

FOSSIL HOLOTHUROIDS FROM MIDDLE EOCENE ROCKS OF KUTCH, INDIA

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ABSTRACT

The paper records fourteen genera (two new, namely *Kutchia* and *Koteshwaria*) under six families, i.e. Stichopitidae, Calclamnidae, Etheridgellidae, Priscopedatidae, Synaptitidae and Calcancoridae from Middle Eocene rocks of Kutch, India. Forty-eight species of holothuroid sclerites are recorded and described out of which forty-one are new. This is the first record of fossil holothuroid sclerites from Middle Eocene rocks of Indian subcontinent.

INTRODUCTION

In recent years fossil holothuroids have drawn the attention of stratigraphers and palaeontologists, as they have definite stratigraphical distribution and palaeoecological significance. Records of fossil holothuroids from India are few and are known only from Cretaceous of Trichinopoly (GOWDA, 1954), Pleistocene core samples off coast from Bombay (ZAFAR, 1970) and Jurassic-Palaeocene rocks of Kutch (SOODAN, 1972, 1973, 1975). The present work is the first attempt to study the Middle Eocene holothuroids of India from the rocks exposed in Ratchelo nala section about 2 km S15°E of Baranda (23°34'20" : 68°43'10"), S. W. Kutch. The biostratigraphic classification (TANDON, 1966, 1976) of the Middle Eocene rocks exposed in between above nala section and Jhadwa village (23°30'30" : 68°36'30") is as follows (in descending order) :

LOWER OLIGOCENE (MANIARA STAGE, LATTORFIAN)

..... unconformity

Nummulites maculatus Zone (± 20 m thick)—This zone consists of hard, compact, highly fossiliferous white and cream coloured limestones.

Asterocyclina alticostata Zone (± 12 m thick)—It consists of highly fossiliferous cream and white marls and limestones. Badly preserved fossil holothuroids present.

Assilina cancellata Zone (± 12 m thick)—Rocks consist of fossiliferous white and cream coloured sandy marls and limestones.

Discocyclina (Discocyclina) dispansa Zone (± 2.5 m thick)—This fossiliferous zone consists of light grey sandy marls and clays with nodules of pyrites.

Fasciolites (Fasciolites) elliptica Zone (± 3 m thick)—This zone consists of highly fossiliferous white and cream coloured sandy marls with small limonitic nodules.

M Upper part more calcareous and compact.

I *Nummulites beaumonti* Zone (± 6.5 m thick)—It consists of fossiliferous greenish grey and brown clays and marls. Zone is very rich in fossil holothuroid remains.

D *Nummulites perforatus* Zone (± 5.5 m thick)—Zone consists of highly fossiliferous pale olive marls, clays and limestone partings with tinges of dusky yellow colour and separable with overlying zone by a thin limonitic gypseous band. Few fossil holothuroids present.

- E Unfossiliferous zone (± 1.5 m thick)—Lithologic contents are light brown clays containing yellowish clayey concretions and gypsum.
- C *Crocodylus* Zone (1 to 1.5 m thick)—Rock consists of greyish black coloured, sulphide rich gritty clays with a 6 to 10 cm thick limonitic and gypsified dark red band at the base.
- E Dicot leaf zone (± 2.5 m thick)—Consists of yellowish grey clays containing very thin partings of carbonaceous matter and lignite.
.....contact not seen.....
- Corbula subexarata* Zone (± 4.7 m thick)—Zone consists of fossiliferous olive clays and brown clayey limestones. Well preserved fossil holothuroids are present but very rare.
- Unfossiliferous zone (± 21.5 m thick)—Consists of unfossiliferous red ferruginous clayey shales, pale brown, yellowish grey and pale olive gypseous clays and sands.
..... unconformity

LOWER EOCENE

In this paper, the holothuroid faunal assemblage has been studied from *Corbula subexarata* Zone, *Nummulites perforatus* Zone and *Nummulites beaumonti* Zone. In the former two zones the holothuroid sclerites are very rare while the last mentioned zone is rich in holothuroids. Although, they are also present in *Asterocyclina alticostata* Zone but the preservation is very poor and complete specimens could not be isolated. An attempt is being made to isolate the holothuroid sclerites for their study from this zone.

The classification of fossil holothuroid sclerites has been followed after FRIZZELL AND EXLINE (1966) except in case of family Priscopedatidae which has been emended by SOODAN (1975).

The fossil holothuroids have been isolated from shales, marls, clays and clayey limestones by boiling in sodium bicarbonate mixed water. But when treated with dilute acetic acid a good number of sclerites are partly dissolved or effected.

In systematic descriptions of new species where type locality and type horizon have not been given, are as follows :

Type Locality—About 3.6 km S15°E of Baranda village in a nala section, Kutch, India.

Type Horizon—*Nummulites beaumonti* Zone, Lutetian, Middle Eocene.

All the holotypes, syntypes, paratypes and hypotypes are in author's collection, Geology Department, Lucknow University, Lucknow, India.

SYSTEMATIC DESCRIPTION

Phylum—ECHINODERMATA

Class—HOLOTHUROIDEA

Family—STICHOPITIDAE Frizzel & Exline, 1955

Genus—**Kutchia** gen. nov.

Type Species : *Kutchia tewarii* gen. et sp. nov.

Diagnosis—Sclerite in form of multiradiate solid arms in one plane ; ornamented with pits or smooth with a subcentral or excentric spire and/or stirrup present on one side ; opposite side without any depression or perforation.

Stratigraphic Horizon—Lutetian, Middle Eocene.

Remarks—*Kutchia* gen. nov. somewhat resembles *Tetravirga* Frizzell & Exline, but differs

from it in having a subcentral or excentric spire and multiradiate 3 to 5 solid arms at different angles, whereas in the latter genus the number of arms is 4, at right angles and grooves or slots are present at the tips of the arms which are absent in this new genus. *Kutchia* also differs from *Cucumurites* Deflandre-Rigaud in having a subcentral or excentric spire and solid arms.

***Kutchia tewarii* gen. et sp. nov.** (Pl. 1, Fig. 1)

Description—Sclerite consists of five solid elongate arms in one plane, unequal in length, three arms at an angle of about 80° and 100°, broad at base, narrow and rounded at apex, the angle between remaining two arms about 120° with pointed or tapering apex, arms elliptical in cross-section ; a well-developed, high, broad, circular, sub-central spire present on one side of the sclerite ; both sides of the sclerite ornamented with very small longitudinal and polygonal pits, sides of the spire also pitted, opposite side slightly concave.

Measurements in mm

	Diameter of sclerite across the arms		Height of spire	Diameter of spire
	Longer	Shorter		
Holotype No. L. U. H. 302	0.712	0.65	0.063	0.087
Paratype No. L. U. H. 303	0.675	0.637	0.125	0.106
	0.437	0.337	0.06	0.056

Remarks—It is a rare species. As the sclerite is highly pitted, it is very difficult to differentiate between stirrup and longitudinal raised ridges of the pits. One of the arms of holotype near apex slightly broken but appears to be pointed which is so in paratype.

Kutchia tewarii gen. et sp. nov. differs from *Kutchia jhingrani* sp. nov. in having five arms and with slightly shifted subcentral spire while in the latter species it is highly excentric and has four arms.

Etymology—This species is named after Prof. B. S. Tewari, Head of the Geology Department, Panjab University, Chandigarh, in recognition of his work in Kutch.

***Kutchia jhingrani* sp. nov.** (Pl. 1, Fig. 2)

Description—Sclerite consists of four solid elongate arms in one plane, arms opposite to each other, broad at base, elliptical in cross-section, apex broadly rounded, three arms almost of equal length while fourth slightly smaller, arms at different angles ; on one side of the sclerite a prominent circular, very high, broad, excentric spire present at the base of one of the arms ; both sides of sclerite and sides of spire ornamented with small longitudinal and polygonal pits ; opposite side flat.

Measurements in mm

	Diameter of sclerite across the arms		Height of spire	Diameter of spire
	Longer	Shorter		
Holotype No. L. U. H. 304	0.525	0.487	0.152	0.112
Paratype No. L. U. H. 305	0.7	0.663	0.75	0.087
	0.825	0.812	—	—
	0.725	0.687	—	—

Remarks—It is a rare species. The spire is not perfectly vertical but slightly inclined in holotype.

Etymology—This species is named in honour of Late Prof. A. G. Jhingran, former Head of the Geology Department, Delhi University, Delhi.

Kutchia naredaensis sp. nov. (Pl. 1, Fig. 3)

Description—Sclerite consists of three unequal elongate arms in one plane, arms broad at base, apex broadly rounded and elliptical in cross-section, two longer arms almost opposite to each other but not in a straight line, smallest arm in between two longer arms comparatively much broader at the base than the remaining two, just opposite to the shortest arms the outer margin of the sclerite slightly protruded and it may be a very short arm; spire prominent, low, broad, circular, excentric in position and at the base of the shortest arm; surface of the sclerite ornamented with small polygonal and elongate pits, the latter one are present in the central area or where the arms meet, sides of the spire also ornamented with pits; opposite side slightly convex and also pitted with similar pits present on spiral side.

Measurements—Holotype No. L. U. H. 306; longer diameter of sclerite across the arms 0.897 mm; shorter diameter of sclerite across the arms 0.493 mm; height of spire 0.094 mm and diameter of spire 0.087 mm.

Remarks—Only one specimen has been met with. In holotype on one of the sides of the spire a sand grain is attached due to which in photograph it appears to be elongate transversely and the pits are generally polygonal in shape.

Kutchia naredaensis sp. nov. differs from *Kutchia jhingrani* sp. nov. in having three arms where as in the latter species there are four well developed arms. This new species also differs from *Kutchia tewarii* sp. nov. in number of arms and position of the spire.

Genus—**Uncinulina** Terquem, 1862

Uncinulina subrecta Frizzell & Exline (Pl. 3, Text-fig. 16).

Uncinulina polymorpha Terquem (in part), 1862, pp. 433-434, pl. 5, fig. 7a.

Uncinulina subrecta Frizzell & Exline, 1955, p. 64, pl. 1, fig. 9.

Description—Sclerite in form of 'C' rod, slightly arched and pointed at both ends.

Measurements—Hypotype No. L. U. H. 307; length of rod 1.13 mm and maximum diameter of rod 0.13 mm.

Remarks—Only one specimen has been met with.

The specimen is identical to *Uncinulina subrecta* Frizzell & Exline but is slightly smaller in size.

Locality—About 3.6 km S15°E of Baranda village in a nala section, Kutch, India.

Horizon—*Nummulites beaumonti* Zone, Lutetian, Middle Eocene.

Family—**Calclamnidae** Frizzell & Exline, 1955

Genus—**Calclamna** Frizzell & Exline, 1955

The species described here have been provisionally kept under the genus *Calclamna* because FRIZZELL AND EXLINE in Monograph (1955), p. 76 define it as "Sclerite in form of a bilaterally symmetrical perforate plate, rectangular or sub-rectangular, relatively wide, perforations in cruciform pattern or with more than two rows of holes", while in the Treatise (MOORE) part 'U' Echinodermata 3, p. U664 it has been described by them as "Bilaterally symmetrical broad plate, hole pattern cruciform of more than two holes". There is omission of the sentence "or more than two rows". Probably it is a printing error

and should have been printed as, "or more than two rows of holes", instead of, "of more than two holes". Our specimens show somewhat bilateral symmetry and the plates have more than two rows of perforations. Therefore, the forms have been kept under this genus.

Calclamna harudiensis sp. nov. (Pl. 2, Text-figs. 1, 2)

Description—Sclerite in form of perforate plate, thin, flat, medium in size, subrectangular to oval in shape, almost bilaterally symmetrical, periphery irregularly scalloped, perforations large to small in size, varying from 26 to 43 in number, oval, subcircular and elongate ; four slightly oblique, longitudinal rows of perforations at an angle of about 80° to 85°, near the periphery smaller perforations also present. Length of the plate varies from 0.35 to 0.44 mm and breadth is inbetween 0.225 and 0.32 mm and ratio of breadth and length from 1 : 1.34 to 1 : 1.6.

Measurements in mm

	Length of sclerite (L)	Breadth of sclerite (B)	Number of perforations	L/B
Holotype No. L. U. H. 308	0.4	0.28	38	1.42
Paratype No. L. U. H. 309	0.35	0.225	26	1.6
	0.35	0.26	26	1.34
	0.44	0.32	43	1.37

Remarks—This is a common species.

Calclamna harudiensis sp. nov. differs from *Calclamna germanica* Frizzell & Exline, in not having cruciform arrangement of perforations and shape of the plate. It also differs from *Calclamna* sp. 1 and *Calclamna* sp. 2 described by HANNA, in shape of the plates and nature of the arrangement of rows of the perforations.

Calclamna ramwaraensis sp. nov. (Pl. 2, Text-figs. 3, 4)

Description—Sclerite in form of elongate perforate plate, thin, flat, medium in size, broadest almost in the middle, periphery irregularly scalloped, both ends of the plate rounded ; the plate slightly bulges out on one of the longitudinal sides ; two central elongate rows of large perforations are followed on each side by a single incomplete row of 2 to 6 small perforations, each central row has 5 to 8 perforations, shape of the perforations generally oval. The number of perforations in plates varies from 17 to 26. Length of sclerite is inbetween 0.287 and 0.344 mm ; breadth from 0.156 to 0.194 mm and ratio of breadth to length varies from 1 : 1.77 to 1 : 1.95.

Measurements in mm

	Length of sclerite (L)	Breadth of sclerite (B)	Number of perforations	L/B
Holotype No. L. U. H. 310	0.344	0.194	17	1.77
Paratype No. L. U. H. 311	0.331	0.169	21	1.95
	0.287	0.156	26	1.83

Remarks—It is a common species. In paratype (Pl. 2, Text-fig 4) periphery of sclerite is more scalloped and the size of the perforations are comparatively smaller than the holotype.

Calclamna ramwaraensis sp. nov. differs from *Calclamna harudiensis* sp. nov. in the shape of the plate and number of perforations. It also differs from *Calclamna germanica* Frizzell & Exline in having elongate rows of perforations while in the latter species the perforations are arranged in a cruciform pattern.

Genus—**Calclamnella** Frizzell & Exline, 1955

Calclamnella agrawali sp. nov. (Pl. 2, Text-fig. 5)

Description—Sclerite in form of elongate perforate plate, slightly curved, somewhat rectangular in shape, periphery highly scalloped, generally each perforation is bounded by a scallop, perforations slightly offset, large, oval to sub-pentagonal, arranged in two longitudinal rows, each row has 5 to 6 perforations. Length of the plate varies from 0.28 to 0.35 mm, breadth measures from 0.14 to 0.156 mm and ratio of breadth to length varies from 1 : 2 to 1 : 2.24.

Measurements in mm

	Length of sclerite (L)	Breadth of sclerite (B)	Number of perforations in each row	L/B
Holotype No. L. U. H. 312	0.35	0.156	5	2.24
Paratype No. L. U. H. 313	0.3	0.144	6	2.08
	0.28	0.14	5	2.0
	0.32	0.15	6	2.13

Remarks—It is a common species.

Calclamnella agrawali sp. nov. somewhat resembles with *Calclamnella elliptica* (Deflandre-Rigaud) but differs in shape, size and in nature of periphery. The former species is larger in size, highly scalloped and generally each perforation is bounded by a peripheral scallop while in the latter species the periphery is irregular to nearly smooth. This new species also differs from *Calclamnella irregularis* (Schlumberger), in shape of sclerite, number of perforations and ratio of breadth to length.

Etymology—This species is named in honour of Prof. S. K. Agrawal, Head of the Geology Department, Banaras Hindu University, Varanasi, for his contributions to the Geology of Kutch.

Calclamnella cf. **C. elliptica** (Deflandre-Rigaud) (Pl. 2, Text-fig. 6)

Priscopedatus ellipticus Deflandre-Rigaud, 1946, p. 514, text-fig. 12.

Calclamnella elliptica (Deflandre-Rigaud), Frizzell & Exline, 1955, p. 78, pl. 2, fig. 8.

Calclamnella elliptica (Deflandre-Rigaud), Deflandre-Rigaud, 1962, p. 48, pl. 5, fig. 3.

Description—Sclerite in form of elongate perforate plate, periphery slightly scalloped to nearly smooth, rectangular in shape with rounded ends ; two longitudinal rows of large, oval to subquadrangular perforations present, perforations offset, five in each row. Length of the plate varies from 0.3 to 0.312 mm ; breadth varies from 0.15 to 0.157 mm and ratio of breadth to length varies from 1 : 1.9 to 1 : 2.1

Measurements in mm

	Length sclerite (L)	Breadth of sclerite (B)	Number of perforations in each row	L/B
Hypotype No. L. U. H. 314	0.3	0.15	5	2.1
	0.312	0.157	5	1.9

Remarks—It is a very rare species.

The specimens are comparable with *Calclamnella elliptica* (Deflandre-Riagaud) (Pl. 5, fig. 3) in shape but differ from it in being almost of uniform breadth, subrectangular in shape while the form described from France is broadest in the middle and somewhat elliptical.

Locality—About 3.6 km S15°E of Baranda village in a nala section, Kutch, India.

Horizon—*Nummulites beaumonti* Zone, Lutetian, Middle Eocene.

Calclamnella jaini sp. nov. (Pl. 2, Text-fig. 7)

Description—Sclerite in form of elongate, perforate, thin plate, flat, periphery irregularly scalloped, broadest slightly away from the centre ; plate with two longitudinal rows of unequal perforations, 4 to 5 in each row and slightly offset, their size varies from small to large, somewhat oval and subcircular in shape. Length of the plate varies from 0.262 to 0.29 mm ; breadth measures from 0.137 to 0.16 mm and breadth to length ratio varies from 1 : 1.7 to 1 : 2.1.

Measurements in mm

	Length of sclerite (L)	Breadth of sclerite (B)	Number of perforations in each row	L/B
Holotype No. L. U. H. 315	0.262	0.15	4 to 5	1.7
Paratype No. L. U. H. 316	0.268	0.15	4 to 5	1.79
	0.287	0.137	4 to 5	2.1
	0.29	0.16	4	1.8

Remarks—This is a common species.

Calclamnella jaini sp. nov. differs from *Calclamnella agrawali* sp. nov. in being broadest slightly away from centre while the latter species is subrectangular in shape. The outer margin of the former species is irregularly scalloped while the latter has a scallop in front of each perforation.

Etymology—This species is named in honour of Dr. S. P. Jain, Reader in the Geology Department, Panjab University, Chandigarh.

Calclamnella khariensis sp. nov. (Pl. 2, Text-fig. 8)

Description—Sclerite in form of elongate perforate plate, thin, slightly curved, periphery irregularly scalloped, a distinct peripheral notch present ; broad at one end, narrow at other ; plate with two longitudinal rows of perforations, each row with 5 to 6 oval to elongate perforations of unequal size, offset and elongate perforations present towards the broader side of the plate. Length of the sclerite measures from 0.306 to 0.412 mm ; breadth from 0.131 to 0.15 mm and ratio of breadth to length varies from 1 : 2.3 to 1 : 2.8.

Measurements in mm

	Length of sclerite (L)	Breadth of sclerite (B)	Number of perforations in each row	L/B
Holotype No. L. U. H. 317	0.412	0.144	6	2.8
Paratype No. L. U. H. 318	0.35	0.15	5 to 6	2.3
	0.331	0.137	6	2.4
	0.306	0.131	6	2.3

Remarks—It is a common species. Two sclerite plates have one to two very small additional perforations near the outer margin and the peripheral notch is not very distinct.

Calclamnella khariensis sp. nov. somewhat resembles with *Calclamnella irregularis* (Schlumberger) but differs from it in not having a raised median flange and in shape of perforations. This new species also differs from *Calclamnella agrawali* sp. nov. in shape of the plate and being irregularly scalloped. *Calclamnella khariensis* differs from *Calclamnella jaini* sp. nov. in being more elongate and in having larger number of perforations.

Calclamnella satyendrai sp. nov. (Pl. 2, Text-figs. 9, 10)

Description—Sclerite in form of elongate somewhat subrectangular perforate plate, thin, almost flat, having outer periphery irregularly scalloped, a distinct peripheral notch present on the longer side of the plate, both the ends of the plate broadly rounded in most of the specimens, one end slightly narrower than the other; two elongate offset longitudinal rows of perforations, each row with five oval to subcircular perforations, small peripheral subtriangular 2 to 7 perforations also present. Length of the plate varies from 0.287 to 0.344 mm; breadth measures from 0.144 to 0.181 mm and ratio of breadth to length varies from 1 : 1.6 to 1 : 2.08.

Measurements in mm

	Length of sclerite (L)	Breadth of sclerite (B)	Number of perforations in each row	L/B
Holotype No. L. U. H. 319	0.344	0.181	5	1.9
Paratype No. L. U. H. 320	0.287	0.175	5	1.6
	0.3	0.144	5	2.08

Remarks—It is a common species. This species is very variable but is characterised by its subrectangular shape, presence of peripheral notch, five large perforations in each row in most of the plates, besides variable number of smaller peripheral perforations. As the two longitudinal rows of perforations are very prominent in this species, therefore, it has been placed under genus *Calclamnella*. It may be a highly aberrant form of this genus.

Calclamnella satyendrai sp. nov. differs from *Calclamnella jaini* sp. nov., *Calclamnella khariensis* sp. nov., *Calclamnella irregularis* (Schlumberger) and *Calclamnella elliptica* (Deflandre-Rigaud) in shape of the sclerite, in having additional small perforations near the periphery and a distinct peripheral notch.

Etymology—This species is named in honour of Dr. Satyendra Kumar Singh, Reader in the Geology Department, Lucknow University, Lucknow.

Genus—**Costigerites** Deflandre-Rigaud, 1961

Costigerites sinhai sp. nov. (Pl. 2, Text-fig. 13)

Description—Sclerite in form of elongate perforate plate, subrectangular in shape, elongate sides of the plate parallel; 20 medium to large oval to subpentagonal perforations present in four elongate rows and each row has five perforations.

Measurements—Holotype No. L. U. H. 321; length of sclerite 0.325 mm (approx.) and breadth of sclerite 0.225 mm.

Remarks—A single slightly broken specimen has been found.

Costigerites sinhai sp. nov. differs from *Costigerites piveteaui* Deflandre-Rigaud, in being unornamented and in having nondenticulate margin. The number of vertical rows in the former species are four while in the latter species six.

Etymology—This species is named in honour of Prof. R. C. Sinha, Head of Geology Department, Patna University, Patna.

Genus—**Elgerius** Deflandre-Rigaud, 1959

Elgerius aff. **E. ostrea** Deflandre-Rigaud (Plate 1, Fig. 4)

Description—Sclerite perforated concavo-convex plate, somewhat spoon shaped, perforations numerous, very small, arranged in semicircular pattern; on the concave side a second layer of perforations present at the edges of the sclerite, central portion and longer margin of sclerite consist of single layer of perforations and diameter of perforations varies from 6μ to 10μ .

Measurements—Hypotype No. L. U. H. 322 ; longer diameter of sclerite 0.287 mm and shorter diameter 0.225 mm.

Remarks—Only one specimen has been met with. The specimen under description is somewhat identical with *Elgerius ostrea* Deflandre-Rigaud but differs from it in having less convex outer longer margin of the plate and the latter species is more triangular than the form from Kutch.

Locality—About 3.6 km S15°E of Baranda village in a nala section, Kutch, India.

Horizon—*Nummulites beaumonti* Zone, Lutetian, Middle Eocene.

Elgerius rampurensis sp. nov. (Pl. 1, Fig. 5)

Description—Sclerite perforated concavo-convex plate, subpentagonal in shape, perforations numerous, very small in size, slightly elongate, arranged in somewhat concentric pattern; most of the part of sclerite single layered but the second layer is present only near the broader margins of the plate. Longer diameter of sclerite varies from 0.237 to 0.24 mm and shorter from 0.2 to 0.22 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite
Holotype No. L. U. H. 323	0.237	0.2
Paratype No. L. U. H. 324	0.24	0.22

Remarks—It is a rare species.

Elgerius rampurensis sp. nov. differs from *Elgerius ostrea* Deflandre-Rigaud, in being subpentagonal in shape while the latter is subtriangular ; area occupied by second perforated layer which in the former species is very poorly developed is well developed in the latter. This new species also differs from *Elgerius innienensis* Deflandre-Rigaud, in the shape of sclerite and the area occupied by the second perforated layer.

Elgerius ratcheloensis sp. nov. (Pl. 1, Fig. 6)

Description—Sclerite perforated concavo-convex plate, general form of the plate subtriangular with rounded ends, one side more elongate than the remaining two, central part and extreme lower margin with only single layer of perforations, while the double layer of perforations present at the lateral margins, perforations very small somewhat subtriangular, abundant, regularly arranged in concentric pattern, on the two adjoining sides of the sclerite two prominent constrictions present ; longer side almost straight or slightly curved. Longer diameter of sclerite varies from 0.262 to 0.294 mm ; shorter diameter from 0.206 to 0.237 mm and diameter of perforations varies from 5μ to 9μ .

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite
Holotype No. L. U. H. 325	0.294	0.206
Paratype No. L. U. H. 326	0.281	0.237
	0.262	0.231

Remarks—It is a common species.

Elgerius ratcheloensis sp. nov. differs from *Elgerius ostrea* Deflandre-Rigaud, in having broadly rounded apex with marked constrictions at adjoining sides and straight to slightly curved base while in the latter species the apex is somewhat pointed and its both adjoining sides without constrictions with a highly curved base. The perforations in the species described from Kutch are also smaller.

Genus—**Eocaudina** Martin, emend. Gutschick & Canis, 1971

Eocaudina bhatiai sp. nov. (Pl. 3, Text-fig. 17)

Description—Sclerite in form of subcircular perforate plate, small to medium in size, thick at centre and thin near periphery, slightly concavo-convex ; periphery smooth and at places scalloped with two distinct peripheral notches ; at centre four large widely spaced central perforations surrounded by two irregular concentric rows of perforations, beside these near the periphery of the plate few very small perforations also present ; perforations generally oval and subtriangular in shape, number of perforations varies from 24 to 42; in the central part of the plate perforations are generally larger than the surrounding ones. Longer diameter of plate varies from 0.28 to 0.42 mm and shorter diameter measures from 0.237 to 0.362 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 327	0.42	0.36	42
Paratype No. L. U. H. 328	0.28	0.237	24
	0.38	0.362	34

Remarks—This is a common species. Holotype slightly broken at the external margin. One of the sclerite is slightly elongate and the number of perforations are comparatively less (24). Although there are 26 specimens but only three almost complete specimens are present in the collection.

Eocaudina bhatiai sp. nov. differs from *Eocaudina scotica* Frizzell & Exline, in having two distinct peripheral notches, in the shape of the sclerite and nature of periphery. This new species somewhat resembles with *Eocaudina marginata* Langenheim & Epis but differs in having two distinct peripheral notches, shape of perforations and their arrangement.

Etymology—This species is named after Prof. S. B. Bhatia, Geology Department, Panjab University, Chandigarh, in recognition of his work in field of micropalaeontology.

Eocaudina bhujensis sp. nov. (Pl. 3, Text-fig. 18)

Description—Sclerite in form of perforate plate, small to medium in size, almost flat, subcircular in shape with irregular scalloped periphery ; four large subcentral perfora-

tions present, surrounded by a concentric row of small to large perforations, in addition to these few very small perforations also present near the outer margin of the sclerite, perforations oval, subcircular, subtriangular in shape and their number varies from 18 to 26. Longer diameter of the sclerite measures from 0.244 to 0.312 mm and shorter diameter varies from 0.169 to 0.26 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 329	0.312	0.26	21
Paratype No. L. U. H. 330	0.27	0.21	18
	0.244	0.169	23
	0.263	0.225	26

Remarks—It is a rare species. One of the sides of the periphery of sclerite comparatively more scalloped than others.

Eocaudina bhujensis sp. nov. somewhat resembles with *Eocaudina cassianensis* Frizzel & Exline, but differs from the latter in nature of the periphery of the sclerite. *Eocaudina bhujensis*, also differs from *Eocaudina bhatiai* sp. nov. in shape of plate, number of perforations and their arrangement. This new species also differs from *Eocaudina scotica* Frizzell & Exline, in nature of surrounding concentric row of perforations and periphery.

Eocaudina duncani sp. nov. (Pl. 3, Text-fig. 19)

Description—Sclerite in form of perforate plate, thin, slightly concavo-convex, small to medium in size, oval in shape, periphery smooth; four large oval central perforations present, surrounded by a concentric row of unequal, small to large, subcircular, oval, elongate and subtriangular perforations, number of perforations varies from 20 to 24. Longer diameter of sclerite measures from 0.275 to 0.32 mm and shorter in between 0.2 and 0.26 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 331	0.298	0.253	20
Paratype No. L. U. H. 332	0.275	0.2	22
	0.32	0.26	24

Remarks—It is a common species. Although there are 18 specimens but only 3 complete specimens are present. One sclerite plate has slightly undulatory margin.

Eocaudina duncani sp. nov. differs from *Eocaudina columcanthus* Gutschick, Canis & Brill, in nature of arrangement of perforations and their number. *Eocaudina duncani* also differs from *Eocaudina bhujensis* sp. nov. in being smaller in size, having lesser number of perforations and smooth periphery.

Etymology—This species is named after Late Mr. P. M. Duncan, in recognition of his pioneer work on echinoids of Kutch, Kathiawar and Sind.

Eocaudina jhadwaensis sp. nov. (Pl. 3, Text-fig. 20)

Description—Sclerite in form of perforate plate, thick, slightly concavo-convex, medium in size, subtriangular in shape, periphery scalloped; one side of the periphery irregularly

denticulate ; two distinct peripheral notches present almost opposite to each other, one at the narrower end while other just in the middle at the broader side, peripheral denticles fine ; perforations oval, subcircular and elliptical in shape ; at the centre of the sclerite four central perforations present, surrounded by two irregular subtriangular rows of perforations, outer most row has generally smaller perforations, number of perforations varies from 30 to 35. Longer diameter of the sclerite varies from 0.37 to 0.42 mm and shorter measures from 0.3 to 0.35 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 333	0.42	0.35	35
Paratype No. L. U. H. 334	0.37	0.3	30
	0.38	0.33	31

Remarks—It is a very rare species.

Eocaudina jhadwaensis sp. nov. differs from *Eocaudina bhatiai* sp. nov. in having more scalloped and denticulate periphery and being subtriangular in shape. This new species also differs from *Eocaudina guembeli* Frizzell & Exline, in the shape of the plate, arrangement of perforations and nature of marginal denticles. In the former species denticles are fine, irregularly placed while in the latter they are more pronounced and regularly placed throughout the outer margin of the plate.

Eocaudina kutchensis sp. nov. (Pl. 5, Text-fig. 47)

Description—Sclerite in form of perforate plate, subcircular to circular, small in size, slightly concavo-convex, thickest at centre and thin towards periphery, periphery irregularly scalloped, a part of one of the sides of plate finely denticulate ; four central perforations surrounded by single concentric row of perforations, 2 to 4 very small marginal perforations also present, central perforations somewhat smaller than the surrounding ones ; perforations oval to elongate, medium in size and their number varies from 16 to 19. Longer diameter of sclerite varies from 0.25 to 0.256 mm and shorter diameter measures from 0.219 to 0.225 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 335	0.25	0.219	19
Paratype No. L. U. H. 336	0.256	0.225	16
	0.25	0.22	18

Remarks—It is a very rare species.

Eocaudina kutchensis sp. nov. differs from *Eocaudina jhadwaensis* sp. nov. in size, shape, rows and number of perforations. The former species is smaller in size, subcircular in shape and has a row of concentric perforations while the latter has two peripheral notches, subtriangular in shape and central perforations are surrounded by two rows of subtriangular perforations. This new species also differs from *Eocaudina guembeli* Frizzell & Exline, in being smaller in size and also in the shape, size and arrangement of denticles.

Eocaudina maniarraensis sp. nov. (Pl. 3, Text-figs. 21-23)

Description—Sclerite in form of elongate perforate plate, small to medium in size, thin, flat to concavo-convex, periphery irregularly scalloped; perforations oval in shape, unequal, small to large in size and their number is inbetween 14 and 21; perforations arranged in three to four elongate rows which make an angle of 70° to 85°; generally plates broadest in the middle; a distinct peripheral notch present at the narrower end due to which the plates become somewhat sigmoid in shape. It is one of the characteristic feature of this species. Length of sclerite is inbetween 0.25 and 0.36 mm and breadth measures from 0.18 to 0.231 mm.

Measurements in mm

	Length of sclerite	Breadth of sclerite	Number of perforations
Holotype No. L. U. H. 337	0.36	0.18	17
Paratype No. L. U. H. 338	0.262	0.181	14
Paratype No. L. U. H. 339	0.3	0.2	17
	0.356	0.231	21
	0.25	0.187	19
	0.287	0.219	19

Remarks—This is a common species. Although some of the specimens have two peripheral notches near the narrower end but their periphery is not highly scalloped. *Eocaudina maniarraensis* sp. nov. appears to be a highly aberrant form and does not resemble with any known species.

Eocaudina marhensis sp. nov. (Pl. 5, Text-fig. 48)

Description—Sclerite in form of perforate plate, small to medium in size, oval in shape, slightly curved, highly fragile, margin highly scalloped and very finely irregularly denticulate; four central oval perforations, medium in size, surrounded by single concentric row of small to medium perforations and small marginal perforations also present. The perforations are oval, elliptical, subcircular and subtriangular in shape and their number varies from 19 to 25. Longer diameter of sclerite measures from 0.25 to 0.31 mm and shorter diameter varies from 0.2 to 0.225 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 340	0.25	0.2	19
Paratype No. L. U. H. 341	0.31	0.225	25

Remarks—Only two specimens have been found.

Eocaudina marhensis sp. nov. differs from *Eocaudina jhadwaensis* sp. nov. in the shape of sclerite, number and nature of arrangement of the perforations. This new species also differs from *Eocaudina kutchensis* sp. nov. in being oval while in the latter species the plate is circular and the periphery is not highly scalloped.

Eocaudina mittali sp. nov. (Pl. 2, Text-fig. 12)

Description—Sclerite in form of somewhat oval perforate plate, almost flat, medium in size; one end pointed while the other broader, a prominent peripheral notch present

at the broader side, periphery thick, margin scalloped ; at the centre four large oval perforations present, surrounded by generally oval irregularly placed small to large perforations and number varies from 20 to 24. Longer diameter of sclerite is 0.33 mm and shorter diameter varies from 0.312 to 0.325 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 342	0.33	0.312	24
Paratype No. L. U. H. 343	0.33	0.325	20

Remarks—It is a rare species. In the paratype the peripheral notch is poorly developed and the base is gently curved. Only two complete and three partly broken specimens have been found.

Eocaudina mittali sp. nov. somewhat resembles with *Eocaudina jhadwaensis* sp. nov. but differs from it in being oval, having a non-denticulate periphery, larger perforations and in the nature of their arrangement. This species also differs from *Eocaudina bhatiai* sp. nov. in the shape of the sclerite and nature of the arrangement of perforations.

Etymology—The species is named in honour of Prof. R. S. Mittal, Head of Geology Department, Roorkee University, Roorkee.

Eocaudina piparensis sp. nov. (Pl. 3, Text-fig. 24)

Description—Sclerite in form of perforated plate, slightly oblong in shape, medium in size, almost flat, margin slightly undulatory, smooth ; four large slightly subcentral perforations present, surrounded by two irregular concentric rows of medium size perforations and near the outer margin of the plate smaller perforations also present. Perforations generally oval, subcircular and subpentagonal in shape and their number varies from 53 to 56. Longer diameter of the sclerite measures from 0.406 to 0.42 mm and shorter diameter varies from 0.337 to 0.345 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 344	0.406	0.337	53
Paratype No. L. U. H. 345	0.42	0.345	56

Remarks—It is a rare species. Only two complete specimens have been met with.

Eocaudina piparensis sp. nov. differs from *Eocaudina bhatiai* sp. nov. in having entire periphery, shape of sclerite and nature of arrangement of the perforations.

Eocaudina soodani sp. nov. (Pl. 3, Text-fig. 25)

Description—Sclerite in form of elongate perforate plate, medium in size, thin, flat, periphery smooth, at places scalloped, one end of sclerite broadly rounded while the other pointed, narrowest almost in the middle, broadest slightly away from the pointed end ; almost three vertical elongate rows of oval perforations present, two rows complete each with 6 to 7 perforations, third one incomplete, generally larger perforations present in the middle of the plate and their number varies from 18 to 22. Length of sclerite measures from 0.4 to 0.42 mm and breadth between 0.169 and 0.18 mm.

Measurements in mm

	Length of the plate	Breadth of the plate	Number of perforations
Holotype No. L. U. H. 346	0.4	0.169	18
Paratype No. L. U. H. 347	0.42	0.18	22
	0.41	0.175	20

Remarks—This species is rare.

Eocaudina soodani sp. nov. somewhat resembles with the genus *Costigerites* Deflandre-Rigaud but differs from it in not having with sides essentially parallel to each other. This new species somewhat resembles with *Eocaudina maniarraensis* sp. nov. but differs from it in shape of the plate and being more elongate.

Etymology—This species is named after Mr. K. S. Soodan, Geologist, Oil and Natural Gas Commission, Dehra Dun, in recognition of his work in field of fossil holothuroids.

Eocaudina vermai sp. nov. (Pl. 3, Text-fig. 26)

Description—Sclerite in form of perforate plate, medium in size, slightly curved, subhexagonal in shape, one side very narrow while the opposite broadly curved with a distinct peripheral notch, margin irregularly scalloped and at places finely denticulate; four large, oval, widely spaced central perforations surrounded by irregularly distributed perforations, most of them smaller than the central perforations, generally oval and subcircular in shape. Number of perforations varies from 34 to 36. Longer diameter of sclerite measures from 0.38 to 0.402 mm and shorter diameter varies from 0.29 to 0.325 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 348	0.402	0.325	36
Paratype No. L. U. H. 349	0.38	0.29	34

Remarks—This species is very rare. Only one complete specimen has been found and there are three partly broken specimens. It is characterised by its subhexagonal shape, a distinct peripheral notch at the broader side and irregularly denticulate margin.

Eocaudina vermai sp. nov. differs from *Eocaudina jhadwaensis* sp. nov. in being subhexagonal in shape while the latter is subtriangular. The four central perforations in the former species are larger and widely spaced but in the latter they are closer and almost of the same size as surrounding ones. In *Eocaudina vermai* the surrounding perforations are irregularly distributed, while in *Eocaudina jhadwaensis* they are arranged in two subtriangular rows. This new species also differs from *Eocaudina septaforaminalis* Martin, in shape of the sclerite, in having irregularly denticulate periphery and in arrangement of perforations.

Etymology—The species is named in honour of Prof. V. K. Verma, Head of Geology Department, Delhi University, Delhi.

Eocaudina waiorensis sp. nov. (Pl. 2, Text-fig. 13).

Description—Sclerite in form of subquadrangular perforated plate, one side broader than the opposite one, small to medium in size, slightly curved, highly fragile; the outer margin on one side of the sclerite finely denticulate, periphery scalloped; four unequal

central perforations surrounded by small to medium irregularly distributed, oval, elongate, subtriangular perforations and the number varies from 19 to 25. Length of the sclerite is inbetween 0.225 and 0.313 mm and breadth measures from 0.181 to 0.256 mm.

Measurements in mm

	Length of the plate	Breadth of the plate	Number of perforations
Holotype No. L. U. H. 350	0.225	0.181	19
Paratype No. L. U. H. 351	0.313	0.256	25
	0.22	0.223	22

Remarks—It is a very rare species. The holotype is slightly broken at one side.

Eocaudina waiorensis sp. nov. differs from *Eocaudina marhensis* sp. nov. in shape of the sclerite and nature of arrangement of the perforations. In the former species the sclerite is subquadrangular in shape and the four central perforations are surrounded by irregularly distributed perforations while the latter species is oval and the four central perforations are surrounded by a concentric row of perforations. It also differs from *Eocaudina kutchensis* sp. nov. in shape of the sclerite and nature of arrangement of perforations.

Eocaudina wynnei sp. nov. (Pl. 2, Text-figs. 14, 15)

Description—Sclerite in form of perforate plate, small in size, slightly curved, thick at centre and thin near the periphery, subcircular in shape, periphery highly scalloped, almost each perforation near the outer margin of the plate bounded by a scallop ; four central perforations surrounded by two concentric rows of perforations, inner row with slightly irregularly placed perforations, while outer incomplete and consists of smaller perforations. The perforations of the concentric rows either of the size of central perforations or larger, generally oval, subcircular and elliptical in shape. The number of perforations varies from 18 to 25. The longer diameter of sclerite measures from 0.237 to 0.28 mm and shorter diameter varies from 0.187 to 0.25 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L. U. H. 352	0.28	0.25	25
Paratype No. L. U. H. 353	0.237	0.187	18
	0.25	0.22	23

Remarks—This is a very rare species. In paratype (Pl. 2, Text-fig. 15) the four central perforations are surrounded by a concentric row of perforations and besides this there are four small perforations near the periphery of the plate.

Eocaudina wynnei sp. nov. very much resembles in shape with *Eocaudina scotica* Frizzell & Exline but differs from it in being smaller in size and the four central perforations are not larger than the surrounding perforations.

Etymology—This species is named after Late Mr. A. B. Wynne, in recognition of his monumental geological study of Mesozoic and Tertiary rocks of Kutch and Kathiawar.

Eocaudina sp. A (Pl. 3, Text-fig. 27)

Description—Sclerite in form of perforate plate, slightly concavo-convex, thick, flat, medium in size, broadly elliptical in shape, broadest in the middle, periphery smooth, six

central perforations surrounded by a concentric row of perforations, perforations generally oval ; very small, oval and subtriangular perforations also present near the periphery of the sclerite ; the number of perforations varies from 28 to 36. Longer diameter of sclerite is in between 0.32 and 0.38 mm and shorter diameter measures from 0.23 and 0.28 mm.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Hypotype No. L. U. H. 354	0.38	0.28	36
	0.32	0.23	28

Remarks—Only two slightly broken specimens are present. Probably there is a peripheral notch. It appears to be a new species but as the specimens are broken at the notch it has not been assigned a new name.

Eocaudina sp. A differs from *Eocaudina bhatiai* sp. nov. in shape of the plate and absence of two peripheral notches ; also differs from *Eocaudina mccormacki* Frizzell & Exline, in being more elliptical in shape and in arrangement of perforations.

Locality—About 3.6 km S15°E of Baranda village in a nala section, Kutch, India.

Horizon—*Nummulites perforatus* Zone and *Nummulites beaumonti* Zone, Lutetian, Middle Eocene.

Family—ETHERIDGELLIDAE Frizzell & Exline, 1955

Genus—**Frizzellus** Hampton, 1958

Frizzellus irregularis Hampton (Pl. 5, Text-fig. 49)

Etheridgella sp., Hampton, 1957, p. 510, text-figs. 11-12.

Frizzellus irregularis, Hampton, 1958, p. 310, pl. 1, figs. 1-30.

Remarks—It is a common species.

The specimens are almost identical with *Frizzellus irregularis* Hampton, described from Middle Jurassic rocks of England. In the present collection most of the sclerites are subcircular to subhexagonal in shape.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite
Hypotype No. L. U. H. 355	0.35	0.319
	0.35	0.35
	0.337	0.325
	0.437	0.412

Locality—About 3.6 km S15°E of Baranda village in a nala section, Kutch, India.

Horizon—*Nummulites beaumonti* Zone, Lutetian, Middle Eocene.

Family—PRISCOPEDATIDAE Frizzell & Exline, 1955

Genus—**Fedenella** Soodan, 1975

Fedenella sp. (Pl. 5, Text-fig. 50)

Description—Sclerite in form of table, disc perforated, concavo-convex ; on convex

side at centre very prominent four footed stirrup with a very low spire, surrounded by number of broadly oval, subcircular, elliptical perforations, they vary in size from small to large ; on concave side of the disc a central circular hole present and the four footed stirrup of opposite side clearly seen.

Measurements—Hypotype No. L. U. H. 356 ; longer diameter of sclerite 0.325 mm, shorter diameter of sclerite 0.262 mm and diameter of central hole 0.075 mm.

Remarks—Sclerite has not been assigned to any species as the margin of the disc is broken. It consists of clear almost transparent shell material.

Locality—About 2.6 km S15°E of Baranda village in a nala section, Kutch, India.

Horizon—*Carbula subexrata* Zone, Lutetian, Middle Eocene.

Genus—**Koteshwaria** gen. nov.

Type species—*Koteshwaria sureshi* gen. et sp. nov.

Diagnosis—Sclerite in form of table, disc flat or convavo-connex with four or five solid arms in one plane ; arms broad at base, tapering towards apex, circular to elliptical in cross-section, at right angle or different angles to each other, equal or unequal in length ; on convex side (one side) at the centre of the disc a spire and/or stirrup present. It is surrounded by four or five central perforations facing each arm (i.e. number of perforations at the centre of the disc depends upon the number of arms present on the sclerite) ; on opposite side (concave/flat) of the disc a central or subcentral depression present surrounded by smaller lumen of the perforation.

Remarks—*Koteshwaria* gen. nov. differs from *Fletcherina* Soodan, in having a central depression surrounded by four or five lumen of perforation on one side of the sclerite where as latter has only a central perforation without four lumen of perforations. This new genus also differs from *Sastriella* Soodan, in not having perforations on the arms of various shapes and sizes ; by absence of one circular to subcircular central hole. In the former genus on the spiral side perforation are near the base of arms and their number depends upon the number of arms present on the sclerite whereas in the latter genus arms are perforated and the perforation of arms are not governed by number of arms present on the sclerite (SOODAN 1975, p.260, Text-figs. 23, 24). *Koteshwaria* differs from *Priscolongatus* Hanna, in having a central depression surrounded by lumen of perforations on one of the side. *Koteshwaria* also differs from *Hannaina* Soodan, in not having always five central perforations, secondly the number of arms are always governed by number of perforations which is not so in the latter genus and the central depression present on one of the side in *Koteshwaria* is also absent in *Hannaina*.

Stratigraphic range—Lutetian, Middle Eocene.

Koteshwaria sureshi gen. et sp. nov. (Pl. 4, Text-figs. 28-30)

Description—Sclerite large in form of table, disc concavo-convex, cruciform with four solid elongate arms in one plane almost at right angles, opposite to each other, three arms almost of the same length while fourth about $1\frac{1}{4}$ times longer, elliptical in cross-section, broad at the base, apex round and slightly flat ; on convex side of sclerite four footed stirrup and a high central spire. It is surrounded by four almost equally spaced, small, oval perforations, facing each arm, the narrower ends of the perforations point towards the arms and the foot of the stirrup inbetween the perforations and arms. On concave side of the sclerite a subcircular to circular, large central depression with four almost equally spaced smaller lumen of the perforation.

Measurements in mm

	Diameter of the sclerite across the arms			Diameter of central depression
	Longer	Shorter		
Holotype No. L.U.H. 357	0.75	0.625	..	0.05 × 0.056
Paratype No. L.U.H. 358	0.675	0.592	..	0.05
	0.912	0.785		0.06 × 0.069

Remarks—It is a common species. In holotype the arms are very slightly curved while in paratype the longer arm is about at an angle of about 85°. This may be due to some external pressure during their preservation.

Koteshwaria sureshi gen. et sp. nov. somewhat resembles with *Staurocumites bartensteini* Deflandre-Rigaud but differs from it in not having perforations covering the entire arms and in having a central depression on one of the sides surrounded by lumen of perforation.

Etymology—This species is named after Prof. S. N. Singh, Head of the Geology Department, Lucknow University, Lucknow, in recognition of his work in field of micropalaeontology.

***Koteshwaria chandrai* sp. nov.** (Pl. 4, Text-figs. 31-34)

Description—Sclerite medium to large, in form of table, disc concavo-convex, cross shaped with four solid radiating, elongate arms in one plane, arms almost of equal length and at right angles, opposite to each other, smooth, elliptical in cross-section, broad at base, narrowest in middle, later gradually increase in width towards the apex, tip of the arms smooth, broadly rounded and flat. On convex side of the sclerite low central spire with four footed stirrup, surrounded by four medium, oval perforations facing each arm, alternate with the foot of the stirrup with their pointed ends towards the arms; on concave side of disc a large central circular to subcircular depression surrounded by lumen of smaller perforation.

Measurements in mm

	Diameter of sclerite across the arms			Diameter of central depression
	Longer	Shorter		
Holotype No. L.U.H. 359	0.987	0.952	..	0.069
Syntype No. L.U.H. 360	0.487		..	0.05 × 0.56
Paratype No. L.U.H. 361	0.75		..	0.05

Remarks—It is an abundant species. Not a single complete specimen has been met with. In the holotype the spire is partly broken, while in syntype one arm is broken. But as this species is quite abundant and its arms are so characteristic that it can be very easily assigned to a new species.

Koteshwaria chandrai sp. nov. differs from *Koteshwaria sureshi* sp. nov. in having four equal arms which are narrowest in the middle while the latter species is cruciform in shape, has three arms of the same length and the fourth is longest.

Etymology—This species is named in honour of Mr. G. Chandra, Lecturer, Geology Department, Lucknow University, Lucknow.

Koteshwaria frizzelli sp. nov. (Pl. 4, Text-figs. 35, 36)

Description—Sclerite in form of table, disc slightly concavo-convex, medium in size, with four unequal solid elongate arms in one plane, at acute and obtuse angles, arms broad at base and elliptical in cross section ; two longer opposite arms almost in a straight line, unequal in length, broad at base, tapering towards apex ; the two remaining unequal, shorter, opposite arms not in a straight line but slightly offset, one of the arms broadly rounded at apex while the other with pointed apex. On convex side of sclerite at the centre poorly developed four footed stirrup with a very low spire, surrounded by four small, oval perforations facing each arm with their pointed ends towards the apex of the arms, alternate with the foot of the stirrup ; on concave side of disc a large, slightly subcentral circular depression surrounded by four very small lumen of perforation.

Measurements in mm

	Diameter of sclerite across the arms			Diameter of central depression
	Longer	Shorter		
Holotype No. L.U.H. 362	0.356	0.312	0.056	
Paratype No. L.U.H. 363	0.344	0.3	0.056	

Remarks—It is a very rare species.

Koteshwaria frizzelli sp. nov. differs from *Koteshwaria sureshi* gen. et sp. nov. and *Koteshwaria chandrai* sp. nov. in having four unequal arms at acute and obtuse angles.

Etymology—This species is named after Late Dr. D. L. Frizzell, Professor of Geology, Missouri School of Mines and Metallurgy, Rolla, Missouri, in honour of his pioneer work in field of fossil holothuroids.

Koteshwaria gothathadensis sp. nov. (Pl. 4, Text-figs. 37, 38)

Description—Sclerite in form of table, disc flat to concavo-convex, highly fragile, medium in size, cruciform with four solid, elongate, broad arms in one plane, at right angles ; three arms almost of the same length while the fourth one shorter, arms elliptical in cross-section, broad at base, apex broadly rounded ; on convex side of sclerite at the centre a four footed stirrup with a short spire surrounded by four small oval perforations facing each arm with their pointed ends towards the apex of the arms, each alternate with foot of stirrup ; on concave side a large circular depression surrounded by four smaller lumen of the perforation.

Measurements in mm

	Diameter of sclerite across the arms		Diameter of central depression
	Longer	Shorter	
Holotype No. L.U.H. 364	0.425	0.381	0.081
Paratype No. L.U.H. 365	0.35	0.294	0.062

Remarks—It is a rare species.

Koteshwaria gothathadensis sp. nov. is cruciform but differs from *Koteshwaria sureshi* gen. et sp. nov. in having broader arms and one of the arms is shorter in length than remaining ones while in the latter species one arm is longer than the remaining three equal arms.

Koteshwaria hanna sp. nov. (Pl. 4, Text-figs 39, 40)

Description—Sclerite in form of table, medium in size, disc almost flat with five elongate solid arms at different angles in one plane ; two arms almost parallel to each other and equal in length, broad at base, narrow a little away from centre and again broaden, apex broadly rounded ; third adjoining arm at about 120°, broad at base and narrow towards apex, opposite to it a very short broadly rounded arm ; adjoining to it i.e. the fifth arm broad at base and broadly rounded at the apex ; arms elliptical in cross-section, on one side at the centre of the disc, four footed stirrup with a tiny spire, surrounded by five unequally placed unequal, oval to subcircular perforations facing each arm, only four perforations alternate with the foot of stirrup ; on opposite side of sclerite a subcircular, subcentral depression surrounded by five smaller lumen of perforation.

Measurements in mm

	Diameter of sclerite across the arms		Diameter of central depression
	Longer	Shorter	
Holotype No. L.U.H. 366	0.344	0.225	0.044 × 0.05
Paratype No. L.U.H. 367	0.375	0.237	0.06 × 0.065

Remarks—Only two specimens have been found. In between fourth and fifth perforations there is no foot of the stirrup.

Koteshwaria hanna sp. nov. does not resemble with any described species and appear to be highly aberrant form.

Etymology—This species is named in honour of Dr. G. Hanna, Micropalaeontology Laboratory, Geology Department, University of Zwirki, Warsaw, Poland, in recognition of her contribution in knowledge of fossil holothuroids.

Koteshwaria merhi sp. nov. (Pl. 4, Text-figs. 41, 42)

Description—Sclerite in form of table, disc large, highly fragile, almost flat with five unequal solid arms in one plane at different angles, arms elliptical in cross-section, two arms almost straight, while remaining three curved with undulatory outer margin ; arms broad at base, rounded at the apex ; on one side of the disc at the centre a four footed stirrup with a tiny spire, surrounded by five oval, unequal perforations facing each arm, with their pointed ends towards the apex of the arms, only four perforations alternate with the foot of the stirrup ; on opposite side at the centre a circular depression surrounded by five very small lumen of perforation.

Measurements in mm

	Diameter of sclerite across the arms		Diameter of central depression
	Longer	Shorter	
Holotype No. L.U.H. 368	0.663	0.394	0.062
Paratype No. L.U. H. 369	0.723	0.421	0.056

Remarks—Only two specimens have been met with. There is no foot of the stirrup in between the fourth and fifth perforations. It is a highly aberrant species of the genus. One of the stirrups is poorly developed in holotype.

Koteshwaria merhi sp. nov. differs from *Koteshwaria hanna* sp. nov. in being larger in

size and in having three curved arms with undulatory margin. The depression on one of the sides of sclerite in the former species is central while in the latter subcentral.

Etymology—This species is named in honour of Prof. S. S. Merh, Head of the Geology Department, Baroda University, Baroda.

Koteshwaria sastrii sp. nov. (Pl. 4, Text-figs. 43, 44)

Description—Sclerite in form of table, disc large, slightly concavo-convex, cross shaped with four solid, elongate, unequal arms in one plane, almost at right angles, elliptical in cross-section, two opposite arms very long, unequal in length, the remaining two unequal, comparatively very small in length, arms broad at base, narrow towards apex; on convex side of the sclerite at the centre of the disc a four footed stirrup with a short spire. It is surrounded by four small, oval perforations pointing towards arms, each alternate with the foot of the stirrup; on concave side a subcircular to circular central depression and surrounded by four smaller lumen of perforation.

Measurements in mm

	Diameter of sclerite across the arms		Diameter of central depression
	Longer	Shorter	
Holotype No. L.U.H. 370	0.737	0.362	0.05
Paratype No. L.U.H. 371	0.487	0.325	0.043 × 0.037

Remarks—It is a rare species.

Koteshwaria sastrii sp. nov. somewhat resembles with *Koteshwaria sureshi* gen. et sp. nov. but differs from it in having two very long opposite arms and two short opposite arms, while in the latter species three arms are almost of the same length and fourth is longer.

Etymology—This species is named in honour of Mr. V. V. Sastri, Additional Director, Institute of Petroleum Exploration, O.N.G.C., Dehra Dun.

Koteshwaria sp. A (Pl. 4, Text-figs. 45, 46)

Description—Sclerite in form of table, disc concavo-convex with four solid arms in one plane, at right angles, two opposite arms straight while remaining two curved; on convex side of the sclerite at the centre there is four footed stirrup with a short spire, surrounded by four oval perforations pointed towards apex of the arms, each alternate with the foot of the stirrup; on opposite side a circular depression surrounded by four very small lumen of perforation.

Measurements in mm

	Diameter of sclerite across the arms		Diameter of central depression
	Curved arms	Straight arms	
Hypotype No. L.U.H. 372	0.65	0.587 (broken)	0.07
	0.69	0.6 (broken)	0.078

Remarks—*Koteshwaria* sp. A is rare and appears to be a new species but as one arm is broken in all the specimens in our collection, it is not possible to name it a new species.

Locality—About 3.6 km S15°E of Baranda village in a nala section, Kutch, India.

Horizon—*Nummulites beaumonti* Zone, Lutetian, Middle Eocene.

Genus—**Priscopedatus** Schlumberger emend. Soodan, 1975

Priscopedatus gowdai sp. nov. (Pl. 5, Text-fig. 51)

Description—Sclerite in form of table, circular, concavo-convex perforated disc, small to medium in size, margin smooth and regular ; on convex side of sclerite in the middle of disc four subpentagonal perforations with their pointed ends towards the centre ; stirrup four footed, apparently without spire ; four central perforations surrounded by two concentric rows of polygonal, elongate perforations, inner row has 8 perforations while the outer 12 and total number of perforations present on the sclerite 24.

Measurements in mm

	Longer diameter of sclerite	Shorter diameter of sclerite	Number of perforations
Holotype No. L.U.H. 373	0.187	0.187	24
Paratype No. L.U.H. 374	0.219	0.206	24
	0.206	0.194	24
	0.187	0.187	24

Remarks—This is a common species. All the specimens have four central perforations surrounded by two concentric rows having 8 and 12 perforations in inner and outer rows respectively. In few specimens there appears to be a very minute spire but it cannot be definitely called a spire.

Priscopedatus gowdai sp. nov. somewhat resembles with *Priscopedatus affinis* Deflandre-Rigaud but differs from it in being larger in size, nature of periphery, number of concentric rows of perforations and their shape. In the former species the periphery is smooth while in the latter shallowly scalloped. The new species has two rows of concentric polygonal and elongate perforations while in *Priscopedatus affinis* there is single concentric row of broadly elliptical to subcircular perforations.

Etymology—This species is named after Prof. S. Sambe Gowda, Department of Geology, Central College, University of Bangalore, Bangalore, in recognition of his contribution to the knowledge of fossil holothuroids.

Family—SYNAPTITIDAE Frizzell & Exline, 1955

Genus—**Croneisites** Frizzell & Exline, 1957

Croneisites gutschicki sp. nov. (Pl. 5, Text-fig. 52)

Description—Sclerite in form of concavo-convex perforate plate, small in size, elongate, subhexagonal in outline, periphery broadly scalloped, apex of the sclerite pointed and opposite side broad ; on concave side a narrow arcuate strap connects the peripheries of the sclerite at its narrower end ; six unequal cardinal perforations distributed in three longitudinal rows, each row with two perforations, perforations more or less pentagonal, elliptical in shape and finely denticulate ; on the concave side margins of the denticles of the perforations arranged concavely, while on the convex side convexly ; in the upper part two perforations present in the middle row, upper one near the pointed end of the sclerite, very small, nondenticulate and subcircular in shape while lower one is oval, finely denticulate and of medium size ; at both the sides of the central perforations two nondenticulate elongate elliptic perforations symmetrically arranged, their pointed ends towards the apex of the plate and arcuate strap on concave surface grows out of their peripheral edges.

	Length of sclerite	Breadth of sclerite
Holotype No. L.U.H. 375	0.256	0.231
Paratype No. L.U.H. 376	0.28	0.242

Remarks—This species is very rare. Two cardinal perforations are filled with sediments.

Croneisites gutschicki sp. nov. somewhat resembles in shape with *Croneisites* cf. *C. insignis* Kristan-Tollman, described by HANNA AND LIDIA (1969) from Lower Sarmatian of Zreeze-3, but differs from it in having more pointed apex, in the shape of perforations and strap. In the former species the lower cardinal perforations are subhexagonal, elongate and unequal in size while in the latter species they are generally oval and almost of equal size. *Croneisites gutschicki* also differs from *Croneisites polinicus* Hanna & Lidia, in having more pointed apex, shape of the perforations and number of perforations present near the apical part of the plate.

Etymology—This species is named after Dr. R. C. Gutschick, Department of Geology, University of Notre Dame, Notre Dame, Indiana, in recognition of his work in field of fossil holothuroids.

Genus—**Rigaudites** Frizzell & Exline, 1957

Rigaudites chatterjii sp. nov. (Pl. 5, Text-fig. 53)

Description—Sclerite thin, highly fragile, pear shaped, small, concavo-convex perforate plate with a prominent constricted apex, socket and lip present at the pointed end, periphery smooth with slight undulations at one or two places; on concave side socket very small 'U' shaped, smooth; lip very small, rounded with five very small perforations of variable shape; sclerite has 37 small finely denticulate, subcircular perforations arranged in almost six vertical rows, having 4 to 8 perforations in each row; denticulations of perforations irregularly spaced, 3 to 5 in number and clearly not seen on lower surface.

Measurements—Holotype No. L. U. H. 377; length of sclerite 0.25 mm and breadth 0.156 mm.

Remarks—Only one specimen is met with and except four perforations all are calcified. The sclerite is so small and poorly developed that the denticles of the perforations are not very clearly seen.

Rigaudites chatterjii sp. nov. somewhat resembles with *Rigaudites cunninghami* (Deflandre-Rigaud) but differs from it in being smaller in size and in having pointed top and rounded base while in the latter species both ends are truncated. It does not resemble with any of the described species of this genus.

Etymology—This species is named in honour of Dr. A. K. Chatterji, Incharge, Palaeontological Laboratory, Geological Survey of India, Lucknow.

Rigaudites chiplonkari sp. nov. (Pl. 5, Text-figs. 8, 54, 55)

Description—Sclerite pear shaped, small in size, slightly asymmetrical, very shallowly concavo-convex perforate plate with socket and lip, at the narrower end the concavity of the sclerite more pronounced on the upper part; broadest slightly away from the lower side of sclerite; periphery irregularly scalloped and the top rounded; on concave side socket very prominent large 'M' shaped with short limbs, junction with the outer margin on each side forms very well developed horn like projection on the sides of the lip which

project out of the sclerite, lower side has very prominent large tooth in the middle of the socket, with 6 to 7 fine teeth like projections on either sides, while upper central region has fine 6 teeth like projections ; lip small, broadly rounded with 6 small holes, outer margin smooth ; 20 to 28 large denticulate perforations of variable shape and size present on sclerite, denticulations fine, sharp 3 to 10 in number, irregularly spaced, teeth present on both the surfaces of perforations ; in the centre of the sclerite a central perforation is surrounded by two concentric rows of unequal subcircular, oval and pentagonal perforations, 6 to 8 small and medium size perforations also present near the periphery of the plate.

Measurements in mm

	Length of sclerite	Breadth of sclerite	Number of perforations
Holotype No. L.U.H. 378	0.46	0.356	28
Paratype No. L.U.H. 379	0.42	0.315	20

Remarks—It is a very rare species. The preservation of the specimen is not very good and few perforations of the sclerite are filled with the matrix. In holotype on concave side holes of the lip are not seen as they are covered with matrix; however they are clearly visible on opposite side.

Rigaudites chiplonkari sp. nov. differs from *Rigaudites cuvillieri* (Deflandre-Rigaud) in shape of the socket and lip, number and arrangement of perforations and margin of the sclerite. This species somewhat resembles with *Rigaudites bastropanus* Frizzell & Exline but differs from it in having prominent horn like projections of the socket and arrangement of perforations. In *Rigaudites chiplonkari* perforations are arranged in concentric rows while the latter species has oblique rows of perforations. *Rigaudites tallaili* Frizzell & Exline, has conspicuous horn like projection on each side of the lip but differs from *Rigaudites chiplonkari* in the shape of sclerite, pattern of the arrangement of the perforations and shape of the lip.

Etymology—This species is named after Prof. G. W. Chiplonkar, Maharashtra Association for the Cultivation of Science, Poona, in recognition of his contributions to the knowledge of Palaeontology.

***Rigaudites narainsarovarensis* sp. nov.** (Pl. 5, Text-fig. 56)

Description—Sclerite small, thin, delicate, oval in shape, in form of very shallowly concavo-convex perforate plate with socket and lip at narrower end ; on concave side socket broadly 'M' shaped, prominent, limbs short with 3 to 4 trabeculae, upper side of socket slightly irregular, lip finely denticulate and irregular with 9 to 11 very small holes. Periphery of sclerite irregularly scalloped, more pronounced on the longitudinal sides of the sclerite ; perforations in five almost vertical rows, each row has 5 to 6 denticulate, oval, hexagonal and pentagonal perforations ; denticles present on both surfaces of the perforations and very small 3 to 7 nondenticulate perforations also present near the outer margin of the sclerite. The number of perforations varies from 30 to 34.

Measurements in mm

	Length of sclerite	Breadth of sclerite	Number of perforations
Holotype No. L.U.H. 380	0.344	0.245	34
Paratype No. L.U.H. 381	0.365	0.265	30

Remarks—It is a very rare species. Few perforations are filled up with the sediments.

Rigaudites narainsarovarensis sp. nov. somewhat resembles with *Rigauditesastropanus* Frizzell & Exline but differs in shape of the socket and the angle of arrangement of perforations. This new species also differs from *Rigaudites cuillieri* (Deflandre-Rigaud) in shape, in being smaller in size, structures of socket and lip and in having lesser number of perforations.

Rigaudites rajnathi sp. nov. (Pl. 5, Text-fig. 57)

Description—Sclerite in form of elongate perforate plate, fragile, subelliptical in shape, shallowly concavo-convex, medium in size, broadest at about two third distance from top, socket and lip present at the narrower end ; on concave side socket 'M' shaped, broad, limbs long, lower central part of the socket has one blunt tooth, upper side smooth ; lip moderately large, low, broad, smooth and slightly curved with about 20 to 25 tiny holes which in lower part slightly larger ; perforations in sclerite numerous, unequal in size, 34 to 40 in number, arranged in 5 longitudinal rows at about 80° to 85°, each row has 5 to 7 generally subhexagonal, finely denticulate perforations, denticles irregularly spaced in most of the perforations and their number varies from 4 to 10, perforations at the centre have teeth on both lower and upper surfaces and 4 to 6 very small nondenticulate marginal perforations also present.

Measurements in mm

	Length of sclerite	Breadth of sclerite	Number of perforations
Holotype No. L.U.H. 382	0.425	0.287	34
Paratype No. L.U.H. 383	0.434	0.3	40

Remarks—It is a rare species. Few perforations of the sclerite are filled. In holotype six tiny nondenticulate holes are present adjacent to the left limb of the socket near the periphery.

Rigaudites rajnathi sp. nov. somewhat resembles with *Rigaudites cuillieri* (Deflandre-Rigaud) but differs in being smaller in size, having lesser number of perforations, shape of the sclerite which is much broader in latter species and nature of the socket. *Rigaudites rajnathi* also differs from *Rigaudites narainsarovarensis* sp. nov. in having less scalloped periphery and shape of lip. Although, in both the species the socket is 'M'-shaped but in the former limbs are smooth and there is a small blunt tooth almost in the middle of the lower surface of the socket while in the latter the limbs of the socket have 3 to 4 trabeculae and lower surface of the socket has no tooth.

Etymology—This species is named after Late Prof. Raj Nath, former Head of the Geology Department, Banaras Hindu University, Varanasi, in recognition of his contributions to the Geology of Kutch.

Rigaudites valdiyai sp. nov. (Pl. 5, Text-fig. 58)

Description—Sclerite in form of elongate, perforate plate, oval in shape, shallowly concavo-convex, delicate, small in size, broadest in middle ; top truncated, margin irregularly scalloped ; well developed socket and lip towards narrower end on concave side ; socket 'U' shaped, lip broad almost straight at top, 19 to 22 tiny holes, follow the 'U' shape pattern along the upper surface of the socket ; perforations of the sclerite generally subhexagonal, arranged almost in 6 vertical rows, 34 to 37 in number, larger perforations in the

centre, smaller and elongate ones present near the outer margin of sclerite ; 5 to 7 perforations in each row, perforations finely denticulate; denticles generally unevenly placed, vary in number from 3 to 7 and present on both sides of the perforations.

Measurements in mm

				Length of sclerite	Breadth of sclerite	Number of perforations
Holotype No.	L. U. H. 384	..	..	0.287	0.225	34
Paratype No.	L. U. H. 385	..	..	0.325	0.25	37

Remarks—It is a very rare species and number of perforations are filled.

Rigaudites valdiyai sp. nov. differs from *Rigaudites rajnathi* sp. nov. in being smaller in size and in having 'U' shaped socket. The lip of the former species is almost straight while in the latter curved. This new species also differs from *Rigaudites plummerae* Frizzell & Exline, in having smooth margin and the lip of former species is almost straight at the top while in the latter species the margin is hispid and semicircular.

Etymology—This species is named in honour of Prof. K. S. Valdiya, Head of the Geology Department, Kumaun University, Nainital.

***Rigaudites waghpadarensis* sp. nov.** (Pl. 5, Text-fig. 59)

Description—Sclerite in form of perforate plate, thin, delicate, small in size, oval in shape, shallowly concavo-convex, socket and lip at the narrower end of sclerite, periphery irregularly scalloped ; on concave side 'M' shaped small socket, moderately narrow, limbs medium in size, lip small, protruding, semicircular in shape has 12 to 15 tiny holes arranged haphazardly ; on the sclerite 19 to 23 finely denticulate perforations, hexagonal, subpentagonal and elongate in shape, at the centre of the sclerite there is a perforation surrounded by two concentric rows of perforations, the inner concentric row has 6 to 8 perforations whereas, outer one 12 to 14 ; denticles of perforations unequally spaced, present on both the sides of the perforations.

Measurements in mm

				Length of sclerite	Breadth of sclerite	Number of perforations
Holotype No.	L.U.H. 386	..	..	0.219	0.175	19
Paratype No.	L.U.H. 387	..	..	0.245	0.195	23

Remarks—It is a very rare species. Few perforations are filled up.

Rigaudites waghpadarensis sp. nov. differs from *Rigaudites bastropanus* Frizzell & Exline, in shape of the sclerite and nature of the arrangement of perforations. This new species also differs from *Rigaudites cuvillieri* (Deflandre-Rigaud) in being much smaller in size, in having lesser number of perforations and in structure of the socket.

Family—CALCANCORIDAE Frizzell & Exline, 1955

Genus—**Calcancora** Frizzell & Exline, 1955

***Calcancora ahmadi* sp. nov.** (Pl. 5, Text-figs. 60, 61)

Description—Sclerite in form of anchor with two flukes (one fluke partly broken), shank long, narrow, tapering towards stock, slightly flattened on inner side, broad near the base and narrow near the stock ; a prominent small keel (on inner surface) present near the apex of the shank, occupying about 1/7th of the shank ; flukes broadly curved making an

angle of about 40° with shank, pointed end of fluke slightly incurved, base slightly concave, lower side with 5 weak teeth directed downward towards the base ; stock small, length nearly 1.8 times the maximum diameter of shank, low, smooth, ends broadly rounded unequally, feebly arched at top and slightly inclined towards broken fluke.

Measurements—Holotype No. L. U. H. 388 ; length of anchor 0.413 mm ; length of shank 0.344 mm, maximum diameter of the shank 0.044 mm ; length of stock 0.075 mm, height of stock 0.031 mm ; length of keel 0.05 mm, width of keel 0.012 mm. Distance between fluke tip and outer margin of shank (inner view) 0.1 mm.

Remarks—Only one specimen with a broken fluke has been found. It shows very characteristic features which are sufficient enough to assign it a new species.

Calcancora ahmadi sp. nov. somewhat resembles with *Calcancora kistnai* Jafar but differs from it in being much smaller in size, shape and structure of stock, number and nature of the teeth present on the lower side of the fluke. This new species also differs from *Calcancora galica* Frizzell & Exline, in the shape of the shank, in having nondenticulate stock, the angle of the fluke with shank and in having very weak teeth.

Etymology—The species has been named in honour of Prof. F. Ahmad, Commissioner, Department of Geology and Mining, Government of Jammu and Kashmir, Srinagar.

STRATIGRAPHICAL DISTRIBUTION AND PALAEOECOLOGY

Holothuroids in Middle Eocene rocks (in the section under study) first appear in *Corbula subexarata* Zone which is characterized by the genus *Fedenella*. They are absent in overlying Dicot leaf Zone and *Crocodylus* Zone which were deposited under the dominance of fresh and anaerobic brackish waters respectively. In *Nummulites perforatus* Zone, which marks the beginning of open sea continental shelf area (Neritic Zone) genus *Eocaudina* appears. In overlying *Nummulites beaumonti* Zone there is a sudden increase in number of holothuroid sclerites (13 genera and 47 species). They show the maximum frequency in both number and variety in the middle part of this zone. However, in the upper part their frequency gradually declines, ultimately they disappear in overlying *Fasciolites (Fasciolites) elliptica* Zone. The holothuroids have not been found in any higher biozones except in *Asterocyclina alticostata* Zone, where they are rare, broken and probably belong to *Eocaudina* or *Calclamna*.

The presence of few holothuroids in *Corbula subexarata* Zone, *Nummulites perforatus* Zone and their abundance in *Nummulites beaumonti* Zone suggests shallow to moderate marine depth in subtropical to tropical climate (FRIZZELL & EXLINE, 1955). Furthermore, the rocks such as clays, marls, clayey and marly limestones and shales in which these fossils are found are indicative of an area of weak current/wave activity. The absence of holothuroid sclerites from some highly fossiliferous marine rocks such as *Discocyclina (D.) dispansa* Zone, *Assilina cancellata* Zone etc. may be attributed either due to the higher salinity of sea water which led to the dissolution of their skeletons after their death or conditions were not favourable for their survival. Presence of hook (*Calcancora*) and disc (*Calclamnella*, *Eocaudina*, *Priscopedatus* etc.) are indicative that both the burrowing and clinging forms were present but the former was very rare and restricted to *Nummulites beaumonti* Zone.

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EXPLANATION OF PLATES

(Plates 2—5, Text-figures; all magnifications approximate)

PLATE 1

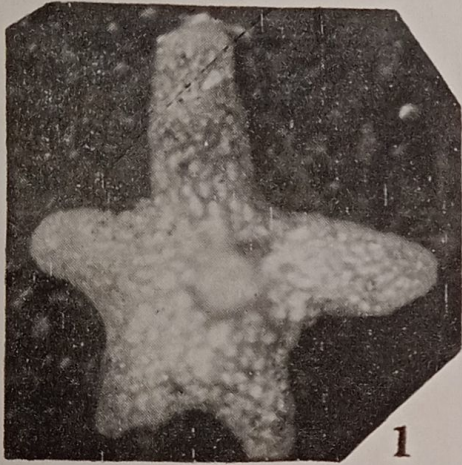
1. *Kutchia tewarii* gen. et sp. nov. Spire view. $\times 67.4$ (Holotype No. L.U.H. 302).
2. *Kutchia jhingrani* sp. nov. Spire view. $\times 66.6$ (Holotype No. L.U.H. 304).
3. *Kutchia narendaensis* sp. nov. Spire view. $\times 67.6$ (Holotype No. L.U.H. 306).
4. *Elgerius* aff. *E. ostrea* Deflandre-Rigaud. $\times 110$ (Hypotype No. L.U.H. 322).
5. *Elgerius rampurensis* sp. nov. $\times 110$ (Holotype No. L.U.H. 323).
6. *Elgerius ratcheloensis* sp. nov. $\times 110$ (Holotype No. L.U.H. 325).

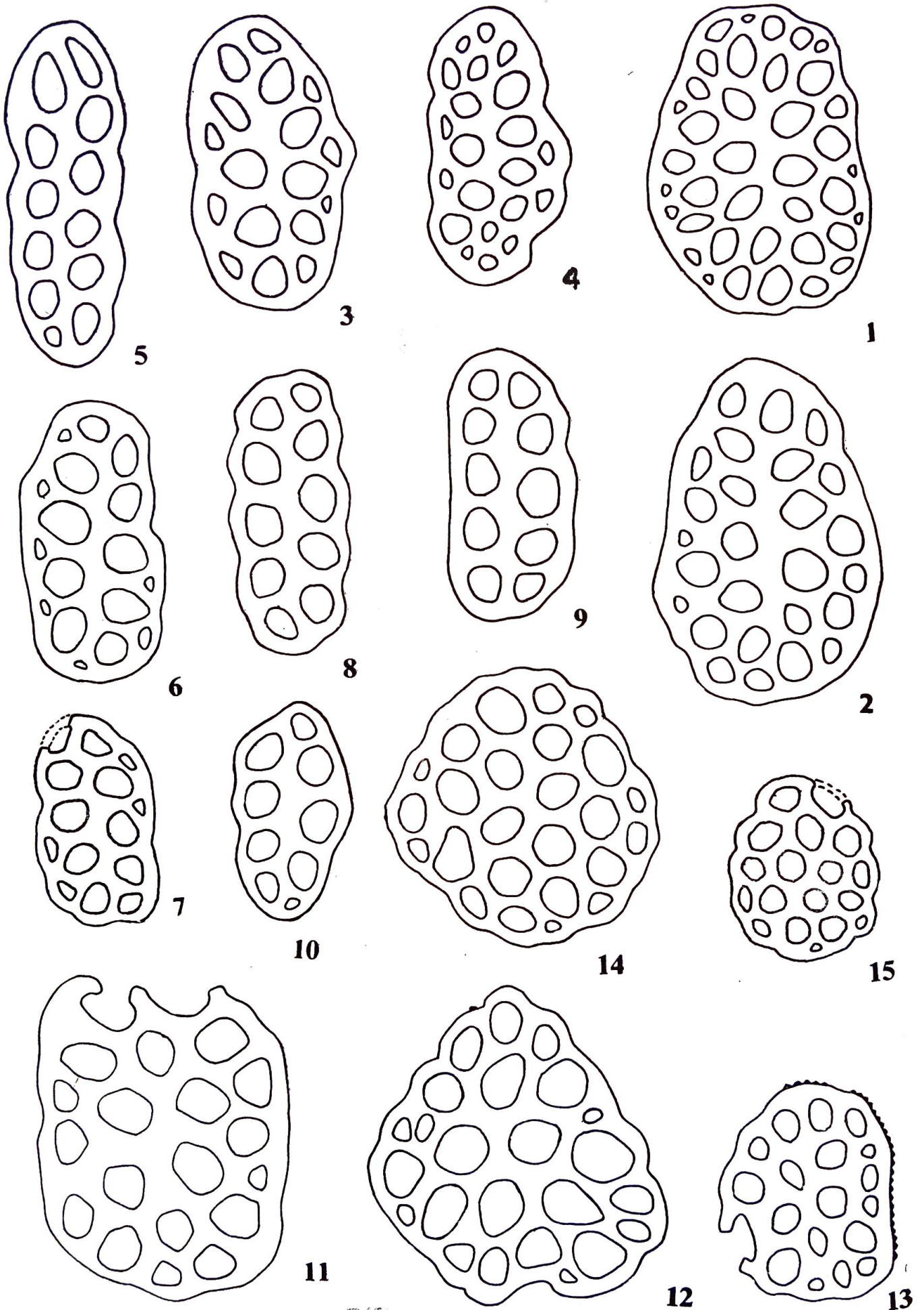
PLATE 2

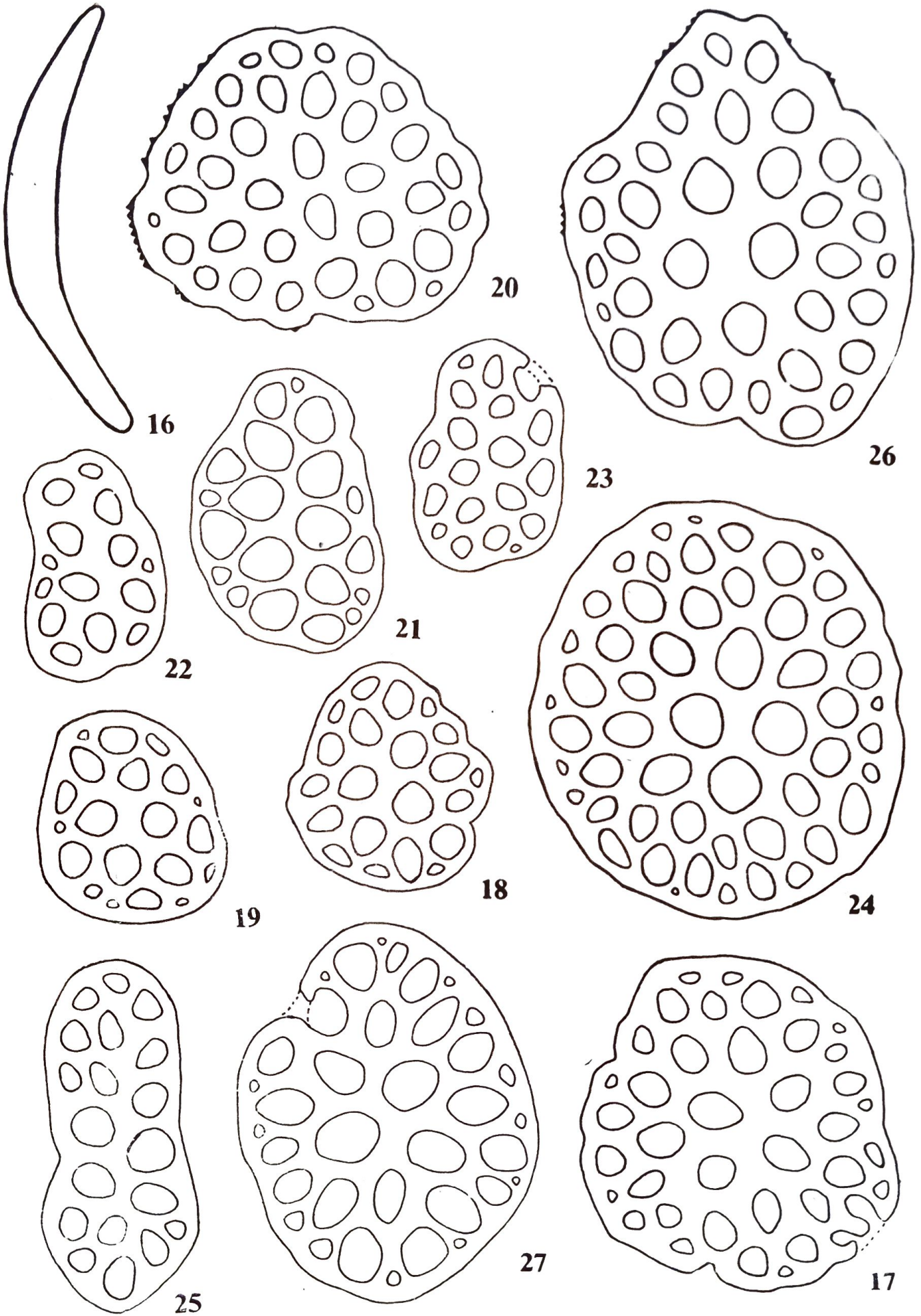
- 1,2. *Calclamna harudiensis* sp. nov. 1. $\times 175$ (Holotype No. L.U. H. 308) ; 2. $\times 228.5$ (Paratype No. L.U.H. 309).
- 3,4. *Calclamna ramwaraensis* sp. nov. 3. $\times 194.7$ (Holotype No. L.U.H. 310) ; 4. $\times 190.3$ (Paratype No. L.U.H. 311).
5. *Calclamnella agarwali* sp. nov. $\times 191.4$ (Holotype No. L.U.H. 312).
6. *Calclamnella* cf. *C. elliptica* (Deflandre-Rigaud). $\times 212$ (Hypotype No. L.U.H. 314).
7. *Calclamnella jaini* sp. nov. $\times 198.5$ (Holotype No. L.U.H. 315).
8. *Calclamnella khariensis* sp. nov. $\times 191.7$ (Holotype No. L.U.H. 317).
- 9,10. *Calclamnella satyendrai* sp. nov. 9. $\times 19.6$ (Holotype No. L.U.H. 319) ; 10. $\times 174.2$ (Paratype No. L.U.H. 320)
11. *Costigerites sinhai* sp. nov. $\times 266.6$ (Holotype No. L.U.H. 321).
12. *Eocaudina mittali* sp. nov. $\times 227.3$ (Holotype No. L.U.H. 342).
13. *Eocaudina waiorensi* sp. nov. $\times 235.5$ (Holotype No. L.U.H. 350).
- 14,15. *Eocaudina wynnei* sp. nov. 14. $\times 2481.1$ (Holotype No. L.U.H. 352) ; 15. $\times 181.4$ Paratype No. L.U.H. 353).

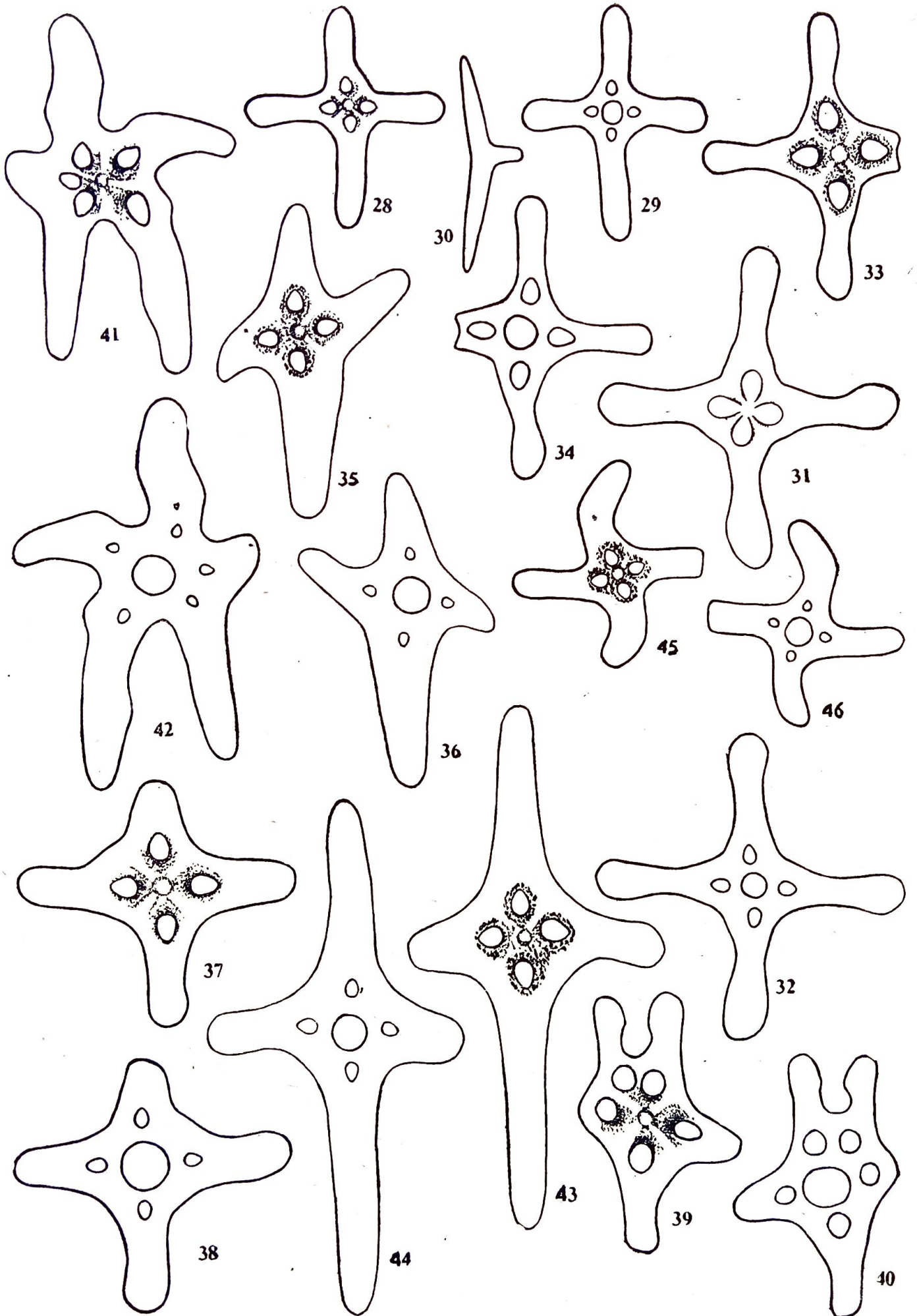
PLATE 3

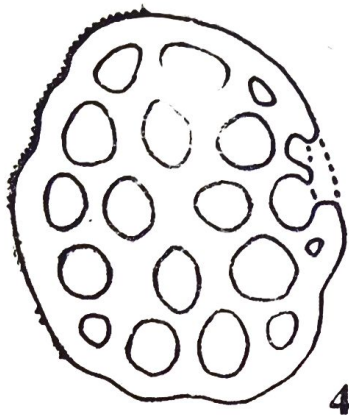
16. *Ucinulina subrecta* Frizzell & Exline. $\times 81.8$ (Hypotype No. L.U.H. 307).
17. *Eocaudina bhatiai* sp. nov. $\times 204.7$ (Holotype No. L.U.H. 327).
18. *Eocaudina bhujensis* sp. nov. $\times 173$ (Holotype No. L.U.H. 329).
19. *Eocaudina duncani* sp. nov. $\times 177.8$ (Holotype No. L.U.H. 331).
20. *Eocaudina jhadwaensis* sp. nov. $\times 200$ (Holotype No. I.U.H. 333).
- 21-23. *Eocaudina maniarraensis* sp. nov. 21. $\times 180.5$ (Holotype No. L.U.H. 337) ; 22. $\times 202.2$ (Paratype No. L.U.H. 338) ; 23. $\times 176.6$ (Paratype No. L.U.H. 339).
24. *Eocaudina piparensis* sp. nov. $\times 238.9$ (Holotype No. L.U.H. 344).
25. *Eocaudina soodani* sp. nov. $\times 202.5$ Holotype No. L.U.H. (346).
26. *Eocaudina vermai* sp. nov. $\times 243.8$ (Holotype No. L.U.H. 348).
27. *Eocaudina* sp. A. $\times 239.5$ (Hypotype No. L.U.H. 354).



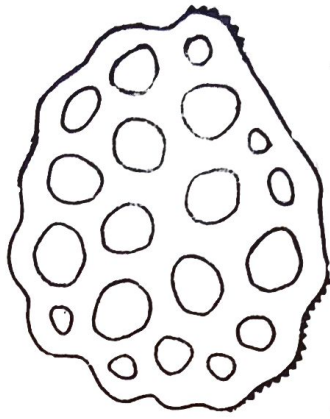




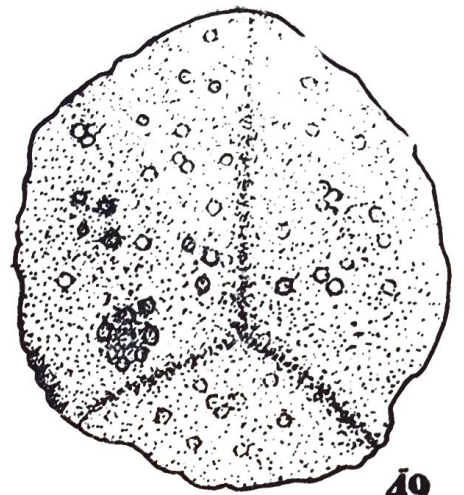




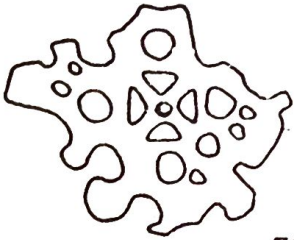
47



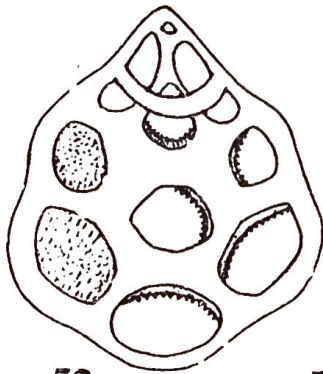
48



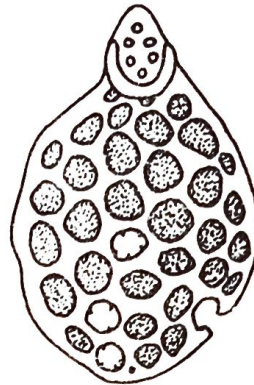
49



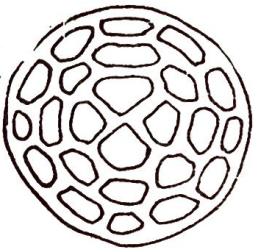
50



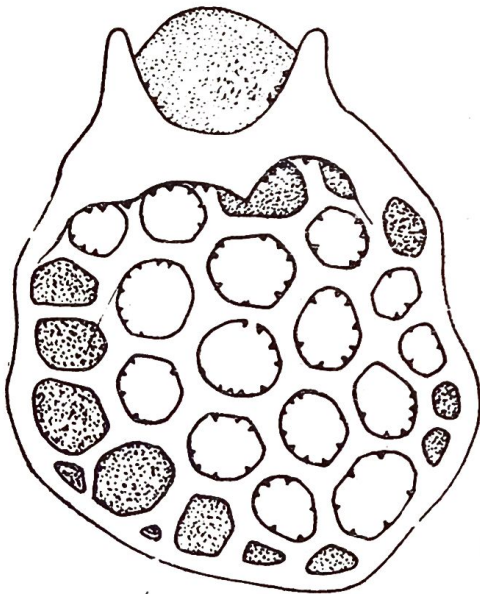
52



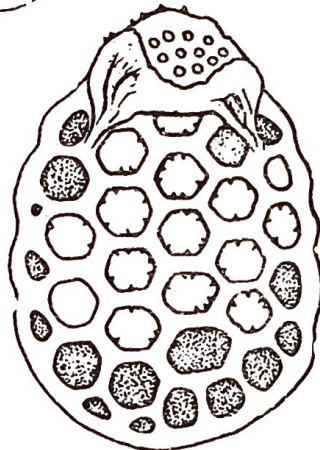
53



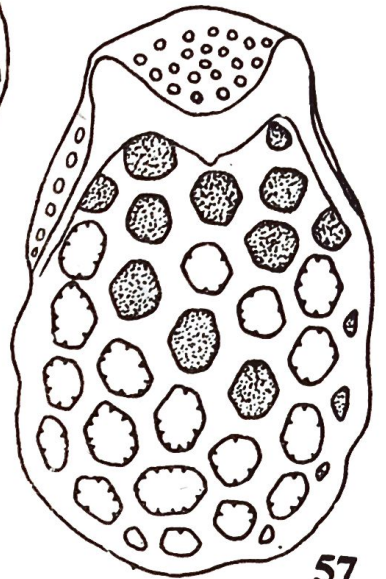
51



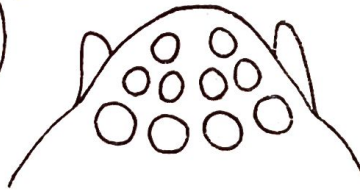
54



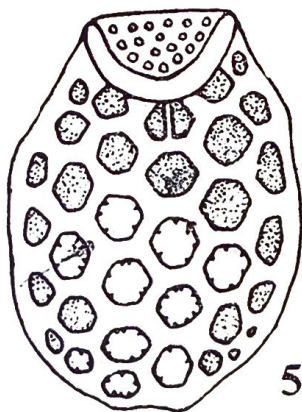
56



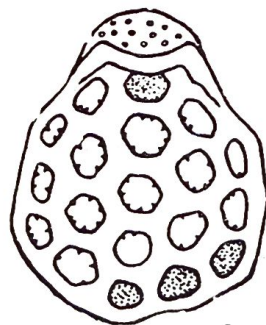
57



55



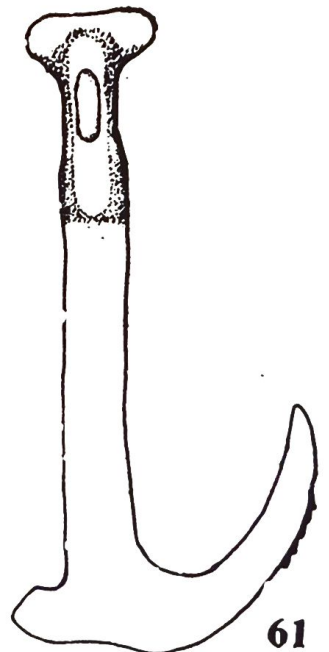
58



59



60



61

PLATE 4

- 28-30. *Koteshwaria sureshi* gen. et. sp. nov. 28. Spire view. $\times 92$; 29. Depression view. $\times 98.5$; 30. Lateral view $\times 89.3$ (Holotype No. L.U.H. 357).
 31-34. *Koteshwaria chandrai* sp. nov. 31. Spire view $\times 101.5$; 32. Depression view. $\times 99.5$ (Holotype No. L.U.H. 359); 33. Spire view. $\times 201$; 34. Depression view. $\times 181$ (Syntype No. L.U.H. 360).
 35,36. *Koteshwaria frizzelli* sp. nov. 35. Spire view. $\times 278$; 36. Depression view. $\times 278$ (Holotype No. L.U.H. 362).
 37,38. *Koteshwaria gothathadensis* sp. nov. 37. Spire view. $\times 233$; 38. Depression view. $\times 233$ (Holotype No. L.U.H. 364).
 39,40. *Koteshwaria hanna* sp. nov. 39. Spire view. $\times 238.5$; 40. Depression view. $\times 241$ (Holotype No. L.U.H. 366).
 41,42. *Koteshwaria merhi* sp. nov. 41. Spire view. $\times 175$; 42. Depression view. $\times 188.5$ (Holotype No. L.U.H. 368).
 43,44. *Koteshwaria sastrii* sp. nov. 43. Spire view. $\times 221$; 44. Depression view. $\times 218.5$ (Holotype no. L.U.H. 370).
 45,46. *Koteshwaria* sp. A 45. Spire view. $\times 101.5$; 46. Depression view. $\times 100$ (Holotype No. L.U.H. 372).

PLATE 5

47. *Eocaudina kutchensis* sp. nov. $\times 232$ (Holotype No. L.U.H. 335).
 48. *Eocaudina marhensis* sp. nov. $\times 236$ (Holotype No. L.U.H. 340).
 49. *Frizzellus irregularis* Hampton $\times 197$ (Holotype No. L.U.H. 355).
 50. *Fednell* sp. Spire view $\times 132.3$ (Hypotype No. L.U.H. 356).
 51. *Priscopedatus gowdai* sp. nov. Convex view. $\times 203.2$ (Holotype No. L.U.H. 373).
 52. *Croneisites gutschicki* sp. nov. Concave view. $\times 211$ (Holotype No. L.U.H. 375).
 53. *Rigaudites chatterji* sp. nov. Concave view. $\times 224$ (Holotype No. L.U.H. 377).
 54,55. *Rigaudites chiplankari* sp. nov. 54. Concave view. $\times 196.6$; 55. Apart of narrow end, convex view. $\times 196.6$ (Holotype no. L.U.H. 378).
 56. *Rigaudites narainsarovarensis* sp. nov. Concave view. $\times 194.7$ (Holotype No. L.U.H. 380).
 57. *Rigaudites rajnathi* sp. nov. Concave view. $\times 200$ (Holotype No. L.U.H. 382).
 58. *Rigaudites valdiyai* sp. nov. Concave view. $\times 198.6$ (Holotype No. L.U.H. 384).
 59. *Rigaudites waghpadarensis* sp. nov. Concave view. $\times 210$ (Holotype No. L.U.H. 386).
 60,61. *Calcancora ahmadi* sp. nov. 60. Lateral view. $\times 239.7$; 61. Inner view. $\times 239.7$ (Holotype No. L.U.H. 388).