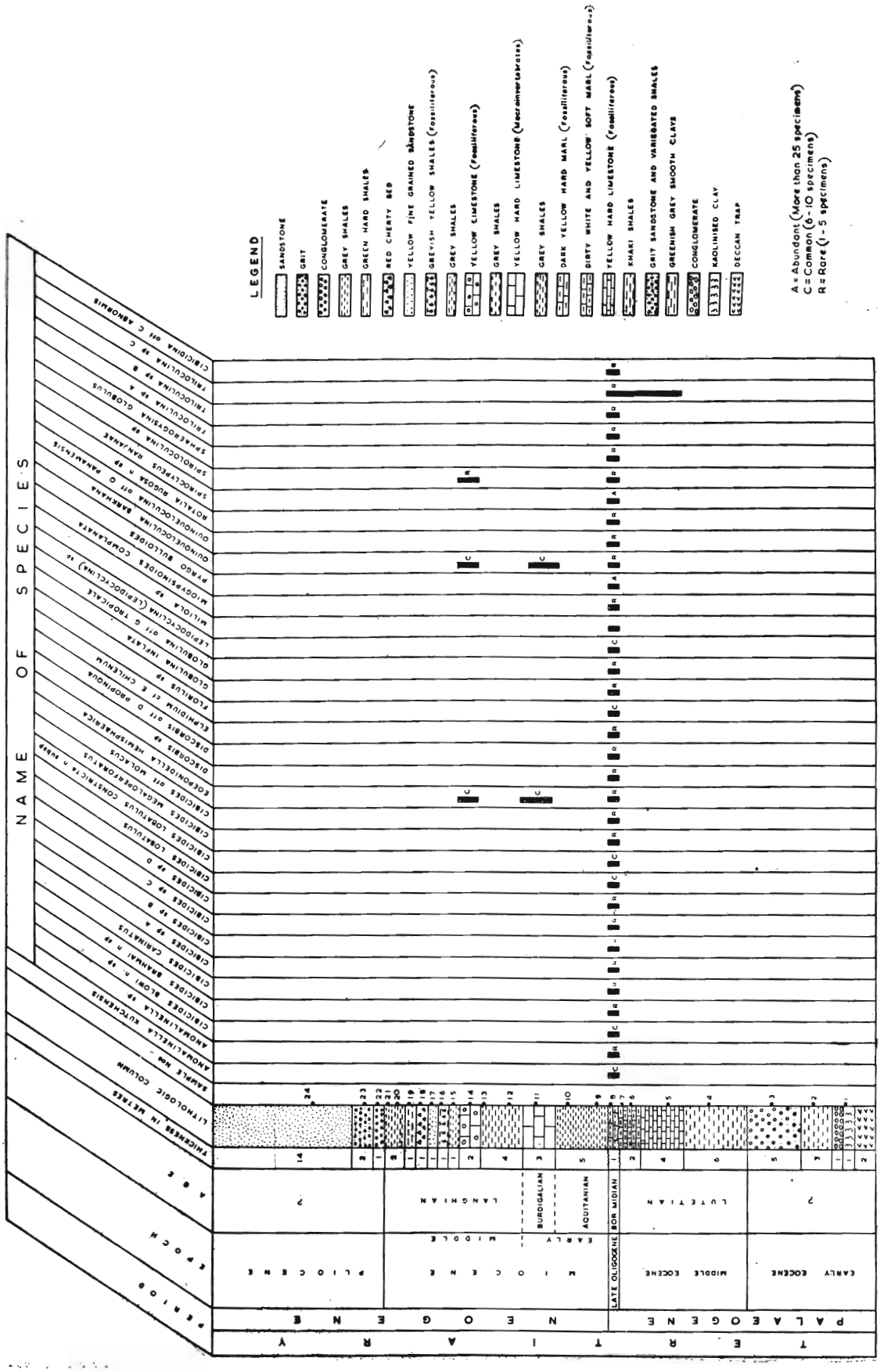

CHART-1 SHOWING FREQUENCY DISTRIBUTION OF LATE OLIGOCENE BENTHONIC FORAMINIFERA

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EXPLANATION OF PLATES

PLATE I

1 *Spiroloculina* sp., side view, ×115.
2-3 *Quinqueloculina barkhana* Mohan and Bhatt, both side views, ×115
4-5 *Quinqueloculina* aff. *Q. panamensis* Cushman, both side views, ×115.
6-7 *Triloculina* sp. A, both side views, ×115.
8-9 *Triloculina* sp. B, both side views, ×115.
10-11 *Triloculina* sp. C, both side views, ×115.

PLATE II

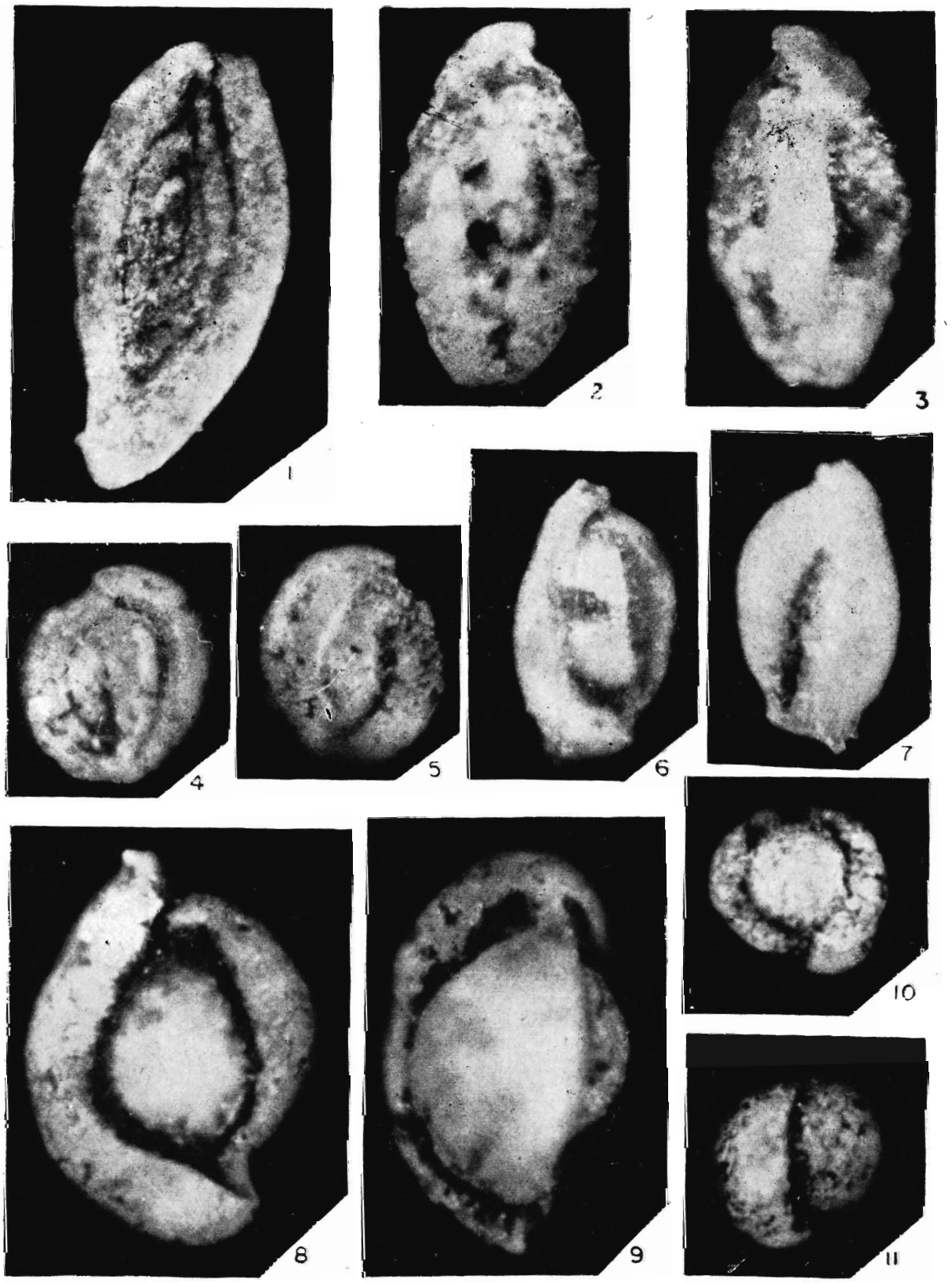
1 *Triloculina* sp. C, top view, ×115
2 *Globulina inflata* Reuss, side view, ×115
3-4 *Pyrgo bulloides* (d'Orbigny), 3 side view, ×115 ; 4 side view, ×115
5-6 *Miliola* sp., both side views, ×115
7-8 *Globulina* aff. *G. tropicale* Petri, both side views, ×115.

PLATE III

1-2 *Eeoeponidella hemisphaerica* (Cushman), 1 spiral view, 2 umbilical view, ×100
3-5 *Discorbis* aff. *D. propinqua* (Terquem) emend. Le Calvez, 3 spiral view, 4 umbilical view, 5 apertural view, ×100.
6-7 *Discorbis* sp., 6 spiral view, 7 umbilical view, ×100
9-10 *Rotalia* sp., 9 umbilical view, ×100 ; 10 umbilical view, ×100
8,11-13 *Elphidium* cf. *Elphidium chilenum* Todd and Kniker, 8 side view, ×115 ; 11-12 side views, 13 apertural view, ×115.

PLATE IV

1-3 *Cibicidina* aff. *Cibicidina abnormis* (Pishvanova), 1 umbilical view, 2 spiral view, 3 apertural view, ×115.
4-10 *Cibicides blowi* n. sp., 4 Paratype, umbilical view, ×100 ; 5-6 Paratype 5 spiral view, 6 umbilical view, ×100 ; 7-9 Holotype, 7 umbi view, 8 spiral view, 9 apertural view, ×100 ; 10 Paratype, umbilical view, ×115.
11-12 *Cibicides* sp. A., umbilical view, ×115; *Cibicides* sp. B., umbilical view, ×115
13-16 *Cibicides brahmai* n. sp., 13-15 Holotype, 13 umbilical, side 14 spiral view, 15 apertural view, ×115 ; 16 umbilical view, ×115,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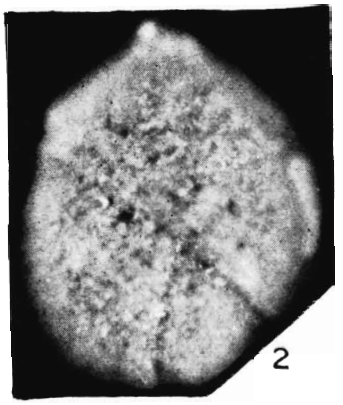

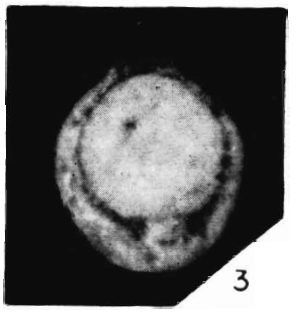

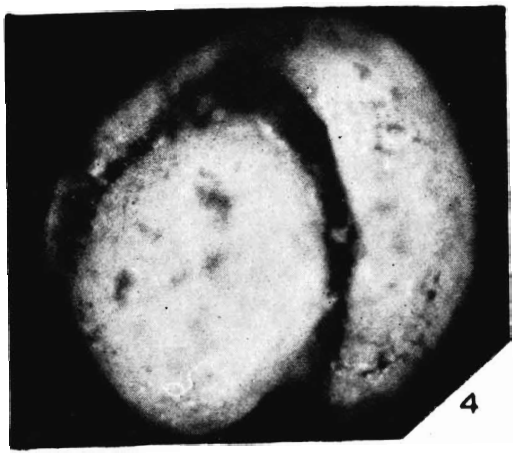

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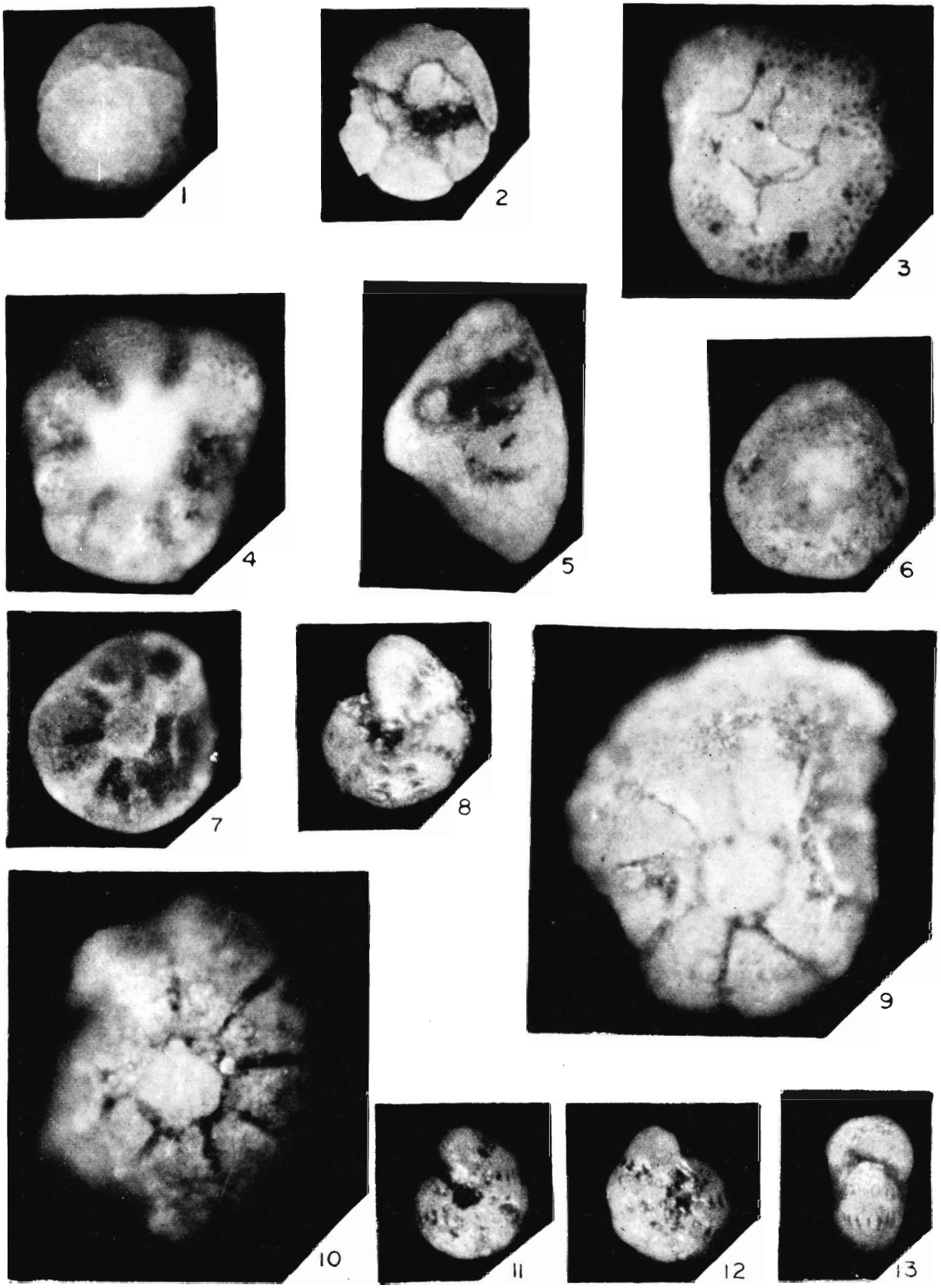
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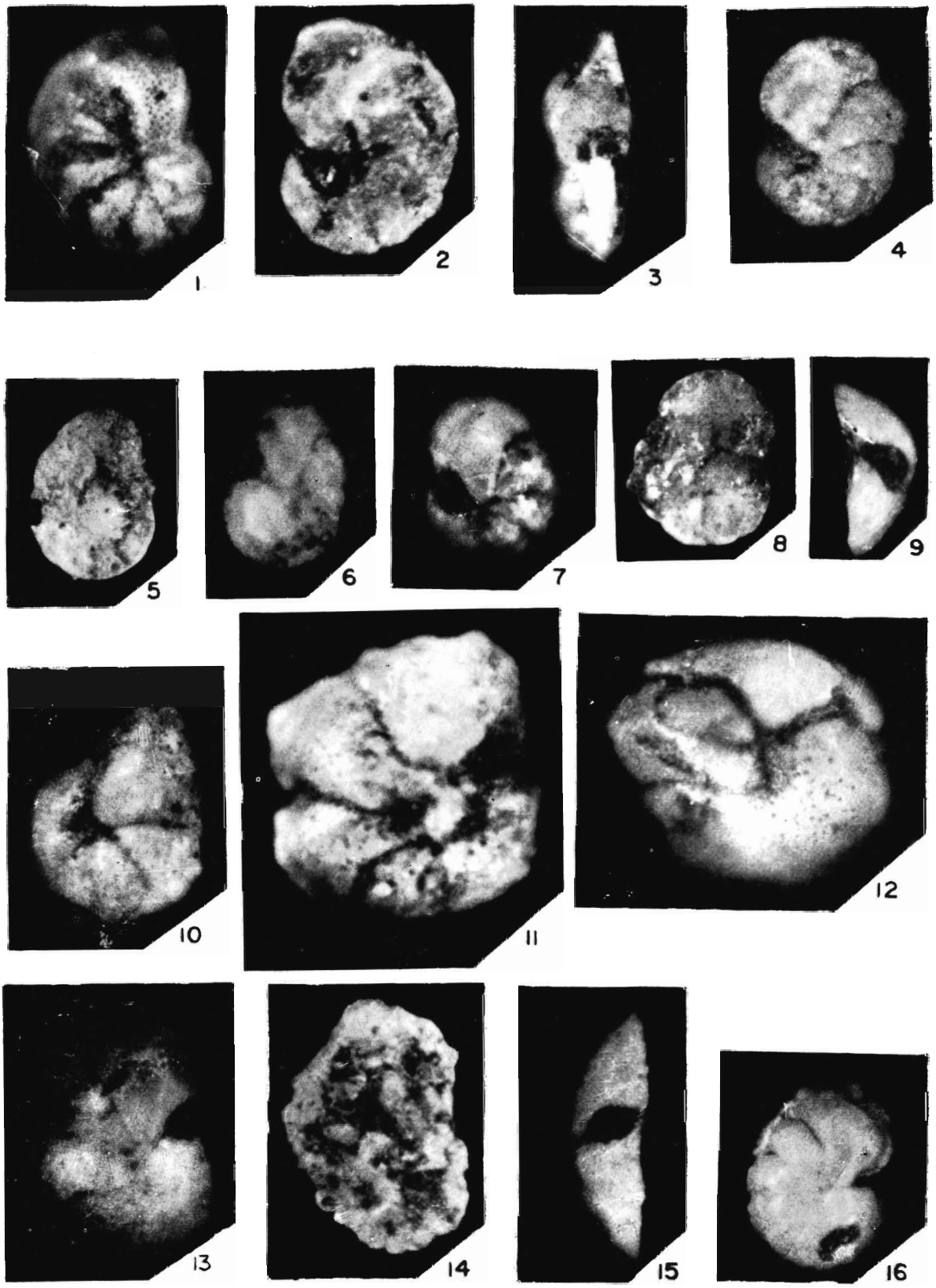
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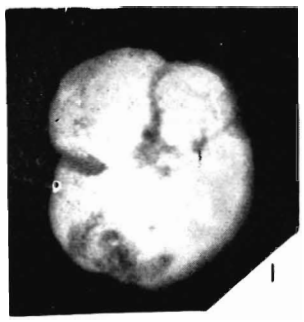
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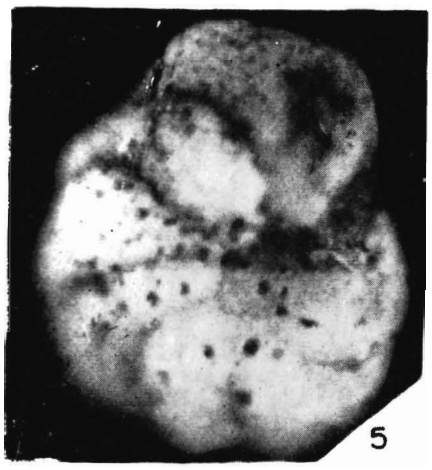
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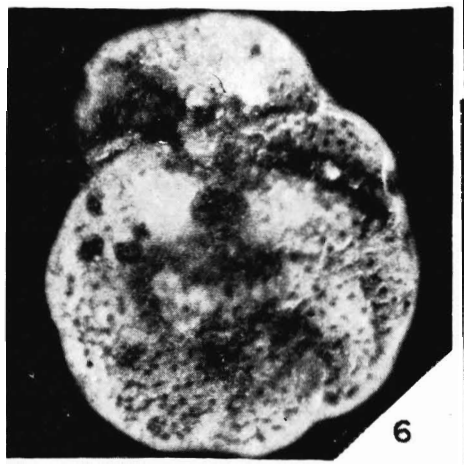
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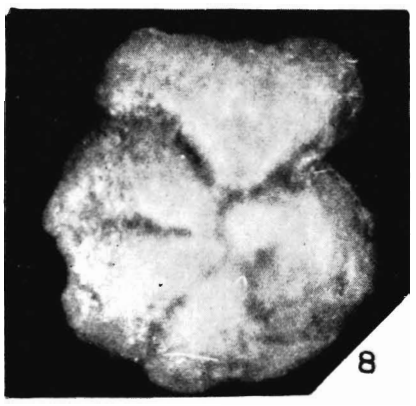
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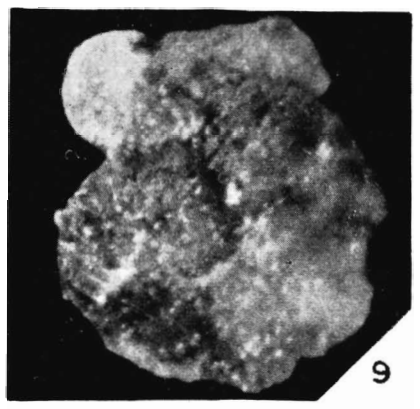
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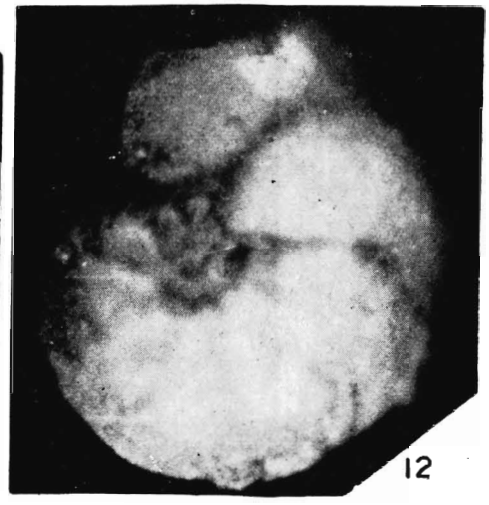
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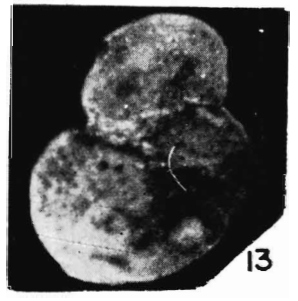
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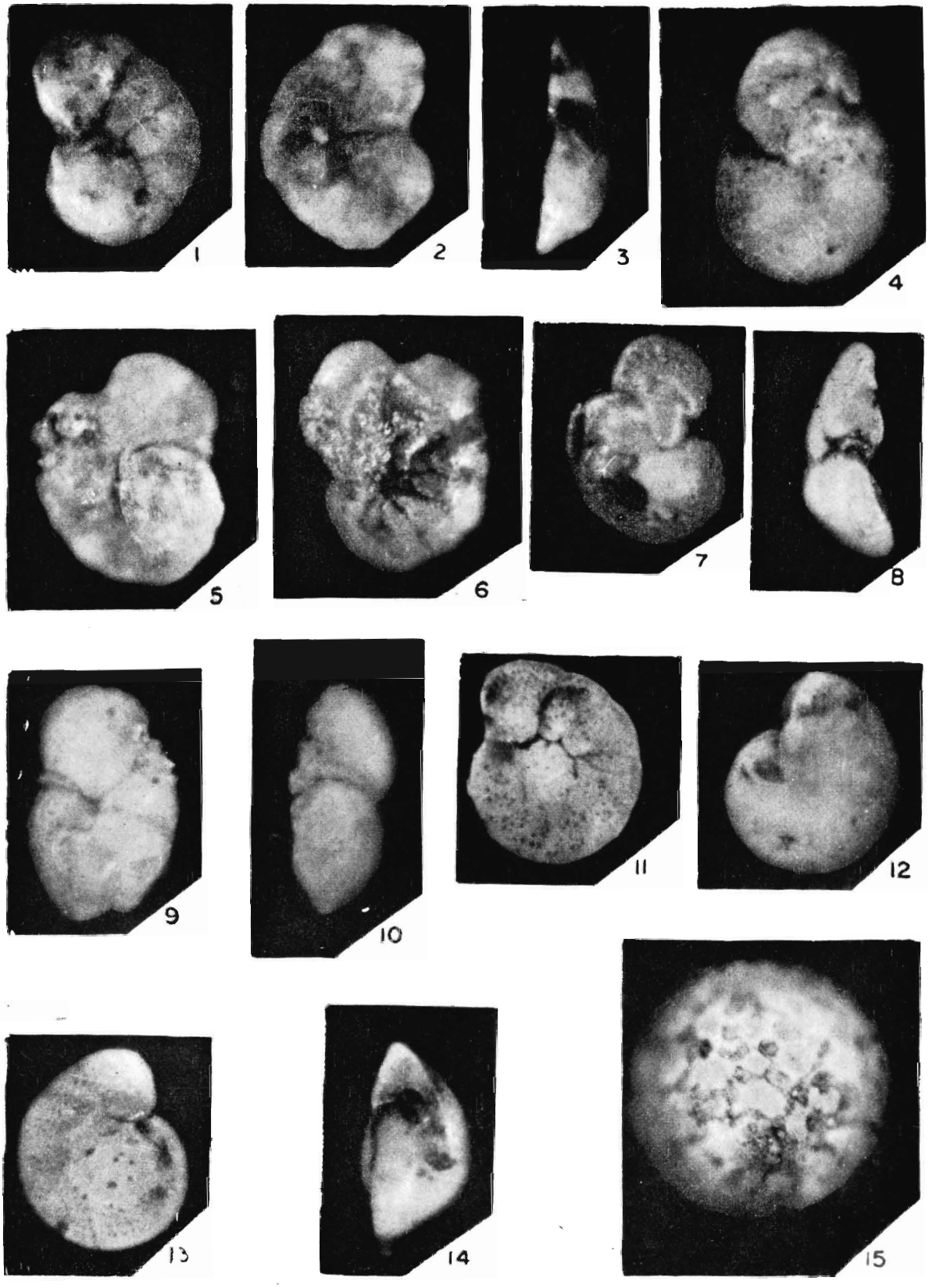
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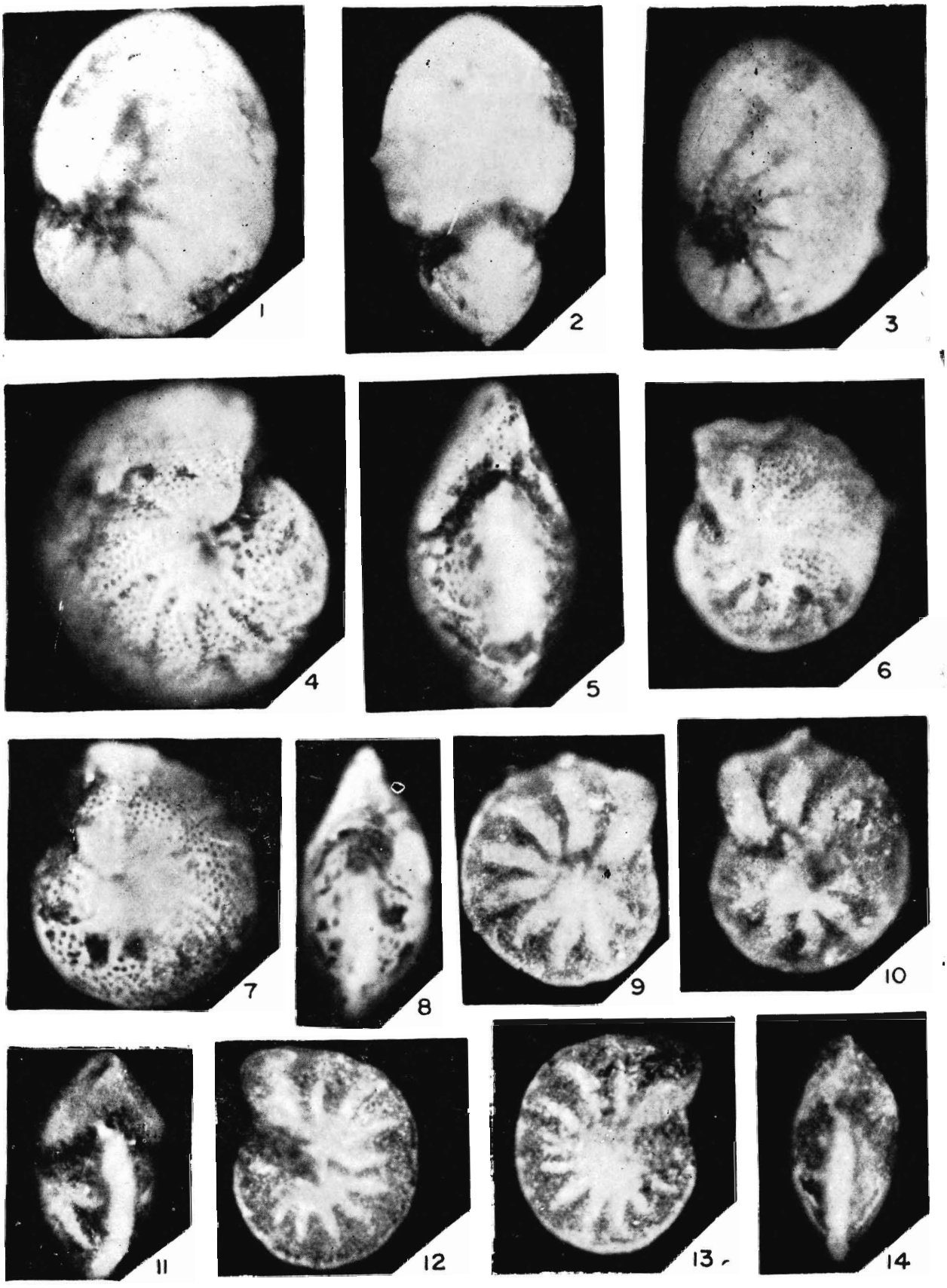
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Plate V

1-3 *Cibicides* sp. C., 1 umbilical view, 2 spiral view, 3 apertural view, ×115.
5-6 *Cibicides* sp. D, 5 umbilical view, 6 spiral view, ×115
8-9,11 *Cibicides carinatus* (Terquem) emend. Le Calvez, 8 umbilical view, 9 spiral view, 11 umbilical view, ×115
4,7,10 *Cibicides lobatulus* (Walker and Jones), 4 umbilical view, 7 spiral view; ×115 ; 10 apertural view, ×115 ; 12 spiral view, ×115.
nd 12
13 *Cibicides lobatulus constricta* n. subsp., 13 Paratype, spiral view, ×115.

Plate VI

1-8 *Cibicides lobatulus constricta* n. subsp., 1-3 Holotype, 1 umbilical view, 2 spiral view, 3 apertural view, 115 ; 4 Paratype, umbilical view, ×115 ; 5-6 Paratype, 5 spiral, 6 umbilical view, ×115 ; 7-8 Paratype, 7 umbilical view, 8 apertural view, ×115.
9-10 *Cibicides megaloperforatus* Said and Kenawy 9 umbilical view ; 10 apertural view, ×115.
11-14 *Cibicides molacus* Poag., 11 spiral view, ×115 ; 12 umbilical view, 13 spiral view, 14 apertural view, ×115.
15 *Sphaerogypsina globulina* (Reuss), 15 external view, ×47.

Plate VII

1-3 *Florilus sp.* 1, 3 side views, 2 apertural view, ×115
5-8 *Anomalinella kutchensis*, 4 side view, 5 apertural view, ×71 ; 6-7 side views, 8 apertural view, ×50.
9-14 *Anomalinella* sp., 9-10 side views, 11 appertural view, ×115 ; 12-13 side views, 14 apertural view, ×115.