

Contributions to the Jurassic of Kachchh, western India.

VII. The gastropod fauna. Part I. Pleurotomarioidea, Fissurelloidea, Trochoidea and Eucycloidea

ANAND K. JAITLY, JÁNOS SZABÓ & FRANZ T. FÜRSICH

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Abstract. Gastropods are uncommon elements of the Bajocian-Oxfordian benthic fauna of the Kachchh Basin, western India, and generally poorly preserved. Most of the described material comes from well defined horizons in which the good to excellent preservation of the fauna allowed identification at the species level. 25 species belonging to 18 genera/subgenera of the superfamilies Pleurotomarioidea, Fissurelloidea, Trochoidea, and Eucycloidea have been described. 15 species are new to science: *Anodomaria latigradata* n. sp., *A. depressa* n. sp., *Leptomaria pseudoumbilicata* n. sp., *L. simplex* n. sp., *Bathrotomaria kachchhensis* n. sp., *B. siebereri* n. sp., *Emarginula (Tauschia) jumarensis* n. sp., *Proconulus (P.) bhujensis* n. sp., *P. (P.) haboensis* n. sp., *P. (P.) wagadensis* n. sp., *Ataphrus kaladongarensis* n. sp., ? *Onkospira praecursor* n. sp., *Riselloidea pileiformis* n. sp., *Amphitrochus acutispira* n. sp., and *A. orbis* n. sp.

■ *Taxonomy, Gastropoda, Jurassic, Kachchh, India*

Zusammenfassung: Gastropoden sind relativ seltene und im allgemeinen schlecht erhaltene benthische Elemente innerhalb der vom Bajoc bis Oxford reichenden Schichtenfolge im Becken von Kachchh, westliches Indien. Der Großteil des beschriebenen Materials stammt aus einzelnen Horizonten, in denen die gute bis sehr gute Erhaltung der Fauna eine Bestimmung auf Artniveau ermöglichte. 25 Arten aus 18 Gattungen bzw. Untergattungen der Überfamilien Pleurotomarioidea, Fissurelloidea, Trochoidea und Eucycloidea werden beschrieben. 15 Arten sind neu: *Anodomaria latigradata* n. sp., *A. depressa* n. sp., *Leptomaria pseudoumbilicata* n. sp., *L. simplex* n. sp., *Bathrotomaria kachchhensis* n. sp., *B. siebereri* n. sp., *Emarginula (Tauschia) jumarensis* n. sp., *Proconulus (P.) bhujensis* n. sp., *P. (P.) haboensis* n. sp., *P. (P.) wagadensis* n. sp., *Ataphrus kaladongarensis* n. sp., ? *Onkospira praecursor* n. sp., *Riselloidea pileiformis* n. sp., *Amphitrochus acutispira* n. sp. und *A. orbis* n. sp.

■ *Taxonomie, Gastropoda, Jura, Kachchh, Indien*

Address of the authors: J. SZABÓ, Department of Geology & Palaeontology, Hungarian Natural History Museum, Budapest VII, Múzeum krt. 14-16, Hungary; A. K. JAITLY, Department of Geology, Banaras Hindu University, Varanasi 221005, India; F. T. FÜRSICH, Institut für Paläontologie der Universität Würzburg, Pleicherwall 1, D-97070 Würzburg, Germany.

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Introduction

The Jurassic of Kachchh is well-known for its rich fauna of macro-invertebrates. The first Jurassic fossils were figured as early as 1840 by J. DE C. SOWERBY. Subsequent attention focused on the ammonites (WAAGEN 1871, 1873-1875, SPATH 1924, 1927-1933), but other groups such as corals (GREGORY 1900), echinoderms (GREGORY 1893), brachiopods (KITCHIN 1900) and bivalves (KITCHIN 1903, COX 1940, 1952) were also treated in a monographic way. Gastropods, however, received very little attention. The first records are by J. DE C. SOWERBY who figured the new species *Buccinum pumilum* from the "Upper Secon-

dary Rocks" [probably Callovian] of Mhurr (1840: pl. 23, figs. 1, 1a) and *Tornatella striata* from "hills 12 to 15 miles north of Booj" (in SYKES 1840: pl. 56, figs. 6, 6a). Although being by now means very rare, gastropods were subsequently figured and described solely by MAITHANI (1968) who discussed four taxa of pleurotomariids, among them the new species *Pleurotomaria rajnathi* and *P. tewarii* from the Callovian-Oxfordian of Habo Dome, and MITRA & GHOSH (1979), who described "Jurassic Turritellas". The present account is the first one in a series of papers the purpose of which is to provide a comprehensive up-to-

date description of the Jurassic gastropod fauna of Kachchh.

Generally, gastropods are uncommon elements of the benthic shelly macrofauna of the Kachchh Jurassic and in most associations represent less than one per cent in terms of relative abundance (FÜRSICH et al., unpublished data). In addition, they are often poorly preserved, unidentifiable, internal moulds. There are, however, horizons in which gastropods are common

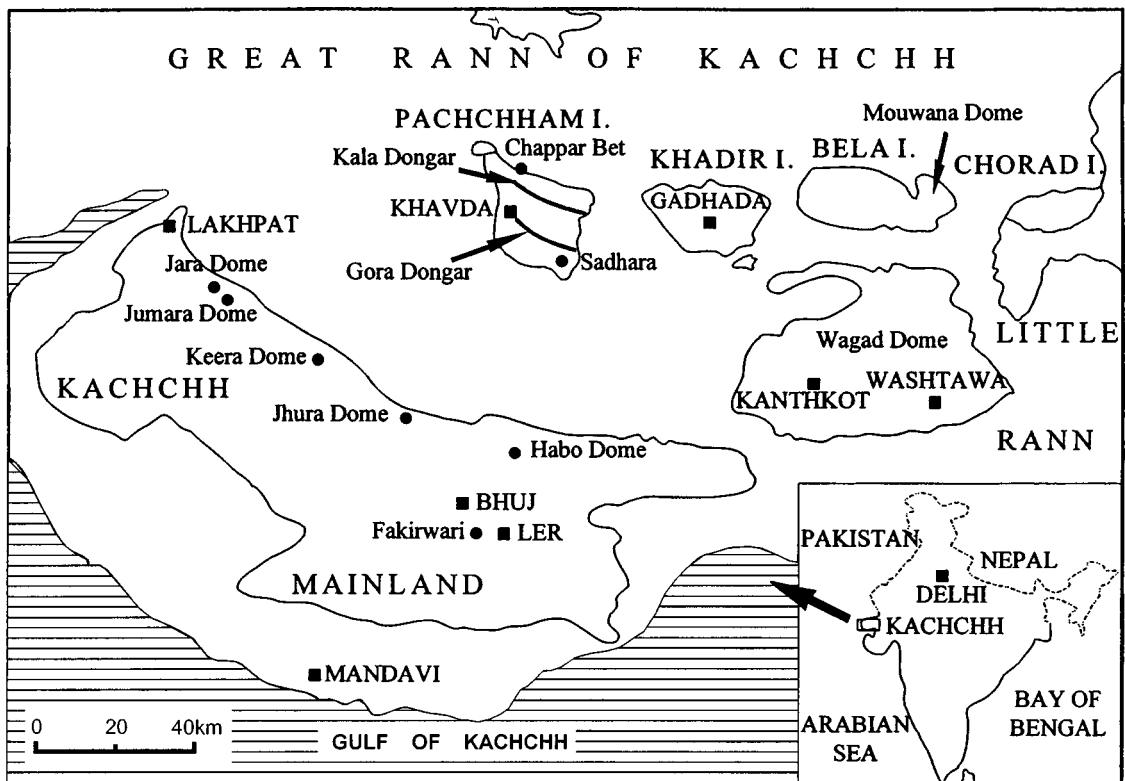
and well preserved. A systematic, quantitative collecting of the benthic macrofauna from Bajocian to Oxfordian rocks has therefore resulted in a data base of several hundred specimens which document a moderately diverse fauna.

The figured material is housed in the collections of the Banaras Hindu University (prefix BHU1998III), the rest in the collections of the Palaeontological Institute of Würzburg University (prefix PIW 1999VII).

Geological and stratigraphic framework

Jurassic rocks of Kachchh, a district of Gujarat State, crop out in a series of hills ("domes") arranged in two E-W trending belts, one situated on the so-called Kachchh Mainland, the other forming "islands" in the Great Rann of Kachchh (Text-fig. 1). The rocks represent deposits of a pericratonic rift basin which was situated at the western margin of the Indian plate (e.g. BISWAS 1987). The earliest ammonite found within the basin indicates a Late Bajocian age (SINGH et al. 1982). However, the bed in which it occurs, is

underlain by more than 200 m of partly terrestrial, partly marginal marine sediments. They suggest that the earliest marine sediments may be Early Bajocian or even Aalenian in age. Facies range from terrestrial red beds and fluvial sandstones to deltaic and nearshore coarse siliciclastics and fine-grained basinal sediments (argillaceous silt, calcareous mudstone). They represent environments ranging from coastal plains, brackish lagoons, and nearshore sand bar complexes to storm-dominated ramp and shallow basinal deposits.



Text-fig 1. Locality map.

Two lithostratigraphic schemes exist; a traditional one that goes back to WAAGEN (1873) and a more recent one proposed by BISWAS (1980). The lithostratigraphic scheme used here is a mixture of the two. Whereas the traditional scheme is used for rocks found on Kachchh Mainland, BISWAS' formational names are

used for much of the island (see also FÜRSICH et al. 1994). In addition, the lithostratigraphic scheme presented in Text-fig. 2 contains several new lithostratigraphic members that are in the process of being formalized (FÜRSICH et al., in prep.).

	MAINLAND		PACHCHHAM ISLAND				WAGAD DOME	REMAINING ISLANDS				
OXFORD.	* DHOSA OOLITE MB		CHARI FM				WAGAD SS. FM	KHADIR FM				
	* DHOSA SANDSTONE MB						WASHTAWA FM					
CALLOVIAN	* GYPSIFEROUS SHALES MB						CHARI FM				KHADIR FM	
	* RIDGE SANDSTONE MB											
	* SHELLY SHALE MB											
BATHONIAN	* KEERA GOLDEN OOLITE MB		RAIMALRO LIMESTONE MB				KHADIR FM					
	PATCHAM FM	* SPONGE LIMESTONE MB						PATCHAM FM				
	JHURIO FM	1 2 3						GADAPUTA SANDSTONE MB		GORA DONGAR FM		
		* BADI WHITE LIMESTONE MB						MIDDLE SANDSTONE MB	KALADONGAR BABIA CLIFF SS. MB			
								LOWER YELLOW FLAGSTONE MB				
		EOMIODON RED SANDSTONE MB										
BAJOCIAN			SADHARA CORAL LIMESTONE MB		KALADONGAR SS. MB	KALADONGAR FM						
		KHAVDA FM		DINGY HILL MB								

1: JUMARA CORAL LIMESTONE MB

↑ GORA DONGAR

↑ KALA DONGAR

2: JHURA GOLDEN OOLITE MB

3: GORADONGAR YELLOW FLAGSTONE MB

Text-fig. 2. Lithostratigraphic scheme of the Jurassic rocks of Kachchh, based partly on BISWAS (1980), partly on FÜRSICH et al. (1994; in prep.). Lithostratigraphic units marked with an asterisk have not yet been formalized. K.S. mb: Kaladongar Sandstone mb; D. mb: Diny mb.

Taxonomy

Recently a wide range of publications has attempted to eliminate the gaps between the palaeontological and the neontological gastropod classifications and to

revise fossil taxa in order to find real phylogenetic connections as basic requirements for evolutionary systematics. Unfortunately, many of these studies

demonstrated mainly the errors of earlier classification schemes but failed to build up a new one. As a new classification is also beyond the scope of the present paper, the classification below mainly follows that of KNIGHT et al. (1960) for Archaeogastropoda and WENZ (1938) for Caenogastropoda. Most of these discussions concern classification at the highest taxonomic categories; classification in the present paper will therefore stop at the superfamily level. In the lowest taxonomic categories, beside identification of the species, revised generic names will be applied for the taxa.

Terminology used is mainly that of KNIGHT et al. (1960).

Measurements (in mm and °).

- H = height of shell
- L = anterior-posterior length (in case of limpets)
- W = width (in case of limpets)
- HL = height of last whorl
- HP = height of peristome
- D = maximum diameter of shell
- WP = width of peristome
- AA = apical angle
- AL = coiling angle of (apparent) last (measurable) whorl
- * = measured on slightly damaged or reconstructed shell

Superfamily *Pleurotomarioidea* SWAINSON 1840

Family *Pleurotomariidae* SWAINSON 1840

Within the family *Pleurotomariidae* (of traditional interpretation), two basic groups of genera can be found: shells with gradate outline and conical shells. The two groups probably stem from different ancestors in spite of the fact that the two outline types are sometimes combined. In the present work, the conical group needs more attention because they are fairly common and diverse in the Kachchh fauna but some genera cannot really distinguished by means of shell characters. From a conchological point of view, *Mikadotrochus* LINDHOLM 1927 and *Perotrochus* P. FISCHER 1885 are hardly distinguishable from *Leptomaria* E. EUDES-DESLONGCHAMPS 1864 and, therefore, should be treated as synonyms in palaeontology. This is particularly obvious if not only the type species are studied. This is why we apply the name *Leptomaria* to forms for which one could also use the name of one of the other two extant genera.

Low-spired *Leptomaria* and (higher-spired) *Obornella* COX 1959 are frequently homoeomorphs. In these cases, the position of the selenizone [close(r) to midwhorl in *Leptomaria* and close(r) to the periphery in *Obornella*] is the most reliable feature to distinguish

the two genera.

Anodomaria was erected by SZABÓ (1980: 58) as a subgenus of *Pleurotomaria* to accommodate species having the general shape of *Pleurotomaria* DEFRANCE 1826 but lacking the nodes (nodulae) or ridges of the ornament. In the type species of *Anodomaria* [*A. scacchi* (GEMMELLARO, G. G. 1874)], in *A. trochotomopsis* (GEMMELLARO G. G. 1874), and in *Anodomaria latigradata* n. sp. (see below), the ornament is a network of spiral and collabral threads or cords of equal strength. The collabral elements may be weaker than the spiral ones (in *Anodomaria depressa* n. sp. described below) or lacking (in *A. anodosa* SZABÓ 1980).

Because a definite phylogenetic connection between the form group of *Pleurotomaria* and that of *Anodomaria* has not been found, *Anodomaria* should be treated as an independent genus.

Mesozoic pleurotomarioideans with cancellate ornament have been usually regarded as members of the Phymatopleuridae BATTEN 1956. However, this ornament frequently appears also in other families, e.g. within the *Pleurotomariidae* mainly as juvenile sculpture. Until an upgraded classification of the *Pleurotomarioidea* has been established, accommodation of *Anodomaria* in the *Pleurotomariidae* (the older family name) seems to be the best solution.

Up to now *Anodomaria* has been known only from the Liassic and was restricted to NEUMAYR's (1872) "Mediterranean-Province". The Kachchh finds are the first record outside this palaeobiogeographic area. At the same time, they are also the youngest known occurrences of this genus.

Genus *Pleurotomaria* DEFRANCE 1826

Type species. *Trochus anglicus* J. SOWERBY 1818.

Pleurotomaria sp.

Pl. 1, Fig. 1

Material. A single, fragmentary specimen being mainly an internal mould (BHU1998III 17).

Distribution. Chari Formation of Jara Dome.

Measurements (BHU1998III 17).

H	HL	HP	D	WP	AA	AL
-	*51.5	*10.5	25.5	*41.5	-	83°

Description. Specimen consisting of two whorls of a gradate-trochiform shell. Ramp rather narrow and angulation of the whorls strongly rounded. Outer face flattened and inclined to the axis with which it forms a rather wide angle. The moderately wide selenizone

occurs near the angulation. Periphery rounded-angular and bearing a weakly swollen band. Base slightly convex and moderately phaneromphalous.

Dense spiral threads cover the whorls; they are crossed, on the ramp, by ribs in the earlier and low collabral ridges in the later growth stages. Ornament of the base not visible.

Remarks. The weak ridges of the ramp suggest that the specimen belongs to the genus *Pleurotomaria*. Because no description and figure matching the specimen has been found in the literature, most likely, it belongs to a new species. However, due to its poor state of preservation, it has been described here without a definite statement.

Genus *Anodomaria* SZABÓ 1980

Anodomaria latigradata n. sp.

Pl. 1, Fig. 2

Holotype. Specimen BHU1998III 13.

Derivation of name. *latus* (Latin) = wide; *gradatus* (Latin) = gradate, referring to the widely gradate outline.

Type locality. "Astarte Hill", south of Gadhada village, Khadir Island.

Type strata. Khadir Formation (Callovian).

Distribution. Callovian part of Khadir Formation, Khadir Island.

Material. A single specimen with damaged peristome (BHU1998III 13).

Measurements (BHU1998III 13).

H	HL	HP	D	WP	AA	AL
*23.5	*15.5	*10	26	-	82°	70°

Diagnosis. Height and diameter almost equal; juvenile whorls sharply, last whorl rounded-angular; network of equally strong spiral and collabral threads.

Description. Gradate trochiform shell with convex whorls, sharply angular in earlier growth stages, but rounded-angular in the case of the last whorl. Sub-

sutural ramp narrow and slightly convex. Selenizone rather wide, situated some distance below the angulation. Outer face wider than the ramp and almost vertical, sloping slightly abaxially in the earlier whorls but gradually changing to less steep on the last whorl. Periphery angular and carrying a moderately strong spiral swelling. Base feebly convex, probably anomphalous with median depression (pseudo-umbilicus) but a narrowly phaneromphalous nature of the shell cannot be completely excluded owing to the state of preservation. Only a short, slightly thickened columellar (umbilical) part of the peristome is preserved.

Last whorl with a network of spiral and collabral threads of the same strength. On the ramp of the earlier two whorls, the second or third collabral threads became are stronger than the rest. On the base, the network is dominated by the spiral elements.

Remarks. Comparable species are *A. scacchi* (GEMMELLARO, G. G. 1874) from the Middle Liassic of Sicily and the Pliensbachian of the Bakony Mountains, Hungary (SZABÓ 1980), *Pleurotomaria* cf. *pisana* DE STEFANI of DUBAR (1949) from the Domerian of Djebel Bou-Dahar; *A. trochotomopsis* (GEMMELLARO, G. G. 1874). They also are reticulate *Anodomaria* species. However, all have a much smaller spiral angle and narrower ramp than *Anodomaria latigradata*. In addition, the outer face is concave at the selenizone in *A. scacchi* but flat in *A. latigradata*.

Anodomaria depressa n. sp.

Pl. 1, Fig. 3

Holotype. Specimen BHU1998III 16.

Derivation of name: *depressus* (Latin) = flattened, depressed.

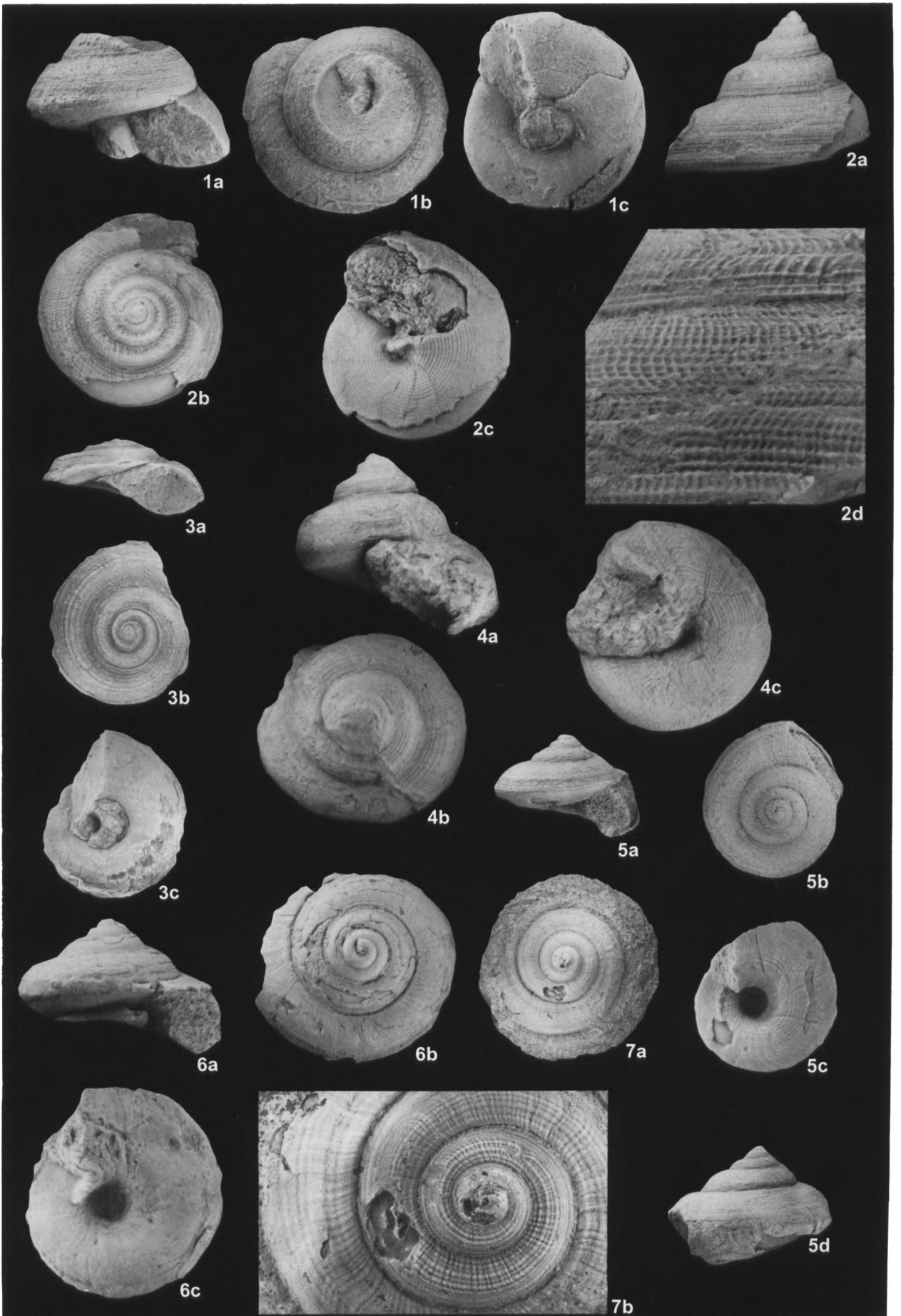
Type locality. Central area of Jumara Dome.

Type strata. Diverse coral layer, Patcham Formation.

Material. A single specimen with well-preserved spire but basal part preserved as internal mould (BHU1998III 16).

EXPLANATION OF PLATE 1

Fig. 1. *Pleurotomaria* sp.; a: apertural view; b: apical view; c: basal view. Chari Formation, Jara Dome; x 1.5.- BHU1998III 17.
 Fig. 2. *Anodomaria latigradata* n. sp., holotype; a: abapertural view; b: apical view; c: basal view; d: enlargement of ornament. Callovian part of Khadir Formation, "Astarte Hill", south of Gadhada village, Khadir Island; a-c: x 1.5, d: x 3.- BHU1998III 13.
 Fig. 3. *Anodomaria depressa* n. sp., holotype; a: apertural view; b: apical view; c: basal view. Dhosa Oolite member, Jara Dome; x 1.5.- BHU1998III 16.
 Fig. 4. *Anodomaria* ? sp.; a: apertural view; b: apical view; c: basal view. Callovian part of Khadir Formation, "Astarte Hill", south of Gadhada village, Khadir Island. x 1.- BHU1998III 14.
 Figs. 5-7. *Obornella granulata* (J. SOWERBY 1818). 5. a: apertural view; b: apical view; c: basal view. Dhosa Oolite member, Jhura Dome. x 1.5.- BHU1998III 1b. 6. a: apertural view; b: apical view; c: basal view; d: abapical view. Dhosa Oolite member, Jhura Dome. x 1.5.- BHU1998III 1. 7. a: apical view, x 1; b: enlargement of ornament, x 3. Dhosa Oolite member, Jhura Dome.- BHU1998III 1a.



Distribution. Diverse coral layer (Patcham Formation) of central Jumara Dome.

Measurements (BHU1998III 16).

H	HL	HP	D	WP	AA	AL
9	8.5	7	20.5	11.5	-	147°

Diagnosis. Depressed, almost planispiral shell; collabral elements of network ornament much weaker than spiral ones.

Description. Rather small shell with strongly depressed spire, consisting of angular whorls. Suture running in a deep canal. Ramp almost horizontal, abaxially delimited by the rounded angulation of the whorls. Outer face wide and inclined towards the axis with which it forms a fairly wide angle. Selenizone wide (about half of the outer face), periphery extremely sharp. Base flattened-convex and broadly phaneromphalous, the umbilical margin being subangulate.

Several spiral cords ornament the ramp and the outer face (except the selenizone). Much weaker collabral threads cross them. They are more conspicuous on the ramp and at the periphery but are hardly visible on the selenizone. Ornament of the base unknown.

Remarks. The strongly depressed spire distinguishes *Anodomaria depressa* from all other known species of the genus.

Anodomaria ? sp.

Pl. 1, Fig. 4

Material. 1 specimen, damaged on the last whorl near the peristome and at the juvenile spire region (BHU1998III 14).

Distribution. Callovian part of Khadir Formation, "Astarte Hill", southern Khadir Island.

Measurements (BHU1998III 14).

H	HL	HP	D	WP	AA	AL
35.5	27	17.5	40	-	95°	75°

Description. Moderately large, gradate, rather low trochiform shell. Whorls convex, distinctly angular in the juvenile but rounded-angular in the adult stage. Width of ramp and outer face nearly equal. Selenizone situated in the middle of the outer face. Periphery rounded-angular and without swelling. Base weakly convex, possibly phaneromphalous (narrowly).

Widely and unequally spaced ribbons ornament the ramp and the base; the outer face bears weak cords crossed only by growth lines.

Remarks. As no nodes or ridges were found on the preserved shell, the specimen has been tentatively referred to *Anodomaria*. However, there are two kinds of

uncertainties in the identification: a ribbon ornament has not yet been observed in true *Anodomaria* species and typical *Pleurotomaria* ornamental elements may be restricted to juvenile shell parts that are not preserved in this specimen.

Because the angulation of the last whorl is rounded, its shape resembles that of *Leptomaria*. The distinct angulation of the earlier whorls distinguishes this specimen from *Leptomaria*.

Genus *Obornella* COX 1959

Obornella granulata (J. SOWERBY 1818)

Pl. 1, Figs. 5-7

- 1818 *Trochus granulatus* n. sp. - J. SOWERBY: pl. 220, figs. 2-3.
 1849 *Pleurotomaria granulata* var. *laevigata* n. var. - J. A. EUDES-DESLONGCHAMPS: 101, pl. 16, fig. 5a-c.
 1855 *Pleurotomaria Palemon* n. sp. - D'ORBIGNY: 468, pl. 380, figs. 7-11.
 1896 *Pleurotomaria granulata* SOWERBY, 1818 - HUDLESTON: 440, pl. 39, fig. 10a-c.
 1908 *Pleurotomaria Palaemon* D'ORBIGNY - SIEBERER: 45, pl. 3, fig. 6a-c, text-figs. 15-16.
 1997 *Obornella granulata* (SOWERBY, 1818) - FISCHER: 177, pl. 37, fig. 5a-b.

Material. 6 specimens in different states of preservation (BHU 1998III 1a, b, PIW1999VII 1-3).

Distribution. Dhosa Oolite member, Chari Formation of Jhura Dome and Habo Dome.

Measurements (BHU1998III 1).

H	HL	HP	D	WP	AA	AL
*17.5	14.3	*9.4	*26.5	-	112°	112°

Description. Specimens low-spined, conical, medium-sized to large for the genus. Protoconch not preserved, number of teleoconch volutions five. Whorls moderately convex, except for a narrow, feebly concave belt between the selenizone and the peripheral bulge. Suture running in a shallow canal. Periphery rounded-angular and bearing a bulge. Base slightly convex and broadly phaneromphalous. Umbilical margin widely rounded. Only part of the inner lip preserved (between the parietal region and the base) which is somewhat thickened and has a clearly visible outer face. Labial slit not preserved but a rather wide (unusual for *Obornella*); feebly convex selenizone present below the mid-whorl, near the periphery.

On juvenile whorls, the ornament consists of spiral and collabral threads, showing a network pattern with granulae at points of intersections. On the last whorl, below the selenizone to the outermost belt of the base, the collabral threads become stronger (riblets) and dominate. Between the suture and the selenizone, orna-

mental elements become widely spaced, less prominent, and granulae are absent. The base is covered by flattened spiral threads, like those of the last whorl, and crossed by marked growth lines.

Remarks. The Kachchh specimens agree well with SOWERBY's (1818) original description and his fig. 2. The only exception is the shape of the periphery which is rounded in SOWERBY's figure but rounded-angular in the Kachchh specimens. SOWERBY's fig. 3. shows the base of another specimen with nodes on the periphery and no spiral lineation on a wide, central belt. The Kachchh specimens have neither nodes nor a basal surface lacking spiral lines.

Subsequent authors included a wide variety of forms in *granulata*. Here we accept the *granulata* interpretation of FISCHER (1997), i.e. a species, extremely variable both in shape and ornament. However, in the synonymy list we refer only to the most similar forms. They belong to the form group of *Pleurotomaria Palemon* D'ORBIGNY 1855.

D'ORBIGNY's *Pleurotomaria Palemon* was established on two *Pleurotomaria granulata* varieties, *lentiformis* and *laevigata*, of J. A. EUDES-DESLONGCHAMPS (1849). The Kachchh specimens are most similar to *laevigata*, having a rounded periphery. *Lentiformis* differs in having a rather sharply angular periphery.

HUDLESTON'S (1896) figures show as high spires as the Kachchh specimens but the ornament is more pronounced (HUDLESTON states that this figure has been drawn after more than one specimen).

The shape and ornament of SIEBERER's *Pleurotomaria Palaemon* (1908: pl. 3, fig. 6a-c) is also similar to those of the Kachchh specimens but its spire is slightly lower.

Of the figures published in the revision of D'ORBIGNY's gastropod originals of the "Paléontologie française" (FISCHER 1997), the Kachchh material is most similar to the specimen of *Obornella granulata* specimen (figured on pl. 37, fig. 5a-b) which would be the lectotype of *Obornella palemon* (D'ORBIGNY 1855).

Obornella aff. *granulata* (J. SOWERBY 1818)

Pl. 2, Fig. 8a, b

Material. A single, incomplete specimen with preserved shell (BHU 1998III 5).

Distribution. Dhosa Oolite member of northwestern Habo Dome.

Description. Medium-sized shell with low spire. Outline of shell coeloconical, apex distinctly acute. Whorls convex, suture running in a relatively deep

canal. Shell rounded at the periphery and gradually turning into the convex base. Selenizone fairly close to the crenate periphery. Umbilical region not visible.

Ornament consisting of a network of stronger spiral and weaker collabral threads on the whorls and just growth lines on the base.

Remarks. The shell shows enough features to distinguish it from other species but its incomplete nature precludes a precise identification. Considering the wide variability of *Obornella granulata* (J. SOWERBY 1818) as demonstrated by FISCHER (1997), the name might be also applicable to this specimen.

Obornella wuerttembergensis (SIEBERER 1908)

Pl. 2, Figs. 1-2

1908 *Pleurotomaria Palaemon* var. *Wuerttembergensis* n. var.
- SIEBERER: 46, pl. 3, fig. 8a-c.

Material. 4 specimens, one of them relatively well preserved, the others badly damaged and mainly internal moulds (BHU1998III 2, 2A, PIW1999VII 5-6).

Distribution. Diverse coral layers (Patcham Formation) of Jumara Dome, Chari Formation of Habo Dome and Ler.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 2	14	10	*8	*28.5	*15	135°	96°
BHU1998III 2A	*15.5	*12	*9	*25	*13	*132°	102°

Description. Specimens low-spined with cyrtococonical outline. Whorls slightly convex, rather flat and separated by a groove-like suture from each other. Periphery rounded-angular, base flattened and broadly phaneroconical. Umbilical margin rounded. Flat or fairly convex selenizone situated at the lower third of the whorls. Peristome not preserved, only a short, somewhat thickened fragment of the "columellar" lip is visible in the parietal region.

Ornament poorly preserved but dense, spiral threads apparently present on the last and the penultimate whorl and also on the outermost band of the base. In a narrow belt just below the suture, collabral riblets cross the spiral threads; to become increasingly weaker and finally disappear halfway between the upper suture and the selenizone. On one of the specimens, the riblets are weaker than the spiral elements and continue up to the periphery.

Remarks. The specimens closely correspond in their morphology to the figures and description of SIEBERER's *Pleurotomaria Palaemon* var. *Wuerttembergensis*. Their cyrtococonical shape and lower base are the characters, on the basis of which they can be distinguished from *O. granulata* (= *O. palemon*).

Genus *Leptomaria* E. EUDES-DESLONGCHAMPS 1864

Type species. *Pleurotomaria amoena* J. A. EUDES-DESLONGCHAMPS 1849.

Leptomaria fraga

(J. A. EUDES-DESLONGCHAMPS 1849)

Pl. 2, Figs. 3-4

- 1849 *Pleurotomaria fraga* n. sp. - J. A. EUDES-DESLONGCHAMPS: 145, pl. 13, fig. 7a-b.
 1856 *Pleurotomaria fraga* DESLONGCHAMPS - D'ORBIGNY: 499, pl. 393, figs. 6-10.
 1997 *Leptomaria fraga* (J. A. EUDES-DESLONGCHAMPS 1849) - FISCHER: 188, pl. 38, fig. 7 a-b (neo-type); 185, pl. 38, fig. 88a-b.

Material. 2 fragmentary specimens (BHU1998III 6-7), the latter poorly preserved.

Distribution. Callovian part of Khadir Formation, "Astarte Hill" south of Gadhada village, southern Khadir Island and Ler.

Measurements.	HL	HP	D	WP	AL
BHU1998III 6	*7.5	*5.5	*11.5	*7	69°
BHU1998III 7	*11.5	*7.5	*14.5	*7.5	50°

Description Rather small, moderately high cyrt-conical shell with slightly convex whorls, exhibiting a shallow convexity on their lower half, between the mid-whorl selenizone and the periphery. Suture slightly impressed; with spiral ridge at the periphery. Base flattened and bearing a feebly concave belt near the periphery. Shell narrowly phaneromphalous, rim of umbilicus sharply angular. Neither early juvenile nor apertural shell portions are preserved.

Spiral threads of equal strength cover the whorls, except the selenizone. Short, regularly repeating, sparse collabral ribs occur between the suture and the

selenizone and much weaker, denser, and regularly repeating riblets constitute the collabral ornament from the selenizone to the outermost edge of the base. Other parts of the base are without ornament apart from fine growth lines.

Remarks. The specimen BHU1998III 6 does not differ significantly from the figures of *Leptomaria fraga* as given by J. A. EUDES-DESLONGCHAMPS (1849). D'ORBIGNY's (1855) and FISCHER's (1997) figures present specimens, the bases of which carry spiral threads that are absent from the Kachchh specimens (just as in the holotype). However, the spiral elements belong to the most variable ones in pleurotomariid ornament, therefore their presence or absence alone cannot be regarded as distinctive character.

The available two specimens differ markedly from each other. The peripheral swollen band is stronger and the shape of the selenizone is slightly convex on the better preserved specimen BHU1998III 6. The latter element is slightly concave and the collabral ornament is somewhat less opisthocline between the selenizone and the periphery on the poorly preserved specimen BHU1998III 7. These differences do not seem to exceed the variability known in pleurotomariid species but better preserved material is needed for a more reliable identification.

Leptomaria pseudoumbilicata n. sp.

Pl. 2, Figs. 5-6

Holotype. Specimen BHU1998III 3.

Derivation of name. (Latin) referring to the presence of a false umbilicus.

EXPLANATION OF PLATE 2

Figs. 1-2. *Obornella wuertembergensis* (SIEBERER 1908). 1. a: apertural view; b: apical view; c: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 2. 2. a: apertural view; b: apical view; c: basal view. Chari Formation, Habo Dome. x 1.5.- BHU1998III 2a.

Figs. 3-4. *Leptomaria fraga* (J. A. EUDES-DESLONGCHAMPS 1849). 3. a: apertural view; b: abapertural view; c: apical view. Callovian part of Khadir Formation, "Astarte Hill", south of Gadhada village, Khadir Island. x 1.5.- BHU1998III 6. 4. Damaged specimen, abapertural view. Dhosa Oolite member, Ler. x 1.5.- BHU1998III 7.

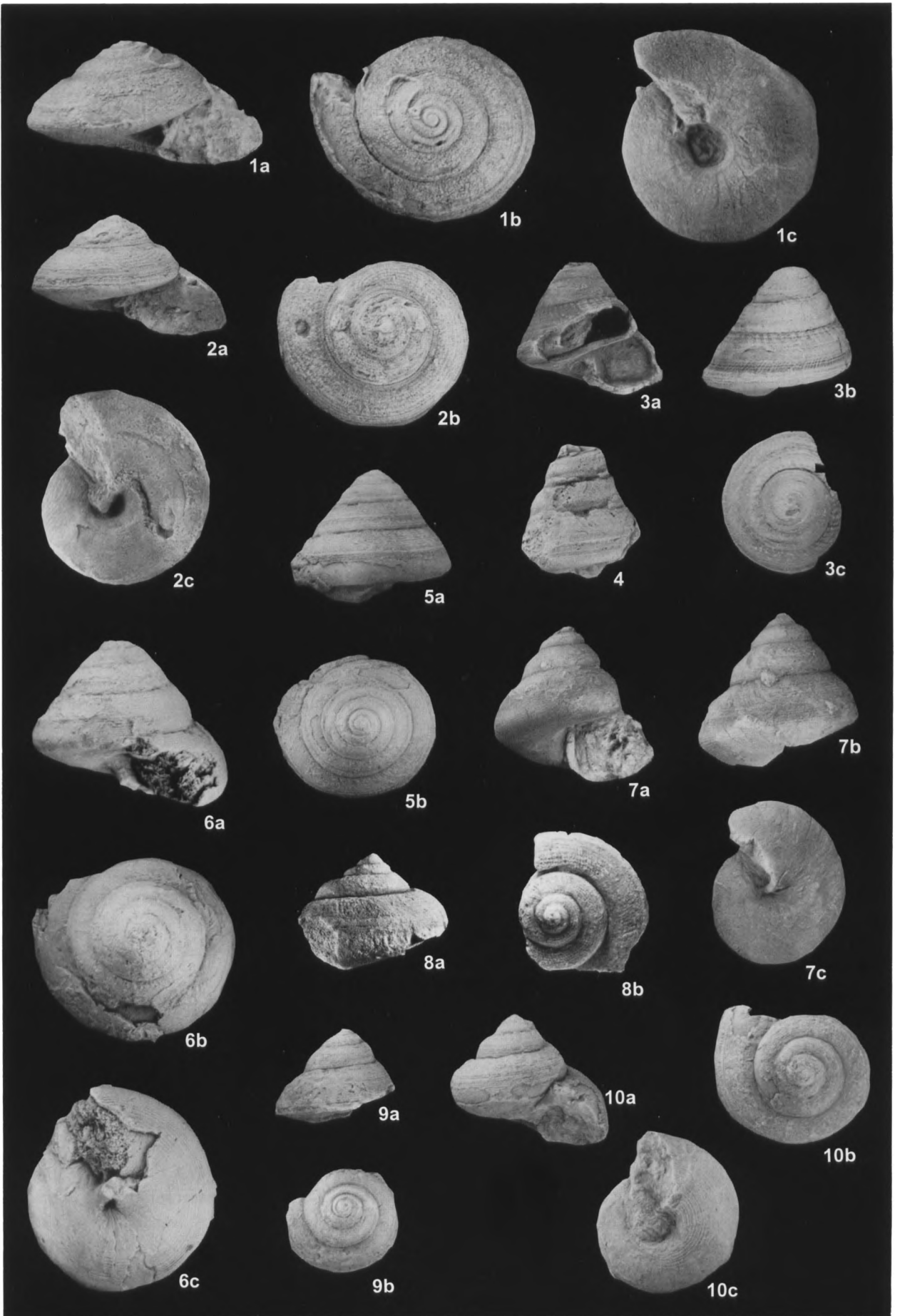
Figs. 5-6. *Leptomaria pseudoumbilicata* n. sp.. 5. a: abapertural view; b: apical view. Callovian part of Khadir Formation, "Astarte Hill", south of Gadhada village, Khadir Island. x 1.- BHU1998III 4. 6. Holotype; a: apertural view; b: apical view; c: basal view. Callovian part of Khadir Formation, "Astarte Hill", south of Gadhada village, Khadir Island. x 1.- BHU1998III 3.

Fig. 7. *Leptomaria simplex* n. sp.; holotype; a: apertural view; b: abapertural view; c: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.- BHU1998III 67.

Fig. 8. *Obornella* aff. *granulata* (J. SOWERBY 1818). a: abapertural view; b: apical view. Dhosa Oolite member, NW Habo Dome. x 1.5.- BHU1998III 5.

Fig. 9. *Leptomaria* sp.; a: abapertural view; b: apical view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 18.

Fig. 10. *Bathrotomaria kachchhensis* n. sp.; a: apertural view; b: apical view; c: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 8.



Type locality. "Astarte Hill", S of Gadhada village, southern Khadir Island.

Type strata. Callovian part of Khadir Formation.

Material. 2 well preserved specimens (BHU1998III 3-4).

Distribution. Callovian part of Khadir Formation, "Astarte Hill" S of Gadhada village, southern Khadir Island.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 3	*29.5	*14.5	*14	37.5	*19.5	-	72°
BHU1998III 4	*29.5	20*	12.5*	-	-	132°	77°

Diagnosis. Apex moderately depressed; last whorl sub-angulate along narrow, convex selenizone; with narrow false umbilicus; reticulate ornament on whorls, spiral threads predominant on last half whorl; base covered with spiral threads.

Description. Specimens medium-sized for the genus, moderately high-spired with depressed, cyrtconical juvenile part. Whorls slightly convex but with a feebly concave belt below the selenizone. Just above the suture, a swollen band is present that is less prominent on the periphery. The suture is groove-like and runs in a shallow canal. On the last whorl, a slightly convex, steep ramp develops and an outer face appears (shape of the last whorl resembles teleoconch whorls of *Bathrotomaria*). Selenizone rather narrow and convex (cord-like), situated just below the mid-whorl. Periphery rounded-angular. Base distinctly flattened and with narrow false umbilicus. A thickened columellar lip is the only preserved part of the peristome on one of the specimens.

The whorls and the outer half of the base bear dense spiral threads of nearly equal strength, crossed by collabral threads. They are conspicuous only on the upper half of the ramp, then gradually weaken and disappear at the periphery. On the base, collabral ornament represented only by growth lines. The spiral ornament dominates the last half whorl.

Remarks. The most similar published form is *Leptomaria agathis* (J. A. EUDES-DESLONGCHAMPS 1849) of FISCHER (1997: pl. 38, figs. 2-5), showing a comparable shape but a more depressed apex than the Kachchh specimens. Apart from that, *L. agathis* is narrowly phanerocephalous and the spiral ornament predominates on the whole shell, while there is only a false umbilicus and a reticulate ornament, except for the last half whorl, in *Leptomaria pseudoumbilicata*.

Pleurotomaria (Leptomaria) tithonia ZITTEL (1873: 455, pl. 49, figs. 7-8) resembles also *L. pseudoumbilicata* but does not even have a false umbilicus and the spiral elements predominate.

Leptomaria simplex n. sp.

Pl. 2, Fig. 7

Holotype. Specimen BHU1998III 67.

Derivation of name. simplex (Latin) = simple.

Type locality. Central area of Jumara Dome.

Type strata. Diverse coral layers of Patcham Formation.

Material. 1 specimen, relatively well-preserved with broken outer lip and earliest whorls (BHU1998III 67).

Distribution. Diverse coral layers of Patcham Formation, Jumara Dome.

Measurements (BHU1998III 67).

H	HL	HP	D	WP	AA	AL
*31	21	13.5	*30	*14.5	-	71°

Diagnosis. Widely conical shell with cyrtconical apex; whorls moderately convex; selenizone feebly convex; last whorl rounded-angular; shell anomphalous; reticulate ornament on whorls consisting of collabral threads and spiral cords, on the base only spiral cords are developed.

Description. Medium-sized, widely conical shell of moderately convex, non-angular whorls, separated by suture in a shallow canal. Juvenile whorls with cyrtconical outline. Position of the wide and feebly convex selenizone at the lower third of the whorls. Periphery rounded-angular; base flattened-convex, anomphalous. Peristome with slightly thickened, vertical columellar lip and traces of thin parietal callosity.

Except for the last half whorl, a special network ornament is visible on the shell, which consists of elements of different strength. Denser, regularly repeating collabral threads cross equally but more widely spaced, weak, spiral cords. Selenizone ornamented with growth-lunulae and weak spiral lines, which may be lacking. On the last half whorl, the collabral threads disappear and some of the spiral cords also fade away in a belt just above the selenizone. Along the upper suture, subregularly repeating, low and short ridges appear on the post-juvenile shell and last to the peristome but become irregular on the last half whorl. (In general, the loss of regularity in the ornament near the peristome of gastropods is regarded as an adult character.) Only spiral cords cover the base.

Remarks. The most similar figured form is *Pleurotomaria gyrocycla* var. *transilis* J.A. EUDES-DESLONGCHAMPS 1849, having the nearest spiral angle to that of the Kachchh shells. *Pleurotomaria saccata* D'ORBIGNY 1856 and *Pleurotomaria transilis* D'ORBIGNY 1856 are also comparable but have a much narrower spiral angle. FISCHER (1997) unified all these species of

earlier authors with *Perotrochus gyroplata* (J. A. EUDES-DESLONGCHAMPS 1849) so that, at present, this name covers a rather variable species of high conical, large, anomphalous shells with slightly cyrtconical apical region. However, all have a (last whorl) spiral angle that is at least 20° smaller at comparable size and their adult shell is much larger than that of the Kachchh specimens. These differences exist also when comparison is made with the British occurrences of the mentioned species.

D'ORBIGNY's (1856) *Pleurotomaria repeliana* [= *Perotrochus repelianus* (D'ORBIGNY 1856) in FISCHER (1997)] from the Upper Liassic of France shows a comparable spiral angle but its whorls are lower. Its adult size is also much bigger than that of the Kachchh specimens.

The shape of J. SOWERBY's (1818) *Trochus fasciatus* (*Leptomaria fasciata*) is also comparable, as is the spiral angle, but the adult shells are rather broadly phaneromphalous, whereas in *Leptomaria simplex*, the shell is anomphalous.

Leptomaria sp.

Pl. 2, Fig. 9

Material. A single specimen with eroded shell (BHU1998III 18).

Distribution. Diverse oral layer of Patcham Formation, central Jumara Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 18	12.5	8.5	6.5	15	-	-	74°

Description. Shell fairly small with slightly convex whorls. Suture running in a moderately deep canal. Flush selenizone just below the mid-whorl. Periphery subangulate, base feebly convex, moderately phaneromphalous.

A network ornament of fine lines is visible on the whorls with tiny granulae at the crossing points. The selenizone is smooth (disregarding the fine growth lines). The ornament of the base is unknown.

Remarks. The most similar species is *Leptomaria pseudoumbilicata* n. sp. which has, however, a lower spire, wider ramp and a conspicuously convex and narrower selenizone. *Leptomaria* sp. is narrowly phaneromphalous, whereas *L. pseudoumbilicata* n. sp. has only a false umbilicus.

Genus *Bathrotomaria* COX 1956

Type species. *Trochus anglicus* J. SOWERBY 1818.

Bathrotomaria kachchhensis n. sp.

Pl. 2, Fig. 10, Pl. 3, Fig. 1

Holotype. Specimen BHU1998III 9.

Derivation of name. After the district Kachchh.

Type locality. Central area of Jumara Dome.

Type strata. Diverse coral layer of Patcham Formation.

Material. 2 well and 1 less well-preserved specimens (BHU1998III 8-9).

Distribution. Diverse coral layer of Patcham Formation, central area of Jumara Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 8	17.5	12.5	10.5	20.5	11	-	75
BHU1998III 9	*23.5	*16.6	*12	21.5	15	89°	68°

Diagnosis. High-spined, gradate shell with strongly convex whorls; suture deeply canaliculate; ramp narrow, convex; outer face almost vertical; selenizone moderately wide, its adapical edge coinciding with angulation of whorls; ornament of reticulate pattern of threads.

Description. Rather high-spined, gradate shell of medium size. Whorls strongly convex, rounded-angulate at the upper third of the distance between two deeply impressed sutures. As a consequence, the ramp is narrow and the outer face is high. Ramp distinctly convex but outer face with a flattened median belt. Selenizone moderately wide and situated at the angulation but slightly shifted towards the upper edge of the outer face. Periphery strongly rounded and turning into the weakly convex base along a rather wide arch. Shell most probably narrowly phaneromphalous with a peri-umbilical angulation on the base.

All whorls covered with reticulate ornament of fine threads; base ornamented also with similar network, except for the last half whorl where the spiral threads dominate over the collabral ones.

Remarks. *Bathrotomaria syssolae* (VON KEYSERLING 1846) as figured by FISCHER (1997: pl. 34, fig. 1a-b) is similar, but its ramp is steeper than in *Bathrotomaria kachchhensis*. The outer face is distinctly convex in *B. syssolae* while flat and vertical in *B. kachchhensis* sp. n. The ornament of *B. syssolae* consists of dominating spiral lines in contrast to the finely reticulate ornament of equally strong spiral and collabral elements of *B. kachchhensis*.

Bathrotomaria siebereri n. sp.

Pl. 3, Figs. 2-3

1858 *Pleurotomaria ornata* cf. *subornata* - QUENSTEDT: 414, pl. 57, figs. 6-7.

1909 *Pleurotomaria subornata* GOLDFUSS - SIEBERER: 48, pl. 3, fig. 2a-b.

Holotype. Specimen BHU1998III 11.

Derivation of name: After KARL SIEBERER who was one of the first to figure a specimen of this species.

Type locality. Central area of Jumara Dome.

Type strata. Diverse coral layer of Patcham Formation.

Material. 6 more or less well preserved specimens (BHU1998III 10-11, PIW1999VII 7-8).

Distribution. Diverse coral layer of Patcham Formation and Shelly Shale member of Chari Formation, Jumara Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 10	23.5	14.5	9.5	23.5	-	84°	63°
BHU1998III 11	19.5	12.5	8	18.5	11.5	80°	65°

Diagnosis. Moderately elevated shell; ramp rather wide, flat; selenizone forming sharp keel; granulate ornament on whorls and base.

Description. Medium-sized, moderately elevated, gradate, sometimes slightly pagodiform shell. Whorls convex with a median angulation that carries the selenizone. Ramp weakly convex but with a narrow concave band running along the selenizone on the last two whorls.

Outer face usually parallel to the coiling axis and feebly concave on adult whorls. In slightly pagodiform cases, outer face sloping to the axis towards the lower suture. Periphery usually coinciding with selenizone. Outer rim of flattened base sharply angulate. Shells narrowly phanerocephalous in earlier growth stages but umbilicus becoming anomphalous usually before adult stage.

The shells have a cancellate ornament of spiral cords and collabral threads. At the crossing points, prominent granulae appear on the post-juvenile whorls and also on the base. The most prominent, granular

line is situated right on the selenizone.

Remarks. QUENSTEDT's (1858) figures display specimens of comparable shape and ornament but the spiral angles are slightly larger than in the Kachchh specimens. SIEBERER's figure shows a specimen of practically the same shape as the Kachchh finds, the only difference being stronger granulae on the specimen from the Middle Jurassic of South Germany. Both authors refer to *Pleurotomaria subornata* MÜNSTER (in GOLDFUSS 1844: 70, pl. 186, fig. 5]. However, the figure of this species shows a depressed form without any granulae. Therefore, it definitely differs from SIEBERER's and QUENSTEDT's figures.

One of the largest (?adult) Kachchh specimens shows cross section of an umbilicus but in a smaller specimen, the umbilicus is closed in an earlier growth stage. In this respect, *Bathrotomaria siebereri* seems to be fairly variable.

Bathrotomaria millepunctata
(J. A. EUDES-DESLONGCHAMPS 1849)

Pl. 3, Fig. 4

- 1849 *Pleurotomaria millepunctata* n. sp. - J. A. EUDES-DESLONGCHAMPS: 83, pl. 13, fig. 2a-c.
1860 *Pleurotomaria Hesione* n. sp. - D'ORBIGNY: 573, pl. 426, figs. 6-8.
1997 *Bathrotomaria millepunctata* (J. A. EUDES-DESLONGCHAMPS 1849) - FISCHER: 204, 205, 209, 210, pl. 34, figs. 2-9.

Material. A single, rather poorly preserved specimen, mainly an internal mould with some remains of shell, and a fragment with preserved juvenile shell (BHU1998III 15).

Distribution. Dhosa Oolite member, Chari Formation, near Medisar, northwestern Jhura Dome.

EXPLANATION OF PLATE 3

Fig. 1. *Bathrotomaria kachchhensis* n. sp., holotype; a: apertural view; b: abapertural view; c: apical view; d: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 9.

Figs. 2-3. *Bathrotomaria siebereri* n. sp.. 2. a: apertural view; b: abapertural view; c: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 10. 3. Holotype; a: abapertural view; b: apical view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 11.

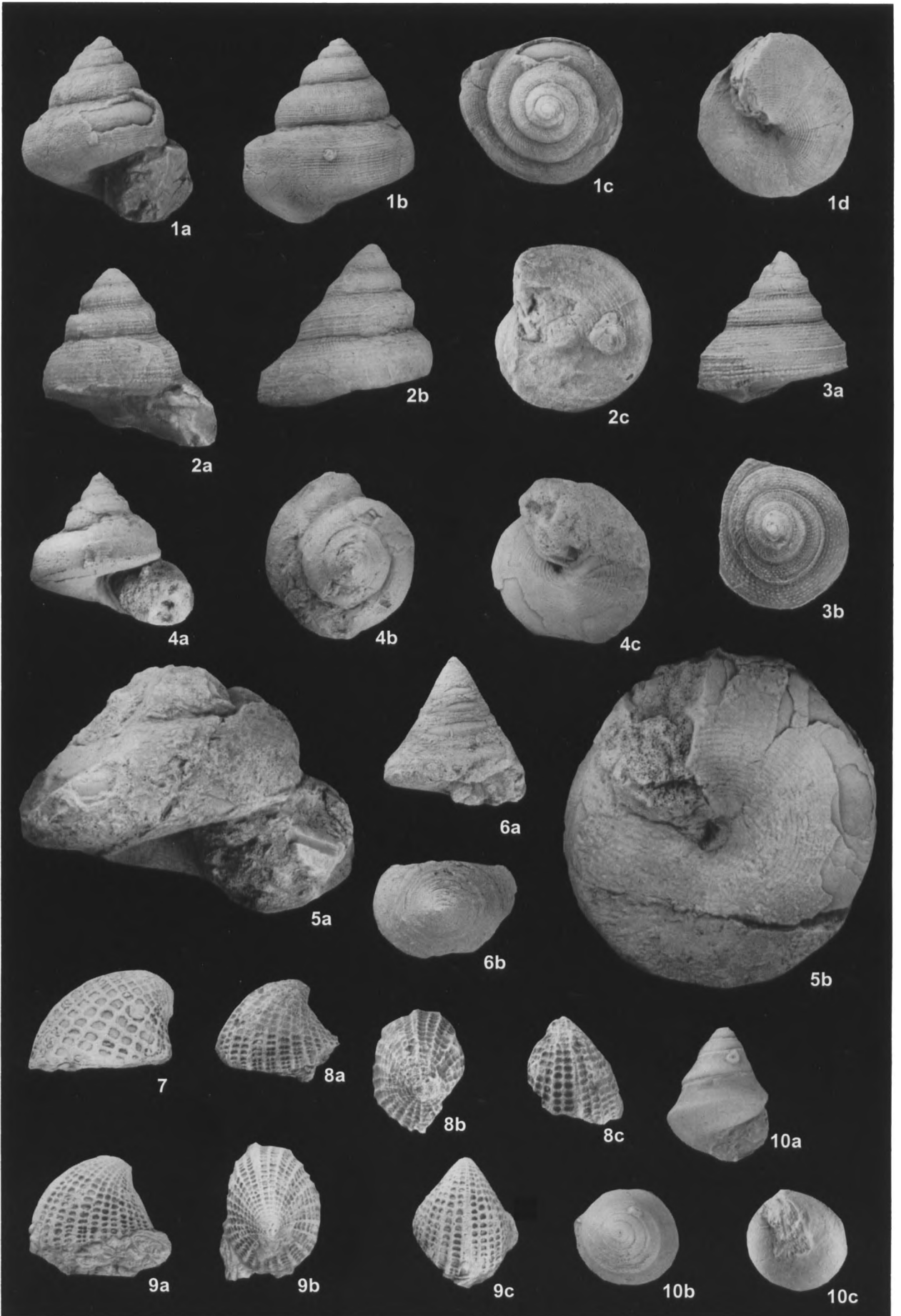
Fig. 4. *Bathrotomaria millepunctata* (J. A. EUDES-DESLONGCHAMPS 1849); a: apertural view; b: apical view; c: basal view. Dhosa Oolite member, Medisar, northwestern Jhura Dome. x 1.- BHU1998III 15.

Fig. 5. *Bathrotomaria* sp., poorly preserved, incomplete specimen; a: apertural view; b: basal view. Chari Formation, Keera Dome. x 1.- BHU1998III 23.

Fig. 6. *Pyrgotrochus* ? sp., incomplete specimen; a: apertural view; b: apical view. Chari Formation, Keera Dome. x 1.5.- BHU1998III 19.

Figs. 7-9. *Emarginula (Tauschia) jumarensis* n. sp.. 7. side view. Diverse coral level, Patcham Formation, Jumara Dome. x 2.5.- BHU1998III 22. 8. a: side view; b: dorsal view; c: side view showing selenizone. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 21. 9. Holotype; a: side view; b: apical view; c: side view showing selenizone. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 20.

Fig. 10. *Proconulus (Proconulus) bhujensis* n. sp.; a: apertural view; b: apical view; c: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 25.



Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 15	*30	*23	*11	*30	*15.5	-	*85°

Description Medium-sized, gradate trochiform shell of convex whorls. Ramp wider than the outer face and weakly convex. Outer face almost vertical, flattened and with a swollen band at the peripheral edge. Angulation between ramp and outer face rounded on earlier whorls but sharp on the last whorl.

A rather narrow selenizone runs on the outer face side of the angulation. Periphery angulate, base slightly convex with narrow umbilicus. Columellar lip moderately thickened; parietal callus present. Outer lip unknown.

Ornament consisting of spiral threads on the whorls and the base; regularly repeated collabral ridges cross them on the ramp. Ridges strongest at the suture and gradually fading away towards the abapical edge of the ramp.

Remarks. FISCHER (1997) regards *Bathrotomaria millepunctata* as an extremely variable species. Under this name, he unified forms that previously had been regarded as independent species, e.g. *Pleurotomaria Euterpe* D'ORBIGNY, *P. millepunctata* J. A. EUDES-DESLONGCHAMPS, *P. Hesione* D'ORBIGNY, *P. Pelea* D'ORBIGNY, and *Pleurotomaria Phoeadra* D'ORBIGNY. The Kachchh specimens are most similar to the specimen figured by FISCHER on pl. 34, fig. 9a-c on which D'ORBIGNY's species *P. Hesione* was based. The two significant differences are that the Kachchh specimens have a sharper periphery and a more flattened base than *P. hesione*.

Bathrotomaria sp.

Pl. 3, Fig. 5

Material. A single, poorly preserved specimen (BHU1998III).

Distribution. Chari Formation of Keera Dome.

Description. A fragmentary specimen of a large (reconstructed diameter: 70 mm), fairly low-spined species. The whorls are rounded-angulate at the mid-whorl selenizone. Ramp feebly convex and gently sloping, outer face vertical. Periphery rounded-angulate, base flattened and narrowly phaneromphalous.

A network of fine lines covers the whorls with tiny granulae at the points of intersection. Only spiral ornament present on the base, consisting of cords near the periphery and ribbons around the umbilicus.

Remarks. The poor state of preservation does not permit a more accurate identification.

Genus ? *Pyrgotrochus* P. FISCHER 1885

Type species. *Pleurotomaria bitorquata* J. A. EUDES-DESLONGCHAMPS 1849.

? *Pyrgotrochus* sp.

Pl. 3, Fig. 6a, b

Material. 1 poorly preserved specimen (BHU1998III 19).

Distribution. Chari Formation of Keera Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 19	18	11	-	18.5	-	68°	65°

Description. Rather high-spined, slightly coelocircular shell with numerous, low, feebly convex whorls. The strongly convex selenizone is situated a short distance below the mid-whorl. Its periphery is subangulate, the base is flattened and anomphalous.

Small remains of the shell suggest a cancellate ornament of fine threads on the whorls and the base.

Remarks. The position of the selenizone is higher than usual in the genus *Pyrgotrochus*, hence the doubtful generic identification. This character suggests that possibly the shell belongs to an extreme-shaped *Conotomaria* COX 1959. However, the coelocircular outline and the high spire indicate *Pyrgotrochus*. The preservation does not permit a specific identification.

Superfamily *Fissurelloidea* FLEMING 1822

Family *Fissurellidae* FLEMING 1822

Genus *Emarginula* LAMARCK 1801

Subgenus *Tauschia* HABER 1932

Type species. *Emarginula orthogonia* TAUSCH 1890.

Emarginula (Tauschia) jumarensis n. sp.

Pl. 3, Figs. 7-9

Holotype. Specimen BHU1998III 20.

Derivation of name. After the type locality., Jumara Dome, Kachchh Mainland.

Type locality. Jumara Dome, Kachchh Mainland.

Type strata. Diverse coral layer of Patcham Formation (Upper Bathonian).

Material. 11 more or less damaged specimens BHU1998III 20-22, PIW1999VII 9).

Distribution. Diverse coral layer of Patcham Formation, central area of Jumara Dome.

Measurements.	H	L	W
BHU1998III 20	11	16	12

Diagnosis. Shell moderately elevated, apex feebly inclined backwards; radial and collabral ribs sparse; selenizone with much stronger ribs than the rest of the shell.

Description. Medium-sized, moderately high, cap-shaped shells. Apex bending backward and posteriorly shifted from the centre, shell behind the apex concave. Aperture elliptical with longer axis parallel to the plane of symmetry.

Ornament consisting of radial ribs of two strength which alternate. Collabral (concentric) ribs cross them, which are similar in strength to the second order radial ones. The strongest radial rib carries the selenizone that lies in the plane of symmetry. Lunulae of the selenizone denser than the collabral ribs. Slit extending back from the peristome to the third or fourth collabral rib.

Remarks. The rib-like selenizone distinguishes this species from *Emarginula* s.s. that has a depressed selenizone.

Most similar is the type species, *Emarginula (Tauschia) orthogonia* TAUSCH 1890, from the Liassic of the Southern Alps, which has, however, more radial ribs (36) than *E. (Tauschia) jumarensis* n. sp. (30). In the Kachchh species, the apex is less strongly inclined backward and the shell below the apex is less concave than in the type species of *Tauschia*.

Another figured form of comparable shape is *Emarginula* cf. *orthogonia* TAUSCH (DUBAR 1948: 138, pl. 11, figs. 14-15) which has, however, an even higher number of radial ribs (44).

Superfamily Trochoidea RAFINESQUE 1815

Family Trochidae RAFINESQUE 1815

Subfamily Proconulinae COX 1960

Genus *Proconulus* COSSMANN 1918

Subgenus *Proconulus* COSSMANN 1918

Type species. *Trochus guillieri* COSSMANN 1885.

Proconulus (Proconulus) bhujensis n. sp.

Pl. 3, Fig. 10, Pl. 4, Figs. 1-4

Holotype. Specimen BHU1998III 24.

Derivation of name. After the city Bhuj, centre of the Kachchh

region.

Type locality. Central area of Jumara Dome.

Type strata. Diverse coral layer of Patcham Formation.

Material. 69 specimens of widely varying preservation quality (BHU1998III 24-28, PIW1999VII 10-30).

Distribution. Chari Formation of Khavda section, Kala Dongar, Habo Dome, Jhura Dome, Jara Dome.; coral layer of Patcham Formation, Jumara Dome; Goradongar Yellow Flagstone Member, Khavda Formation, of Sadhara Dome

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 24	17.5	13	7.5	14	9	-	54°
BHU1998III 25	17	12.5	8.5	14	8.5	-	57°
BHU1998III 26	23.5	13.5	8.5	15.5	6.5	-	54°
BHU1998III 27	*18.5	13	8.5	16	8.5	-	58°
BHU1998III 28	24.5	18.9	14.5	21.5	9.5	-	63°

Diagnosis. Medium-sized, thick-walled, smooth *Proconulus* with few whorls which are slightly convex on juvenile shell, then change through flat into concave on penultimate whorl; peripheral swelling of variable strength from penultimate whorl onwards; outer face of basal lip distinct.

Description. Medium-sized, trochiform-conical, thick-walled shell, with obtuse apex and low number of whorls (~ 6-7), separated by a groove-like suture in a shallow canal. Whorls slightly convex on the juvenile shell, then changing through flat into concave on the penultimate whorl. Together with the concavity, a strongly swollen belt appears just above the suture, forming the periphery on the last whorl. Swelling usually sharp, keel-like on the last whorl and sometimes also on the penultimate whorl. Base is distinctly convex. Rather high peristome strongly prosocline, columella strong, vertical, with a wide outer face. Below the foot of columella, the basal lip part (= outer face of basal lip), characteristic of *Proconulus*, is conspicuously wide and concave. A short, median riblet, running parallel to the rim of aperture, may be present on this surface. A broadly arched rib or angulation separates the outer faces of the inner lip from the base; outer lip sharp.

Shell smooth, except for the strongly prosocline growth lines which are well visible only on the last whorl.

Remarks. The spiral angle and the related measurements are moderately variable. There are also some differences in the strength of the peripheral bulge and the connected concavity of the whorl surface. On the last whorl of the largest specimens (? completely adult or gerontic forms), the peripheral bulge and the concavity of the whorl are less distinct. In the latter specimens, the growth lines are strong and there are irregu-

lar, collabral rib-like elevations on the last half whorl.

The Tithonian *Trochus (Tectus) gemmellaroi* ZITTEL (1873: 442, pl. 48, fig. 20a-d) and *Trochus (Tectus) fraternus* ZITTEL (1873: 443, pl. 48, fig. 21a-c) are comparable species but both have a smaller spiral angle and the concave whorl surface starts at a much earlier growth stage than in *Proconulus bhujensis* n. sp.

Proconulus (Proconulus) haboensis n. sp.

Pl. 4, Figs. 5-8

Holotype. Specimen BHU1998III 29.

Derivation of name. After Habo Dome, Kachchh Mainland.

Type locality. Habo Dome.

Type strata. Chari Formation.

Material. 19 specimens of different states of preservation (BHU 1998III 29-32, PIW1999VII 31).

Distribution. Chari Formation of Habo Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 29	20	13.5	10	16.5	9.5	-	66°
BHU1998III 30	14.5	8.5	7	12.5	7.5	-	60°
BHU1998III 31	17.5	12	9	14	8.5	-	59°
BHU1998III 32	19	14	8.5	15	8	-	62°

Diagnosis. Medium-sized species of few smooth volutions; whorls feebly convex at juvenile and feebly convexo-concave at adult stage; periphery sharply angulate and without bulge.

Description. Medium-sized, conical shell with few whorls and an obtuse apex. Whorls feebly convex, almost flat, except for the last whorl which is sig-

moidal in cross-section (with a slightly concave belt above the periphery). Suture only narrowly incised; periphery sharply angular. Base distinctly convex and anomphalous. Peristome prosocline with a thick and rounded columellar lip, without outer face. Outer face of basal lip of fairly large, feebly concave or flat.

No ornament is visible on the shells apart from growth lines that, near the peristome, are strong and sometimes rib-like.

Remarks. *Proconulus haboensis* n. sp. is similar to *Proconulus bhujensis* but the latter species has a deeper suture and the last two whorls are distinctly concave and have a prominently swollen periphery.

Another comparable species is *Proconulus baldensis* (PARONA 1894: 389, pl. 1, fig. 35) from the Bajocian of the Southern Alps, Central Apennines, and the Bakony Mts. (Hungary). Although similar in shape, it has more convex whorls and an ornament of spiral threads covering the whole shell.

Proconulus (Proconulus) wagadensis n. sp.

Pl. 4, Figs. 9-11

Holotype. Specimen BHU1998III 38.

Derivation of name. After the type locality, Wagad Dome.

Type locality. Washtawa Section, Wagad Dome.

Type strata. Washtawa Formation (Callovian).

Material. 40 strongly worn specimens (BHU1998III 38-40, PIW 1999VII 33-34).

Distribution. Washtawa Formation, Washtawa Section, Wagad Dome; Chari Formation of Habo Dome.

EXPLANATION OF PLATE 4

Figs. 1-4. *Proconulus (Proconulus) bhujensis* n. sp.. 1. a: apertural view; b: apical view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 27. 2. Holotype; a: apertural view; b: apical view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 24. 3. a: abapertural view; b: apertural view; c: basal view. Chari Formation, Khavda section, Gora Dongar, Pachchham Island. x 1.5.- BHU1998III 28. 4. a: apertural view; b: abapertural view. Shelly Shale member, Jumara Dome. x 1.5.- BHU1998III 26.

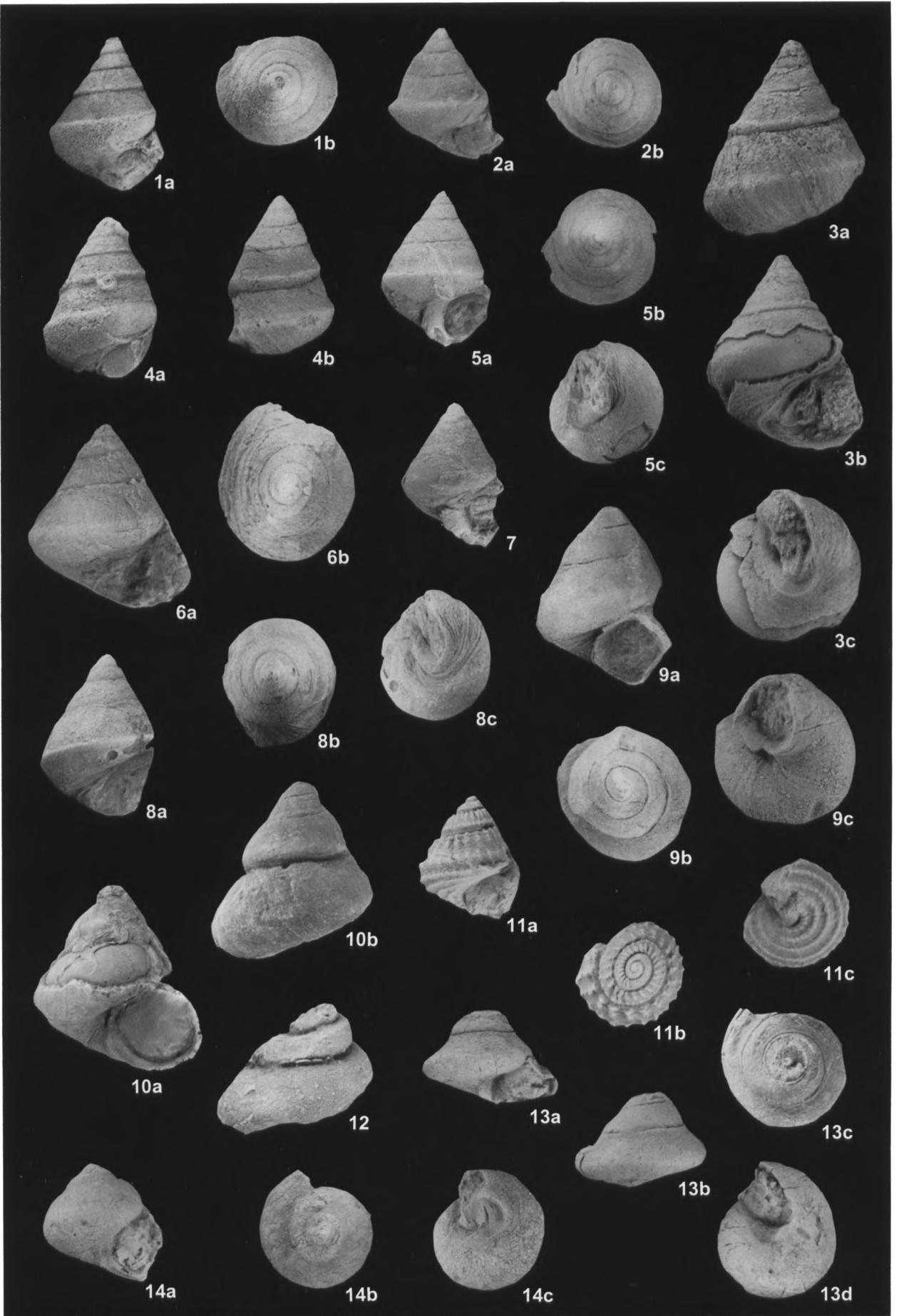
Figs. 5-8. *Proconulus (Proconulus) haboensis* n. sp.. 5. a: apertural view; b: apical view; c: basal view. Chari Formation, Habo Dome. x 1.5.- BHU1998III 32. 6. a: apertural view; b: apical view. Chari Formation, Habo Dome. x 1.5.- BHU1998III 30. 7. Apertural view; Chari Formation, Habo Dome. x 1.5.- BHU1998III 31. 8. Holotype; a: apertural view; b: apical view; c: basal view. Chari Formation, Habo Dome. x 1.5.- BHU1998III 29.

Figs. 9-10. *Proconulus (Proconulus) wagadensis* n. sp.. 9. a: apertural view; b: apical view; c: basal view. Washtawa Formation, Washtawa section, Wagad Dome. x 2.5.- BHU1998III 39. 10. Holotype; a: apertural view; b: apical view; c: basal view. Washtawa Formation, Washtawa section, Wagad Dome. x 2.5.- BHU1998III 40.

Fig. 11. *Proconulus (?Laeviconulus)* sp.; a: apertural view; b: apical view; c: basal view. Washtawa Formation, Washtawa section, Wagad Dome. x 2.5.- BHU1998III 42.

Figs. 12-13. *Calliostoma ?* sp.. 12. Internal mould, abapertural view. x 2.5.- BHU1998III 43. 13. Strongly abraded specimen; a: apertural view; b: abapertural view; apical view; d: basal view. Washtawa Formation, Washtawa section, Wagad Dome. x 2.5.- BHU1998III 44.

Fig. 14. *Ataphrus (Ataphrus) belus* (D'ORBIGNY 1853); a: apertural view; b: apical view; c: basal view. Lower Callovian part of the Khadir Formation, north of Gadhada village, Khadir Island. x 2.5.- BHU1998III 33.



Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 38	*14.5	10	7	13	7	-	50°
BHU1998III 39	*14	10	7	11	6.5	-	*44°
BHU1998III 40	*8.5	5.5	10.5	5.5	-	-	*56°

Diagnosis. Conical-trochiform shell with blunt apex; periphery subangular on juvenile, strongly rounded on penultimate and on last whorl; suture narrowly incised coinciding with periphery of former whorl on juvenile shell then shifting onto base and becoming deeply canaliculate between the last two whorls; with traces of spiral lineation on some juvenile shells.

Description. Medium-sized, conical-trochiform species with strongly depressed apex. Earliest whorls slightly convex, then flat but from the penultimate whorl onwards (strongly) convex again. Periphery rounded-angular, less rounded at earlier growth stages and just overlapped by the suture that, on juvenile whorls, is a shallow groove. Strongly rounded peripheral angulation of the penultimate whorl remaining exposed, because of downward shift of suture and development of a more or less deep canal between the two last whorls. Base moderately convex and anomphalous. Continuous peristome prosocline and shaped like typical *Proconulus*. Inner lip markedly delimited from the base; with narrow and short furrow developing at the central part of the base (sometimes as false umbilicus). Widened frontal surface of inner lip at the foot of columella feebly concave, delimited from the base by a short, sharp carina.

On one of the specimens (BHU1998III 40), the apical whorls show feeble spiral lineation that cannot be observed on the other specimens. Otherwise, only growth lines are visible on the shells, particularly on the last whorl.

Remarks. The periphery of *Proconulus bhujensis* and *P. haboensis* is distinctly angular as opposed to strongly rounded in *P. wagadensis*. The deep suture along the last whorl, which is associated with a convex whorl surface, is characteristic of *P. wagadensis* sp. n. Beside these, the various shell parameters also differ considerably.

? Subgenus *Laeviconulus* CONTI & FISCHER 1984

Type species. *Proconulus (Laeviconulus) acutispira* CONTI & FISCHER 1984.

Proconulus (?Laeviconulus) sp.

Pl. 4, Fig. 12

Material. 1 fragmentary specimen (BHU1998III 42).

Distribution. Washtawa Formation, Washtawa Section, Wagad Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 42	7.5	5	4	10	5.5	-	83°

Description. Fairly small, low cyrtconical specimen with few whorls. Spire subglobular with weakly convex whorls except the last one that is feebly concave. Periphery rounded, base slightly convex and anomphalous. Aperture subquadrate with an almost vertical, short columellar lip; outer lip damaged. Thin parietal callus probably present. At the foot of the columella, a small, flat, oblique, widened surface is present. No ornament visible.

Remarks. Most of the characters correspond to the definition of *Laeviconulus* CONTI & FISCHER 1984, except the distinctly low spire and the lack of the adapertural denticle joined to the enlarged surface in *Laeviconulus*. The enlarged surface at the foot of the columella also present in *Discotectus* but is there much stronger. More, better-preserved material is needed for the accurate description of this species that appears to be a new one.

Family ? *Calliostomatidae* THIELE 1924

Genus ? *Calliostoma* SWAINSON 1840

Type species. *Trochus conulus* LINNÉ 1758.

? *Calliostoma* sp.

Pl. 4, Figs. 13-14

Material. 1 specimen, strongly damaged at the apex, and 1 internal mould (BHU1998III 43-44).

Distribution. Washtawa Formation, Washtawa Section, Wagad Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 44	9	5	4	10	6	-	77°

Description. Medium-sized, rather low-conical specimen with few whorls (~5). Earliest visible whorl with sigmoidal surface later ones slightly convex. Groove-like suture running in a shallow canal. Near peristomal part of the last whorl deviating downward from the spiral of normal coiling. As a result, peristome strongly prosocline and distinctly tangential to base. Peristome itself continuous, simple and lying almost in one plane. Parietal lip forming a narrow callosity, separated from the base by a shallow groove. Aperture slightly ovate.

No ornamentation visible on the shell except for

growth lines that are strongly prosocline on the whorls and opisthoclyt on the base.

Remarks. The simple and incomplete peristome does not provide sufficient information for a more accurate identification. The visible peristome characters distinguish this gastropod from the Jurassic members of the Proconulinae. A similarly simple peristome and comparable shell occur in members of the genus *Calliostoma* but due to the lack of the protoconch, the only diagnostic character, the honeycomb pattern of the initial chamber (HICKMANN & MCLEAN 1990), is not visible. Because no really comparable form has been found, this species is probably a new one, but better material is needed for a satisfactory description.

Family *Ataphridae* COSSMANN 1916

Subfamily *Ataphridae* COSSMANN 1916

Genus *Ataphrus* GABB 1869

Subgenus *Ataphrus* GABB 1869

Type species. *Ataphrus crassus* GABB 1869.

Ataphrus (Ataphrus) belus (D'ORBIGNY 1853)

Pl. 5, Figs. 1-3

- 1853 *Trochus belus* n. sp. - D'ORBIGNY: 283, pl. 305, figs. 9-12.
 1969 *Ataphrus belus* (D'ORBIGNY 1853) - FISCHER: 132, pl. 15, figs. 8-9.
 1997 *Ataphrus belus* (D'ORBIGNY 1853) - FISCHER: 111.

Material. 39 specimens BHU1998III 33-36, PIW1999VII 35).

Distribution. Lower Callovian part of Khadir Formation north of Gadhada village, Khadir Island.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 33	10	8.5	5.5	9.5	5.5	-	81°
BHU1998III 34	15	13.5	6	11	5	-	78°
BHU1998III 35	8.5	7	5.5	9	5	-	78°
BHU1998III 36	9	6.5	5.5	9.5	5.5	-	77

Description. Rather small, low-turbiniform, thick-walled shells with few whorls. Whorls convex, separated by a suture running in a shallow canal. Periphery rounded, base convex and anomphalous. Peristome prosocline and surrounding a circular aperture. Outer face of the columellar lip without tubercle but with flat or feebly concave and moderately wide surface at the foot of columella. Shell smooth.

Remarks. The Kachchh specimens correspond well in all characters to the descriptions and figures of the

specimens mentioned in the synonymy list, especially to those given by FISCHER (1869) from the Bathonian of the Ardennes (France).

Ataphrus (Ataphrus) acis (D'ORBIGNY 1853)

Pl. 5, Fig. 4

- 1853 *Trochus Acis* n. sp. - D'ORBIGNY: 277, pl. 313, figs. 13-16.
 1894 *Ataphrus Acis* D'ORBIGNY 1850 - HUDLESTON: 352, pl. 29., fig. 14.
 1984 *Ataphrus acis* (D'ORBIGNY) - CONTI & FISCHER: 139, pl. 2, fig. 22a-b.
 1997 *Ataphrus acis* (D'ORBIGNY 1853) - FISCHER: 109, pl. 20, fig. 13.

Material. A single specimen with damaged apex and peristome (BHU1998III 45).

Distribution. Chari Formation of Keera Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 45	*8	5	3.5	6	*3.5	-	55°

Description. High-spined, small shell of feebly convex whorls and obtuse apex. Suture weakly impressed; maximum convexity of whorls in the lower half. Periphery rounded, base strongly convex and anomphalous. Aperture circular and peristome in one plane. Upper part of columellar lip preserved, suggesting a rather wide outer face with a slight elevation.

No ornament is visible on the specimen.

Remarks. Although the specimen is damaged, the shape and measurements indicate identity with *A. acis* (D'ORBIGNY 1853).

Ataphrus (Ataphrus) kaladongarensis n. sp.

Pl. 5, Figs. 5-6

Holotype. Specimen BHU1998III 46.

Derivation of name: After one of its localities, Kala Dongar, Pachchham Island.

Type locality. Keera Dome

Type strata. Chari Formation.

Material. 2 specimens with damaged outer lip (BHU1998III 46-47).

Distribution. ?Bajocian Dingy Hill Member, Kaladongar Formation, of Chappar Bet north of Kala Dongar; Chari Formation of Keera Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 46	*5.5	*4.5	*3.5	5.5	-	-	72°
BHU1998III 47	-	-	-	8	4.5	-	70°

Diagnosis. Small *Ataphrus*, columellar lip arched in frontal view and concave adaxially; well-developed tubercle and excavation at foot of columella; furrow

along columellar lip with false or hidden umbilicus; aperture drop-shaped.

Description. Specimens small with rather low, cyrt-conical spire and blunt apex. Whorls convex, their number low (~ 5). Periphery rounded, base convex, with false umbilicus or ?cryptomphalous. Peristome disrupted at parietal region near suture, almost in one plane and slightly prosocline. Aperture drop-shaped, its angulation at the suture. Outer lip simple but inner lip is thickened, with leftward arch in frontal view and concave adaxially. Inner lip with a moderately wide outer face and sharp basal edge. Prominent tubercle present in the middle of the outer face and rather deep excavation just at the foot of columella. Surface covered only with fine growth lines.

Remarks. The aperture is usually circular in *Ataphrus* (as is generally the case in Ataphridae). This species, having an axially elongated drop-shaped aperture, differs in this respect from the rest of the family. The presence of a false or hidden umbilicus is also a unique feature of the genus. The other characters of the shell, however, suggest that it belongs to *Ataphrus* (*Ataphrus*). The mentioned peristome characters distinguish *Ataphrus* (*Ataphrus*) *kaladongarensis* clearly from the

other congeneric species.

Subfamily **Adeorbisininae**
MONARI, CONTI & SZABÓ 1996

Genus *Adeorbisina* GRECO 1899

Type species. *Adeorbisina canavarii* GRECO 1899.

Adeorbisina sp.

Pl. 5, Fig. 7

Material. A single specimen with damaged peristome (BHU1998III 41).

Distribution. Chari Formation of Ler.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 41	12.5	10.5	8	19	9	-	106°

Description. Rather large, thick-walled specimen of sublenticular shape. Whorls slightly convex having a narrow, flat ramp just along the suture. Periphery sub-angulate showing, on the last whorl near the peristome, a moderate abaxial deviation from the normal coiling. Base convex; its central part broken but showing cross-section of an umbilicus. No part of peristome preserved.

EXPLANATION OF PLATE 5

Figs. 1-3. *Ataphrus* (*Ataphrus*) *belus* (D'ORBIGNY 1853). 1. a: apertural view; b: apical view; c: basal view. Lower Callovian part of the Khadir Formation, north of Gadhada village, Khadir Island. x 2.5.- BHU1998III 36. 2. a: apertural view; b: apical view; c: basal view. Lower Callovian part of the Khadir Formation, north of Gadhada village, Khadir Island. x 2.5.- BHU1998III 35. 3. a: apertural view; b: apical view; c: basal view. Lower Callovian part of the Khadir Formation, north of Gadhada village, Khadir Island. x 2.5.- BHU1998III 34.

Fig. 4. *Ataphrus* (*Ataphrus*) *acis* (D'ORBIGNY 1853). a: apertural view; b: apical view; c: basal view. Chari Formation, Keera Dome. x 2.5.- BHU1998III 45.

Figs. 5-6. *Ataphrus* (*Ataphrus*) *kaladongarensis* n. sp.. 5. Holotype; a: apertural view; b: apical view; c: basal view. Chari Formation, Keera Dome. x 2.5.- BHU1998III 46. 6. Abapertural view. Dingy Hill member, Chappar Bet, north of Kala Dongar. x 2.5.- BHU1998III 47.

Fig. 7. *Adeorbisina* sp., strongly abraded specimen; a: apertural view; b: apical view. Chari Formation, Ler. x 1.5.- BHU1998III 41.

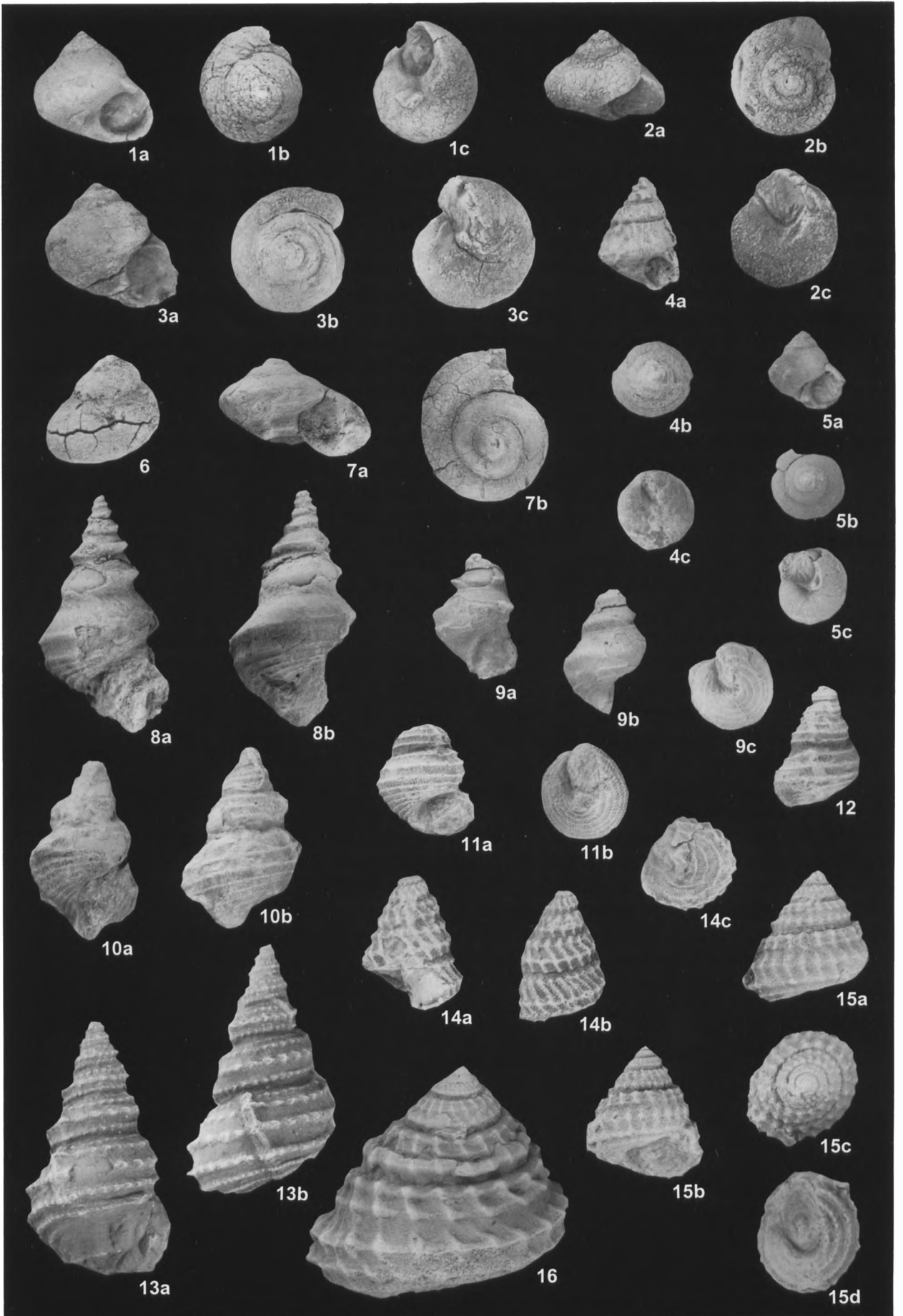
Figs. 8-9. *Eucyclus laevijugatus* (QUENSTEDT 1884). 8. a: apertural view; b: abapertural view. Dhosa Oolite member, Ler. x 1.5.- BHU1998III 49. 9. a: apertural view; b: abapertural view; c: basal view. Dhosa Oolite member, Jumara Dome. x 1.5.- BHU1998III 50.

Figs. 10-12. *Onkospira* ? *praecursor* n. sp.. 10. a: apertural view; b: abapertural view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 52. 11. Damaged specimen, apex missing; a: apertural view; b: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 51. 12. Abapertural view. Diverse coral level, Patcham Formation, Jumara Dome. x 1.5.- BHU1998III 53.

Fig. 13. *Onkospira* ? aff. *praecursor* n. sp.; a: apertural view; b: abapertural view. Shelly Shale member, Jhura Dome. x 2.5.- BHU1998III 66.

Fig. 14. *Riselloidea biarmata* (MÜNSTER 1844); a: apertural view; b: abapertural view; c: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 2.5.- BHU1998III 48.

Figs. 15-16. *Riselloidea pileiformis* n. sp.. 15. a: abapertural view; b: apertural view; c: apical view; d: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 2.5.- BHU1998III 63. 16. Abapertural view. Diverse coral level, Patcham Formation, Jumara Dome. x 4.- BHU1998III 63a.



Remarks. The specimen probably represents a new species but the poor state of preservation does not allow a satisfactory description.

? Superfamily **Eucycloidea** KOKEN 1896

Family **Eucyclidae** KOKEN 1896

Remarks. *Amberleya* MORRIS & LYCETT 1851 and *Eucyclus* J. A. EUDES-DESLONGCHAMPS 1860 are independent genera (GOLIKOV & STAROBOGATOV 1975). Therefore, the valid name for the family containing the following species is Eucyclidae KOKEN 1896. HICKMAN & MCLEAN (1990) found living representatives and incorporated this form group as subfamily Eucyclinae into the family Trochidae. Their decision was based practically on soft body characters. On shell characters, however, the group seems to be separable from the Trochidae. Therefore, we tentatively place it as Eucyclidae within the Eucycloidea. Clearly, this group is in need of a thorough revision.

Genus *Eucyclus* J. A. EUDES-DESLONGCHAMPS 1860

Type species. *Eucyclus obeliscus* J. A. EUDES-DESLONGCHAMPS 1860.

Eucyclus laevijugatus (QUENSTEDT 1884)

Pl. 5, Figs. 8-9

1884 *Turbo laevijugatus* n. sp. - QUENSTEDT: 434, pl. 202, fig. 23.

1909 *Eucyclus laevijugatus* QUENSTEDT - BRÖSAMLEN: 261, pl. 20, fig. 15.

Material. 2 poorly preserved specimens (BHU1998III 49-50).

Distribution. Dhosa Oolite member, Chari Formation, of Ler and Jumara Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 49	-	17.5	-	18	-	-	53°

Description. Rather high-spined, pagodiform shell with convex whorls, bearing a carinate angulation just below the middle, which, on the last whorl, corresponds also to the periphery. Ramp fairly wide, flattened, but with narrow concave belt along the angulation. Surface below the angulation also concave and abapically inclined towards the axis. Base strongly convex, anomphalous.

Carina of the whorls (periphery) crossed by short, dense riblets with tubercles at the top of the carina. On the ramp, only fine, dense growth lines are present. Base bearing some additional spiral carinae (5-6). The strongest one is the one nearest to the peripheral carina

(the suture follows just this line), the others gradually diminish in strength towards the columella. Distance between the carina-pairs also decreasing in the same direction. In addition, the base carries fine growth lines and its carinae fine tubercles.

Remarks. QUENSTEDT's (1884) figure exhibits a somewhat less convex base than the Kachchh specimens, probably because the original specimen lacks shell on this part. The other characters and the measurements well agree with the descriptions and figures of the authors mentioned in the synonymy list.

Amberleya generalis MÜNSTER of HUDLESTON (1894: 287, pl. 23, fig. 3.) has also a comparable shape, size and ornament but the peripheral carina is more strongly ribbed. In addition, the early juvenile whorls carry two nodose spiral cords. These cords are absent from our specimens. MÜNSTER's original figure (1844: pl. 194, fig. 4a-b.) displays a specimen carrying the two spiral cords also on the ramp of the last whorl. This feature clearly distinguishes it from the Kachchh specimens.

Genus ? *Onkospira* ZITTEL 1873

Type species. *Turbo ranellatus* QUENSTEDT 1858.

? *Onkospira praecursor* n. sp.

Pl. 5, Figs. 10-12

Holotype. Specimen BHU1998III 53.

Derivation of name. praecursor (Latin) = forerunner; indicating that the species seems to represent an evolutionary link between *Eucyclus* and *Onkospira*.

Type locality. Central area of Jumara Dome.

Type strata. Diverse coral layer of Patcham Formation.

Material. 6 fragmentary specimens (BHU1998III 51-53, PIW 1999VII 36-37).

Distribution. Diverse coral layer, Patcham Formation, of central Jumara Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 51	-	18	8.5	13	7	-	*45°
BHU1998III 52	*22.5	15	11	15	9.5	-	45°
BHU1998III 53	-	-	-	12	-	-	48°

Diagnosis. High-turbiniform shell with outer lip, bearing outer varix; 0-3 varices/whorl also on post-juvenile whorls; ornament of fine collabral threads, whorls with few and nodose spiral carinae, base with granulated and denser spiral cords.

Description. High-turbiniform species, consisting of strongly convex, high whorls, separated by deep

suture. Base convex and anomphalous. Columellar lip strong and nearly vertical, with siphonal outlet-like modification where it meets the basal lip. Outer lip thickened and forming a moderately strong varix. Varices observable on all specimens, also on earlier parts of shell (0-3/whorl). Their appearance usually irregular but, in a few cases, varices of neighbouring whorls joined as in typical *Onkospira*.

Spiral carinae dominant ornamental elements both on whorls and base, being more widely spaced on the former. Whorls of spire with three exposed carinae. Suture coinciding with fourth carina i.e., the next one below the periphery. Carina forming the periphery strongest. Base with 5-6 additional carinae, the uppermost three bearing nodulae, the others being finely corrugated. Spiral carinae crossed by fine, regularly spaced, collabral threads and delicate growth lines.

Remarks. The number and position of varices strongly vary amongst the specimens. For this reason, the generic position is uncertain. This variability is the only difference to *Onkospira* in which the varices are arranged, on the spire, in one or two slightly twisted rows. This arrangement can be observed in rudimentary form also on a few Kachchh specimens. The Kachchh material seems to represent an evolutionary grade from *Eucyclus* toward typical *Onkospira*.

Shape and character of the ornament are comparable to less strongly ornamented variants of *Eucyclus ornatus* (J. SOWERBY 1819) Such as *Amberleya ornata* of HUDLESTON (1894: pl. 21, fig. 13, in his opinion SOWERBY's original). The most significant differences are the presence of the varices and the slightly smaller spiral angle in the Kachchh specimens.

ZITTEL's (1873) species of *Onkospira* differ from the Kachchh specimens in the formation of the varices and in having a different ornament (higher number of spiral cords, ribs or ridges between the suture and the periphery).

? *Onkospira* aff. *praecursor* n. sp.

Pl. 5, Fig. 13

Material. A single, fairly well preserved specimen with damaged apex and peristome (BHU1998III 66).

Distribution. Shelly Shale member, Chari Formation of Jumara Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 66	*20	*11	*7	*11.5	*6.5	44°	-

Remarks. The specimen differs from ?*Onkospira praecursor* sp. n. in having a deeper, canaliculate suture, an additional (subsutural) cord on the whorls, and much

sparser carinae (not cords!) on the base. All spiral cords and carinae and their nodes are much stronger than in ?*Onkospira praecursor*. These characters are usually regarded as species-diagnostic. However, the few specimens of ?*Onkospira praecursor* are quite variable with respect to these features, except for the additional cord. A reliable decision about the specific position of the specimen has to be postponed until further material becomes available.

Genus *Riselloidea* COSSMANN 1909

Type species. *Risellopsis subdisjuncta* COSSMANN 1908.

Riselloidea biarmata (MÜNSTER 1844)

Pl. 5, Fig. 14

- 1844 *Trochus biarmatus* n. sp. - MÜNSTER in GOLDFUSS: 52, pl. 180, fig. 2.
 1853 *Trochus biarmatus* MÜNSTER - D'ORBIGNY: 271, pl. 312, figs. 1-4.
 1894 *Trochus biarmatus* MÜNSTER - HUDLESTON: 386, pl. 32, fig. 14.
 1909 *Trochus biarmatus* MÜNSTER - BRÖSAMLEN: 214, pl. 18, figs. 4-7.
 1997 *Riselloidea biarmata* (MÜNSTER 1844) - FISCHER: 106, pl. 21, fig. 25a-b.

Material. A single, moderately well preserved specimen (BHU 1998III 48).

Distribution. Coral layer, Patcham Formation of central Jumara Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 48	10	6.5	4.5	7.5	5	-	57°

Description. Small, conical shell with convex whorls, separated by a suture running in a canal. Periphery angulate base is flattened and anomphalous. Peristome prosocline and preserved without outer lip, remaining part slightly widened at foot of columella. Aperture angular where columella and parietal region meet.

Ornament consisting of strong spiral carinae and regularly repeating collabral ribs of the same strength with prominent nodes at crossing points. Number of carinae on the last whorl three, one running some distance below the suture, the others in a peripheral position. Lowermost one just covered by the suture on earlier whorls. The two exposed carinae appear on an early juvenile whorl rather sudden, probably at the end of the protoconch. Base ornamented with three spiral cords running at equal distance from the periphery and from each other.

Remarks. Shape and ornament of the specimen agree well with the figures and descriptions, mentioned in

the synonymy list. The most important difference is that the carinae on the base on the European specimens have nodes, which are absent from the Kachchh specimen. HUDLESTON's figure differs from all others in having, on the whorls, fairly weak as ribs, but carinae with strong nodes.

Riselloidea pileiformis n. sp.

Pl. 5, Figs. 15-16, Pl. 6, Figs. 1-3, Text-fig. 3

Holotype. Specimen BHU1998III 65.

Derivation of name. pileus (Latin) = (high) cap, formis (Lat.) = shaped; referring to the outline.

Type locality. Central area of Jumara Dome.

Type strata. Diverse coral layer of Patcham Formation.

Material. 98 specimens of different preservation quality (BHU 1998III 62-65, PIW1999VII 38-42).

Distribution. Diverse coral layer, Patcham Formation of central Jumara Dome; Shelly Shale member, Chari Formation of Jara Dome.



Text-fig. 3. Protoconch of *Riselloidea pileiformis* n. sp. (BHU1998III 65).

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 62	13.5	9.5	6			99°	55°
BHU1998III 63	10.5	7	4	*9	*5	97°	63
BHU1998III 64	10.5	7.5	4.5			90°	60°
BHU1998III 65	13.5	10	6.5	*12.5	*8.5	93°	59°

Diagnosis. Widely cyrtococonical shell; double sub-sutural cord/carina on teleoconch whorls; wide callus along inner lip.

Description. Fairly large, trochiform, slightly cyrtococonical *Riselloidea* with few whorls (5-6). Whorls convex but composed of concave belts between pairs of strong spiral ornamental elements. Whorls separated by canaliculate suture; increase of whorls rather rapid. Narrow, almost horizontal ramp just below suture on all whorls. Periphery is rounded-angular and bicarinate. Slightly convex base without umbilicus. Peristome discontinuous, subquadrate and prosocline, with simple outer lip and a slightly thickened columellar lip, inclined slightly towards the right from the coiling axis. When viewed from front, columellar lip concave; internally (on the opposite side) with a weak, median, tooth-like swelling. A rather wide, "C"-shaped callus extending from the columellar lip to the first basal cord. This callous surface is feebly concave and carries a riblet at the basal edge. At the parietal region (and within the shell), the cords of the previous base are resorbed.

The initial chamber and the first half whorl are smooth, then suture by suture transversal riblets appear (~20 per whorl). Their strength gradually increases towards the peristome while their number remains constant. These rib(let)s are less prosocline than the growth lines (i.e. the ribs are not collabral). On the second whorl, just above the suture, a carina is visible which doubles on the third whorl. The suture

EXPLANATION OF PLATE 6

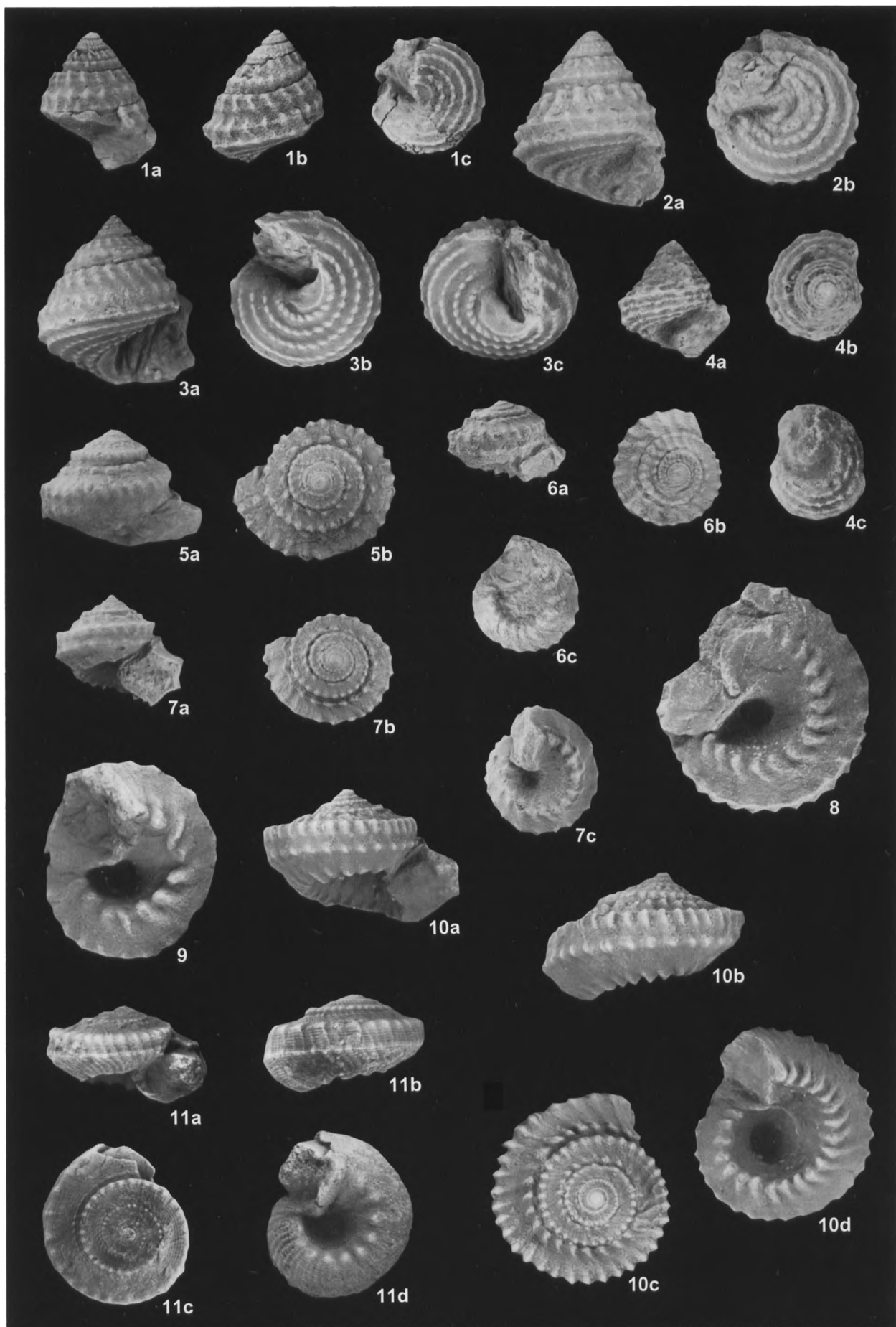
Figs. 1-3. *Riselloidea pileiformis* n. sp. 1. a: apertural view; b: abapertural view; c: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 2.5.- BHU1998III 64. 2. a: apertural view; b: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 2.5.- BHU1998III 62. 3. Holotype; a: apertural view; b: basal view; c: oblique view of the base. Diverse coral level, Patcham Formation, Jumara Dome. x 2.5.- BHU1998III 65.

Fig. 4. *Metriomphalus (Metriacanthus) cf. lyelli* (D'ARCHIAC 1843); a: apertural view; b: apical view; c: basal view. Diverse coral level, Patcham Formation, Jumara Dome. x 2.5.- BHU1998III 61.

Figs. 5-9. *Amphitrochus angulatus* (HUDLESTON 1894). 5. a: apertural view; b: apical view. Shelly Shale member, Chari Formation, Jhura Dome. x 1.5.- BHU1998III 58. 6. a: apertural view; b: apical view; c: basal view. Shelly Shale member, Chari Formation, Jhura Dome. x 1.5.- BHU1998III 56. 7. a: apertural view; b: apical view; c: basal view. Shelly Shale member, Chari Formation, Jhura Dome. x 1.5.- BHU1998III 57. 8. Basal view. Shelly Shale member, Chari Formation, Jhura Dome. x 2.5.- BHU1998III 59. 9. Basal view. Shelly Shale member, Chari Formation, Jhura Dome. x 2.5.- BHU1998III 60.

Fig. 10. *Amphitrochus acutispira* n. sp., holotype; a: apertural view; b: abapertural view; c: apical view; d: basal view. Shelly Shale member, Chari Formation, Jhura Dome. x 2.5.- BHU1998III 55.

11. *Amphitrochus orbis* n. sp., holotype; a: apertural view; b: abapertural view; c: apical view; d: basal view. Upper Callovian part of the Khadir Formation, south of Gadhada village, Khadir Island. x 5.- BHU1998III 54.



coincides with the lower carina that remains exposed on the last whorl only. Half a whorl after the peripheral keels, a double thread develops at the angle of the subsutural ramp and turns into cords on the penultimate whorl. At the crossing points of the spiral and collabral ornamental elements, granulae appear on the earlier whorls that become short, strong spines on later whorls. Four to five strong, nodose carinae are visible on the base of the adult specimens. The growth lines are delicate.

The protoconch (Text-fig. 3) is smooth.

Remarks. On the last whorl, the ribs are frequently interrupted at the widest (mid-whorl) belt between the delimiting carinae. This feature is quite common in the members of the family.

Riselloidea pileiformis differs from *Riselloidea biarmata* (MÜNSTER) in being larger, having wider spiral angle(s), a distinctly cyrtoconical outline, and a double subsutural carina. Of previous publications, only HUDLESTON's (1894: pl. 32, fig. 14) figure of *R. biarmata* exhibits a comparable, slightly cyrtoconical apical portion, but in its other characters it is clearly distinct from *R. pileiformis*.

Family Nododelphinulidae COX 1960

Genus *Metriomphalus* COSSMANN 1916

Subgenus *Metriacanthus* FISCHER 1969

Type species. *Delphinula alta* MORRIS & LYCETT 1851.

Metriomphalus (Metriacanthus) cf. lyelli (D'ARCHIAC 1843)

Pl. 6, Fig. 4

cf. 1969 *Metriomphalus (Metriacanthus) lyelli* (D'ARCHIAC 1843) - FISCHER: 145, pl. 16, figs. 3-5.

Material. 3 moderately well-preserved and 1 incomplete specimen (BHU1998III 61, PIW1999VII 43).

Distribution. Diverse coral layer, Patcham Formation, of central Jumara Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 61	*9	*6.5	*4.5	8	4.5	-	71°

Description. Specimens fairly small, turbiniform. Whorls convex with suture running in a canal. Slight angulation below mid-whorl forming the periphery on the last whorl. Whorls with narrow outer face, its lower part feebly inclined towards the axis. Base slightly convex and probably narrowly phanero-

phalous.

Whorls and base ornamented with nodose cords of two strengths. The stronger ones run along the ramp and at the edges of the outer face. One of the weaker cords situated in the middle of the outer face, the remaining ones (3-4) ornamenting the base. Nodes spirally elongated ("muricate" type) and their strength correlating with the strength of the cords. On the earlier whorls, the nodes are arranged in axial rows, giving the impression of transversal ribs.

Remarks. The Kachchh specimens seem to be identical with those described by FISCHER (1969) but the number of cords is smaller both on the ramp and the base than on the specimens from the Bathonian of the Ardennes. Because of the small specimen number, we are unable to estimate the magnitude of these differences. Further specimens and a comparison with European material are necessary in order to decide whether these differences represent simply intra-specific variability or not. Tentatively, we use the name *Metriomphalus (Metriacanthus) cf. lyelli* (D'ARCHIAC 1843).

Genus *Amphitrochus* COSSMANN 1907

Type species. *Trochus duplicatus* J. SOWERBY 1817.

Amphitrochus angulatus (HUDLESTON 1894)

Pl. 6, Figs. 5-9

1894 *Delphinula angulata* n. sp. - HUDLESTON: 367, pl. 30, figs. 15-16.

Material. 13 specimens of variable preservation quality (BHU1998 III 56-60, PIW1999VII 44-47).

Distribution. Goradongar Yellow Flagstone Member, Khavda Formation, of Sadhara Dome, Pachchham Island; Chari Formation of Jhura Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 56	*11	*10	*7	*14.5	*6.5	-	90°
BHU1998III 57	14	11.5	8	16	8	-	84°
BHU1998III 58	*17	*13	*9	19.5	-	-	79°

Description. Medium-sized subglobose shell with low spire. Protoconch depressed but earliest juvenile whorls coeloconical. All teleoconch whorls angulate and with a wide, concave ramp between the subsutural carina and the angulation carrying the upper peripheral keel. Teleoconch whorls also with a slightly concave outer face. Outer face narrow on the majority of the spire whorls but becoming wider from the middle of the penultimate whorl onwards because the last whorl bends downward from the previous mode of coiling and the suture shifts gradually below the lower carina

of the previous periphery. Suture running in a canal. Base convex and bearing a sharp, median angulation with slightly concave sides. Adaxial slope of base inclined towards the funnel-shaped umbilicus which is bordered by another but strongly rounded angulation. Peristome continuous, prosocline and pentagonal in outline; angulations coinciding with terminations of spiral angulations of the shell. Inner lip strongly extending toward the umbilical cavity.

Almost all angulations on the whorls carinated (just below the suture, at the abaxial edge of the ramp, at the lower edge of the outer face, and in the middle of the base). No carina observed at the rim of the umbilicus i.e., along the umbilical suture. All carinae strongly nodose; the strongest and most widely spaced nodes sitting on the mid-base angulation. Nodes collaterally elongated and occasionally connected by low ridges to a node of the neighbouring angulation(s). More commonly ridges fading away halfway between two carinae. Whorls and base ornamented with weak striae that may be lacking from the shell near the peristome. Growth lines delicate, riblet-like.

Remarks. The main differences between the typical *Amphitrochus angulatus* (HUDLESTON 1894) from England and those from Kachchh concern the last whorl which does not bend so distinctly downward in the former; the nodes that are somewhat weaker and denser in each row; and the apical whorls which, according to the figures, are not acute at all. Because the Kachchh specimens are also considerably variable with respect to these characters, the mentioned differences are not species-diagnostic. The Kachchh specimens vary most strongly in the broadness of the umbilicus.

Amphitrochus acutispira n. sp.

Pl. 6, Fig. 10

Holotype. Specimen BHU1998III 55.

Derivation of name. acutus (Latin) = sharp, spira (Latin) = spire; referring to the coeloconical outline of the spire.

Type locality. Jhura Dome.

Type strata. Shelly Shale member, Chari Formation.

Material. 2 specimens BHU1998III 55, PIW1999VII 48).

Distribution. Shelly Shale member, Chari Formation, of Jhura Dome.

Measurements.	H	HL	HP	D	WP	AA	AL
BHU1998III 55	*10.5	*9.5	*7	*15.5	*6.5	-	128°

Diagnosis. Coeloconical, broadly phaneromphalous shell; umbilicus conical; carina situated below um-

bilical suture; carinae densely nodose, except at umbilical suture.

Description. Medium-sized, low trochospiral, almost discoidal shell with coeloconical spire but blunt apex because of strongly depressed protoconch. Suture narrowly canaliculate, running close to the upper peripheral carina of the previous whorls, except on the penultimate whorl. There it gradually shifts downward, because the last whorl bends down near the final peristome. All belts between neighbouring pairs of five, carinated angulations of the whorls concave. Solely abaxial belt of the base turning feebly convex near the last peristome. Umbilicus wide, its general shape conical but actually a spiral of a concave surface. Peristome continuous and pentagonal in outline, just like the aperture.

Protoconch, consisting of about two almost planispiral whorls, smooth. On the first half of the third whorl, the abaxial angulation of the ramp, and on the second half, its tubercled carina develop. Subsutural carina with tubercles starting half a whorl later. Strength of the tubercles gradually increasing, last whorl with four rows of nodes. Strongest line running in the middle of the base, a somewhat weaker forms the upper peripheral row; the subsutural and the lower peripheral carinae carrying the weakest nodes. No nodes observable on the keel below the umbilical suture. Nodes, except the lower peripheral ones, collaterally elongated; the ones on the mid-base distinctly rib-like.

Whorls and base covered with network of thin spiral threads and riblet-like growth lines.

Remarks. The coeloconical spire and the broad, conical umbilicus distinguish *Amphitrochus acutispira* n. sp. from *A. angulatus* (HUDLESTON 1894), the latter exhibiting a cyrtococonical spire, and a much narrower and funnel-shaped umbilicus with rounded rim. In addition, the adult peristome of *A. angulatus* widely extends into the space of the umbilicus whereas the inner lip of *A. acutispira* does it only slightly.

Amphitrochus orbis n. sp.

Pl. 6, Fig. 11

Holotype. Specimen BHU1998III 54.

Derivation of name. orbis (Latin) = disk.

Type locality. North of Gadhada village, Khadir Island.

Type strata. Lower Callovian part of Khadir Formation.

Material. 2 specimens (BHU1998III 54, PIW1999VII 49).

Distribution. Lower Callovian part of Khadir Formation, north of

Gadhada village, Khadir Island.

Measurements. H HL HP D WP AA AL
 BHU1998III 54 *4 *3.5 *3 *6 3.5 155° 127°

Diagnosis. Small, low-spired, sublenticular species; mid-basal angulation robust, in its nodes of 3-4 riblets converge that start from the periphery.

Description. Shells fairly small, low-spired, sublenticular. First whorl planispiral and flat, the others (and the ramp of the last whorl) concave. Suture narrowly incised, running close to the abaxial angulation of the ramp of the previous whorl (= upper peripheral angulation). Outer face narrow and feebly concave. Outer belt of the base distinctly convex but peri-umbilical belt feebly concave except its innermost part where a rounded angulation connects the concave belt to the umbilical suture. Umbilicus moderately broad. Outer face covered on the spire whorls, except the penultimate one, where it is partly exposed near the peristome, because the last whorl bends downward. Peristome simple, pentagonal; its columellar (umbilical) lip with a narrow outer face.

Protoconch apparently not ornamented, sub- and suprasutural carina appearing one whorl after the initial chamber together with the concavity of the whorls. Shortly after the onset, the suprasutural carina showing undulations that change into distinct, regularly repeating nodulae on the subsequent whorl where the subsutural carina also turns nodose. Subsutural

carina remaining weak (merely a cord) for the next whorls. Lower peripheral carina intermediate in strength between the previous ones. Compared to the others, the fourth, basal carina and its nodes being the strongest, most robust. Short riblets belonging to each subsutural nodule, fading away around midway towards the next carina. Riblets running also from the nodes and internode areas of the peripheral edge of the ramp to the peri-umbilical carina. Each riblet carrying a tubercle where crossing the lower peripheral keel. These riblets cross the base and join one of the nodes on the peri-umbilical carina. Towards each of the latter nodes, three to four riblets converge. Growth lines distinct, riblet-like. Spiral ornament on the whole outer shell surface and on the umbilical side of the base formed by threads.

Remarks. The downward displacement of the near-apertural part of the last whorl suggests that the specimens are adult forms in spite of their small size. The nearest figured form is "*Delphinula* or *Turbo*, species or variety" (HUDLESTON 1894: 366, pl. 30, fig. 13). However, this specimen is twice as large and although its mid-basal angulation is rather strong, the characteristic bundles of riblets of *Amphitrochus orbis* are absent. The juvenile shells of the other Kachchh species are much higher-spired and their subsutural nodules are much sparser and stronger than those of *A. orbis*.

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