Contributions to the Jurassic of Kachchh, Western India. I. The coral fauna

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Abstract. The coral fauna from Bathonian-Oxfordian strata of Kachchh, Western India, originally described by GREGORY (1900), is revised. Based on large own collections, 52 taxa of corals are described including *Cryptocoenia wegeneri* sp. nov.. By far the most prolific coral locality lies within the upper part of the Patcham Formation (Late Bathonian/Early Callovian) at the center of Jumara Dome and yielded 41 taxa. The distribution of the various taxa within the Kachchh Basin is given, as is information on the major coral concentrations.

■ Jurassic, scleractinians, taxonomy, Kachchh, India

Zusammenfassung. Die ursprünglich von GREGORY (1900) beschriebene Korallenfauna der Bathon-Oxford-Schichtenfolge von Kachchh, westliches Indien, wird, basierend auf umfangreichen eigenen Aufsammlungen, revidiert. 52 Korallentaxa werden beschrieben, darunter *Cryptocoenia wegeneri* sp. nov.. Die bei weitem arten- und individuenreichste Korallenlokalität liegt im Zentrum des Jumara Dome und findet sich im oberen Teil der Patcham Formation, die den Grenzbereich Bathon-Callov umfaßt. Die Verbreitung der einzelnen Korallentaxa im Becken von Kachchh wird angegeben, und die wichtigsten Korallenvorkommen werden kurz vorgestellt.

■ Jura, Scleractinier, Taxonomie, Kachchh, Indien.

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Introduction

Kachchh, a district of the Indian state of Gujarat, has been famous for its rich Jurassic faunas for more than 150 years. Extensive collections of these faunas by GRANT, WYNNE, FEDDEN, BLAKE, STOLICZKA, RAJNATH and others in the last century and the early part of this century formed the basis of a series of monographs published in the Memoirs of the Geological Survey of India in which the most important faunal groups were described. These included the ammonites (WAAGEN 1871, 1873-1875; SPATH 1924, 1927-1933), brachiopods (KITCHIN 1900), echinoderms (GREGORY 1893), bivalves (KITCHIN 1903, COX 1940, 1952), and corals (GREGORY 1900). However, earlier descriptions of fossils from Kachchh reach back even to the first half of the last century (e.g. SOWERBY 1840a, b).

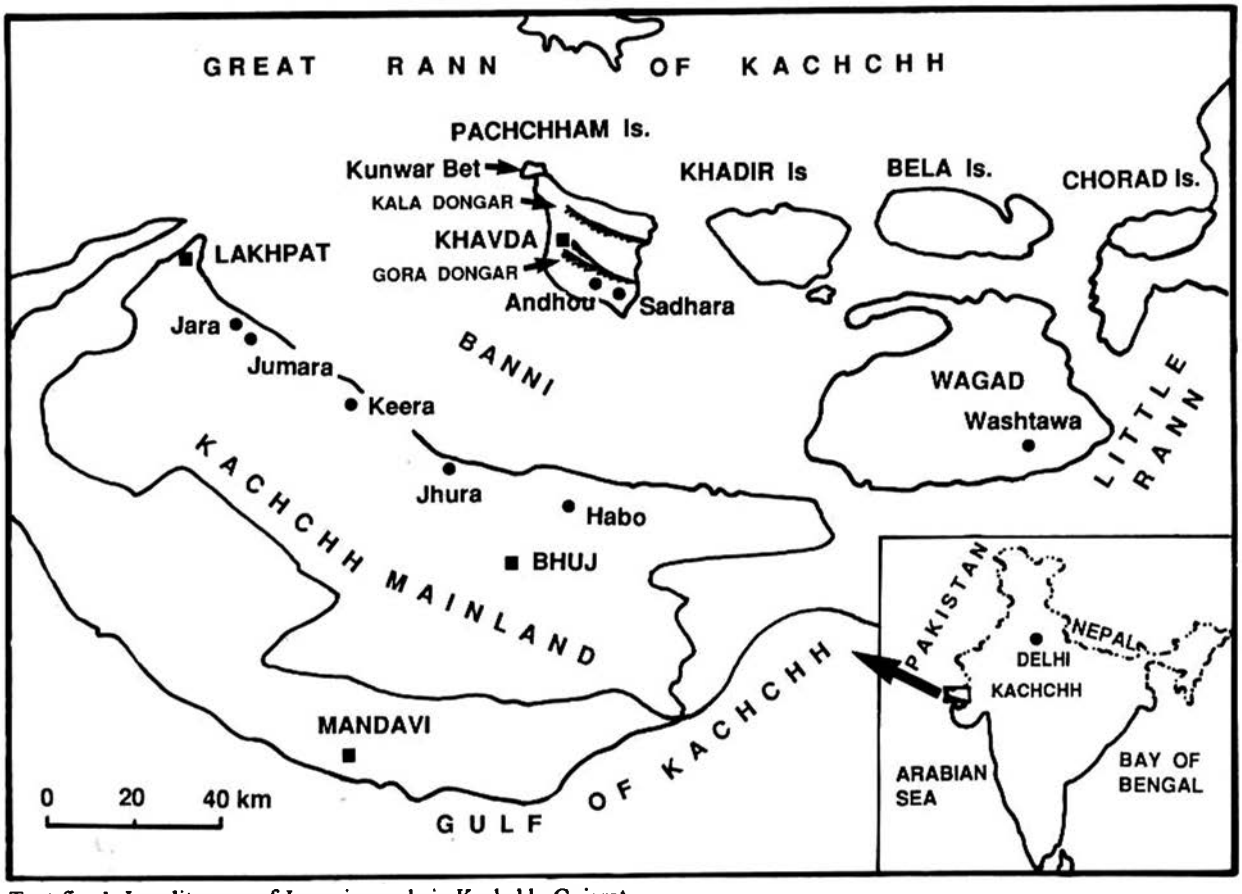
When, in the 1890s, GREGORY started to work on the corals from Kachchh, the collection at his disposal numbered nearly 8000 specimens. He classified this vast material into 71 species, 65 of them new. GREGORY was fully aware of the high variability of the taxa, according to him (GREGORY 1900: 1) this being the main reason why the completion of his monograph took several years. Although GREGORY did a splendid job, there is no question that in the 90 years, which elapsed since the publication of the monograph, views and concepts about coral taxonomy changed considerably, in particular due to new insights into the biology and variability of living corals. When we therefore started a palaeoecological analysis of the most prolific coral site in Kachchh, two levels in the Patcham Formation of Jumara Dome, we felt that meaningful results of our analysis required a revision of the corals in the first place. This is the rationale of the present paper.

Our work was facilitated by the work of BEAUVAIS who in 1978 published a revision of some of the corals of the GREGORY collection in the Natural History Museum London.

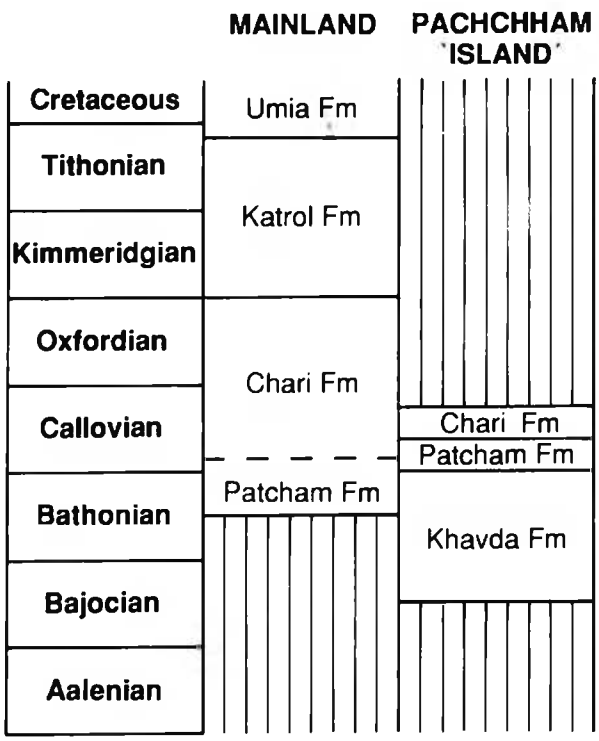
Geological and stratigraphic framework

In Kachchh, Jurassic sediments crop out in a series of domes arranged in two more or less east-west running belts, the so-called Kachchh Mainland and the 'Islands' (Text-fig. 1) situated in the Great Rann of Kachchh.

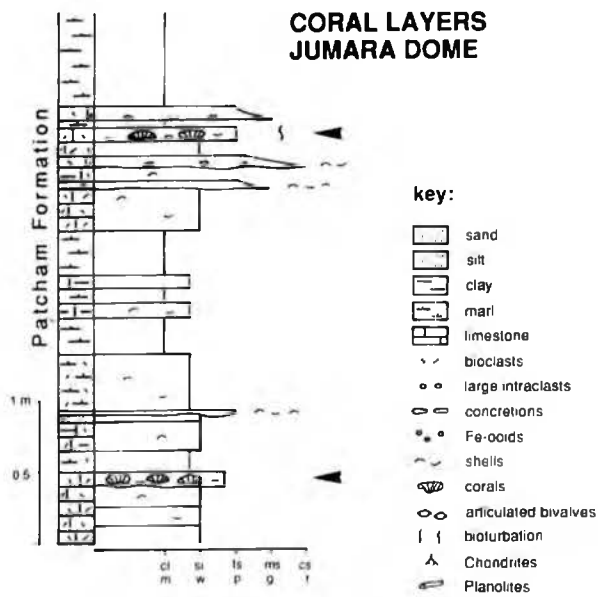
During the Jurassic, Kachchh formed a peri-cratonic rift basin situated at the western margin of the Indian plate (e.g. BISWAS 1987). Inundated by the sea in Bajocian times, shallow marine conditions persisted until the early Cretaceous. In the Jurassic, sediments ranged from nearshore coarse-grained siliciclastics to offshore clays and silts. Carbonate sedi-



Text-fig. 1. Locality map of Jurassic corals in Kachchh, Gujarat.



Text-fig. 2. Stratigraphic framework of Jurassic rocks of Kachchh Mainland and Pachchham 'Island'.



Text-fig. 3. Section through part of the Patcham Formation at Jumara Dome, Kachchh Mainland. Two layers yielding an abundant and highly diverse coral fauna are arrowed. cl: clay; si: silt; fs: fine sand; ms: medium sand; cs: coarse sand; m: mudstone; w: wackestone; p: packstone; g: grainstone; r: rudstone.

ments are rare and confined to the Bathonian Khavda Formation and the Bathonian/Lower Callovian Patcham Formation.

Despite the rich ammonite faunas no detailed biostratigraphic framework exists for the Jurassic of Kachchh. Of the various lithostratigraphic schemes we adopt the traditional one outlined in Text-fig. 2.

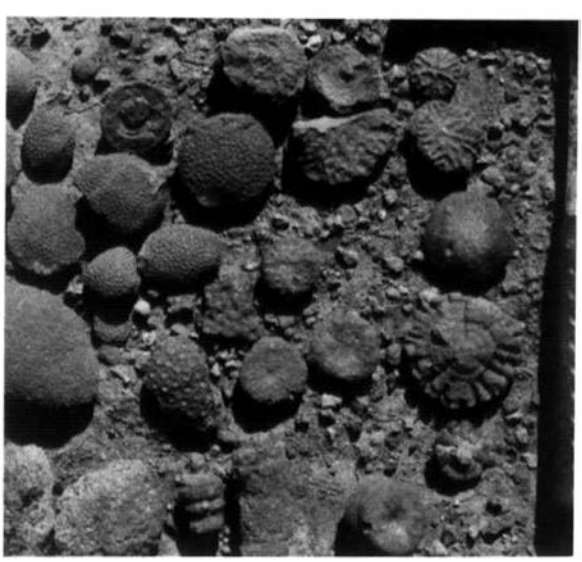
Distribution of corals in the Jurassic of Kachchh

Due to the predominance of siliciclastic facies in the Kachchh Basin, suitable environmental conditions (clear water, hard substrates) for extensive coral growth rarely existed. Because of this, corals usually do not constitute elements of any significance among the benthic communities inhabiting the basin, except for three notable exceptions. The first exception refers to two closely adjacent levels within the upper part of the Upper Bathonian/Lower Callovian Patcham Formation at Jumara Dome (Text-fig. 3). There, a diverse and abundant fauna of corals occurs associated with brachiopods, bivalves, and gastropods in bioclastic wackestones (Text-fig. 4). The bulk of GREGORY's and our material comes from these two levels. Although quite diverse, only few morphotypes occur in this coral fauna, with hemispherical to flat growth forms dominating. Already GREGORY (1900) noticed the virtual absence of branched corals. Apparently, the corals formed meadows on soft, but stable substrates. The ecology of these coral layers will be discussed elsewhere (FÜRSICH et al., in prep.).

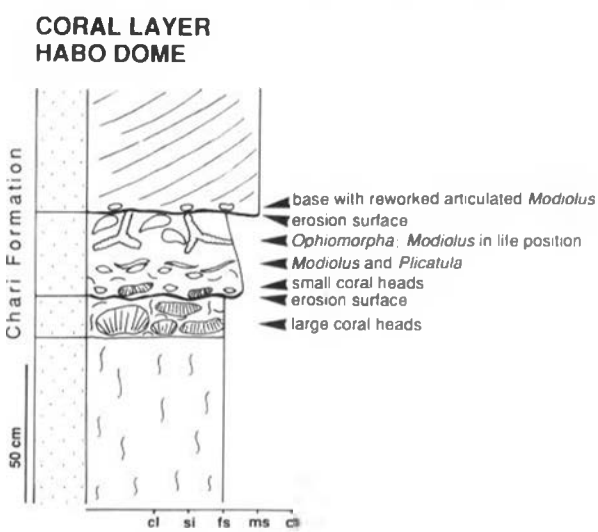
A second horizon in which corals constitute the dominant part of the benthic biota occurs within the Callovian Chari Formation of Habo Dome. There, near the top of a thick sandstone unit exposed for a considerable distance along the crest of the dome, large heads of *Amphiastraea piriformis* form a monospecific coral layer associated with several byssate and cemented bivalves (Text-fig. 5). In contrast to KANJILAL (1990) who interpreted this coral occurrence as "almost a coral bioherm", we could not detect signs of reef growth. Many of the *Amphiastraea* heads apparently grew in different directions at different times, indicating that reworking of the heads and re-established growth were characteristic features of an environment with periodically shifting substrates and relatively turbid water (FÜRSICH et al., in prep.).

A third horizon at which corals are common lies within parts of the Callovian Chari Formation at Keera Dome (Text-fig. 6). Low diversity coral assemblages form parts of reworked shell beds. The corals are often worn, bored and most likely have undergone some transport.

A list of corals, together with their distribution and some information on their stratigraphic position is given in Table 1 (see Appendix). Not all species described by GREGORY are present in our material (Table 2). This is partly due to the fact that not all coral localities which are mentioned in GREGORY (1900) could be visited. Moreover, some of the prolific



Text-fig. 4. Coral assemblage from the lower coral level at Jumara Dome.



Text-fig. 5. Section through the top of the middle sandstone unit of the Chari Formation on top of Habo Dome. For key see Text-Fig. 3.

coral levels apparently have been extensively collected in the last century (hence GREGORY's vast collection), so that rare species no longer could be obtained.

Material and methods

More than 1200 specimens, collected between the years 1988 and 1992, were available for study. The specimens are generally well preserved, although the original aragonitic skeletal material has been replaced, during diagenesis, by calcite. Part of this material has been deposited in the collections of the Department of Geology, Rajasthan University, Jaipur (RUC1992I ...), a reference collection in the collections of the Palaeontological Institute, Würzburg University (PIW1993VIII ...). In addition, the specimens of the GREGORY Collection housed in the Natural History Museum, London, were consulted (BMNH R...). Some of these specimens have received two registration numbers. In these cases, the new number (with 5 digits as opposed to 4 digits of the old numbering system) has been given in this paper.

The synonymy lists of the various species are by no means exhaustive; usually only first references and those pertinent to the Indian material are given. For classification of higher taxa, the scheme of LÖSER (1992) is followed, except when stated otherwise.

Details of the microstructure of the skeletal elements of Middle Jurassic corals are, except for few families and genera (GILL & LAFUSTE 1971, GILL 1975, 1982a, GILL & RUSSO 1980, RONIEWICZ 1982, GILL & LOREAU 1988), not available. This fact hampers the assignment of taxa to higher taxonomic units.

There is no general agreement on the significance of individual morphological features of Jurassic corals for defining species, and the variability of many features is still insufficiently known. Consequently, the ideal approach is to discuss and revise species by species based on large material, thereby being able to take into account intraspecific variation (e.g. LATHUILIÈRE 1988, 1990). In the case of the corals from Kachchh this would have meant a far more extensive treatment of the various taxa, something beyond the scope of this paper. We have steered, therefore, a more traditional course in the following taxonomic descriptions.

Taxonomy

Class **Anthozoa** EHRENBERG 1834

Subclass **Zoantharia** BLAINVILLE 1830

Order **Scleractinia** BOURNE 1900

Suborder **Archeocaeniida** ALLOITEAU 1952

Family **Actinastraeidae** ALLOITEAU 1952

Genus *Actinastrea* D'ORBIGNY 1849

Type species. *Astrocoenia goldfussi* D'ORBIGNY 1849 (= *Astrea geminata* GOLDFUSS 1826 (pars)).

Actinastrea bernensis (KOBY 1886)

Plate 1, Fig. 8

1886 *Astrocoenia bernensis* sp. nov. - KOBY: 291, pl. 86, figs. 9-10.

1900 *Astrocoenia bernensis* KOBY var. *indica* var. nov. - GREGORY: 62, pl. 15, figs. 6-7.

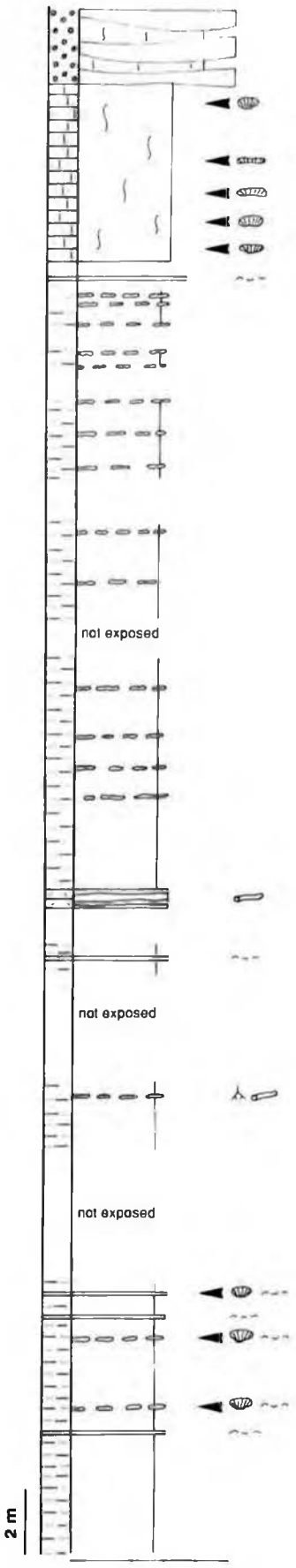
Material. 7 specimens (RUC1992I 9); 2 specimens (BMNH R5278) from the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome; Chari Formation of Keera Dome.

Description. Corallum nodular, cerioid to sub-cerioid; corallites small (1-2mm in diameter), wall septothecal and/or parathecal, prominent. Occasionally, the walls between two adjacent corallites are separated by thin coenosteum. Corallites commonly hexagonal, pentagonal, quadrangular, or subcircular, and rarely circular. Septa 16-25, occasionally subconfluent. Septal surfaces with small granules or spines, upper margins of septa dentate. Endothecal dissepiments common along the periphery of the corallites. Columella well developed, usually thickened by primary septa.

Remarks. The specimens agree well with *Astrocoenia bernensis* KOBY var. *indica* (GREGORY 1900: 62, pl.

corals in the Chari Fm of Keera Dome



15, figs. 6-7). The features mentioned by GREGORY (1900: 62) as characteristic of his new variety *indica*, that is the columella being larger and more conspicuous; the septa being longer and more crowded, and the corallum being more nodular rather than lamellar, are in fact quite variable. It is therefore not meaningful to retain GREGORY's variety.

According to WELLS (1956: F370) the genus *Astrocoenia* MILNE EDWARDS & HAIME lacks a styliform columella. The other genus in the family with similar morphological characters but with a well developed columella is *Actinastrea* D'ORBIGNY. *Astrocoenia bernensis* KOBY has therefore been transferred to *Actinastrea* D'ORBIGNY (see LATHUILIÈRE 1989).

In one of the specimens the corallite wall is thinner and septa are thicker than those illustrated by GREGORY, and outside the wall the septa appear as costae. Differences in the thickness of the corallite wall and septa in the specimens discussed here are very small and can be shown to correspond to intracolonial variation. These features therefore do not justify separation at the species level (BEST et al. 1984: 70).

Suborder **Stylinida** ALLOITEAU 1952

Family **Stylinidae** D'ORBIGNY 1851

Genus *Stylina* LAMARCK 1816

Type species. *Stylina echinulata* LAMARCK 1816.

Stylina kachensis GREGORY 1900

Plate 1, Figs. 1, 5-7, Text-fig. 7

1900 *Stylina kachensis* sp. nov. - GREGORY: 56, pl. 12, figs. 1-17, pl. 13, figs. 1-7.
1966 *Stylina kachensis* GREGORY - FLÜGEL: 56, pl. 15, figs. 3, 5.
1978 *Adelocoenia variseptata* sp. nov. - BEAUVAIS: 2, pl. 1, fig. 1.

Material. 114 specimens (RUC19921 1-2, 4, 6, 145); specimen RUC19921 145 is associated with *Collignonastraea jumarense* (GREGORY 1900). 1 specimen (BMNH R5276) from the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome and Jara Dome.

Text-fig. 6. Section through part of the Chari Formation at Keera. Levels at which corals are common are arrowed. For key see Text-fig. 3.

Description. Corallum plocoid, hemispherical, or with flat upper surface; lower surface with small to large attachment area. Corallites 1.5 - 2.9 mm in diameter, slightly projecting beyond the corallum. Corallite wall septothecal or parathecal, occasionally separated by coenosteum (distance between corallite walls varying from 0.5 to 2.5 mm). Calices shallow to moderately deep and circular in plan view. Septa well developed (numbering mostly 16, but sometimes 13, 14, 17, 18 or 20) with octameral symmetry; primaries may or may not meet the columella; secondaries are short and do not reach the columella. Septal auricula common. Distal margin of septa denticulated. Lateral surface of septa either smooth or spinulate. Vascular and tabular endothecal dissepiments common; tabular dissepiments mostly horizontal, sometimes little inclined (Text-fig. 7). Costae well developed (length varying from 1.0 to 2.3 mm), almost intertonguing or confluent with those of the adjoining corallites. Columella styliform, mostly prominent.

Text-fig. 7. *Stylina kachensis* GREGORY, longitudinal section showing granulated septa and dissepiments. RUC19921 6. Scale bar: 1 mm.

Remarks. GREGORY (1900: 53) discussed at length the variations in morphological characters of *kachensis* such as the timing of development of endotheca (which is poorly developed and according to him does not change significantly at different ontogenic stages), the columella (which according to him varies from very prominent styliform to parietal or totally absent), the width of the exothecal layers (ranging from well developed to constituting only a very narrow band), and the costae (which may be prominent and coarse to almost absent leaving the area between the corallites smooth or granulate). In view of this gradational variation in the characters mentioned above the specimens have been assigned to *Stylina kachensis* GREGORY without reservation.

The nature of septa and columella and their mutual relationships in *S. kachensis* are in agreement with those observed by GILL (1975) in the genus *Stylina*.

FLÜGEL (1966) did not include the specimen of *S. kachensis* figured by GREGORY (1900) on pl. 12, fig. 6a, b, thereby following GEYER (1954: 131) who considered it synonymous with *Stylina delabechii* MILNE EDWARDS & HAIME (1851: 79, pl. 15, fig. 1). The latter is no doubt a comparable form, but shows projecting calices, more septa and more prominent and confluent costae. GREGORY (1900: 59) mentioned that the 850 specimens from India at his disposal show intergrading characters and that the Upper Jurassic species from Europe "have as a rule a more ornamented surface, the costae being more regularly confluent". Bathonian and Callovian species from Europe, in contrast, are more closely related to *S. kachensis*. The holotype (BMNH R5276) of BEAUVAIS' (1978) species *Adelocoenia variseptata*, which she erected out of part of the material recorded by GREGORY as *Stylina kachensis* based on the apparent absence of a columella, does in fact show a columella. BEAUVAIS' species, not showing any other diagnostic features, therefore has been merged with *S. kachensis*.

Genus *Cryptocoenia* D'ORBIGNY 1847

Type species. *Astrea alveolata* GOLDFUSS 1826.

Cryptocoenia wegeneri sp. nov.

Plate 5, Figs. 4, 6, 9, Text-fig. 8

1900 *Stylina kachensis* sp. nov. - GREGORY: 58, pl. 13, fig. 6 only.

Etymology. After Dr. MANFRED WEGENER, Würzburg, for his generous support of palaeontological research.

Diagnosis. Corallum plocoid; corallites large, circular in cross-section, bounded by septotheca and paratheca, usually separated by coenosteum and thin, more or less horizontal exotheca. Septa few in numbers, thick, hexamerally arranged, with small, subangular denticles along the distal margin. Occasionally auricula developed along inner edge of septa. Tabular and vascular endothecal dissepiments present. Septocostae subconfluent. Columella absent.

Material. 5 specimens (RUC19921 3, 5, 248-249). Holotype: RUC19921 248 (Plate 5, Fig. 6), paratypes: RUC19921 3 (Plate 5, Fig. 9) and RUC19921 5 (Plate 5, Fig. 4).

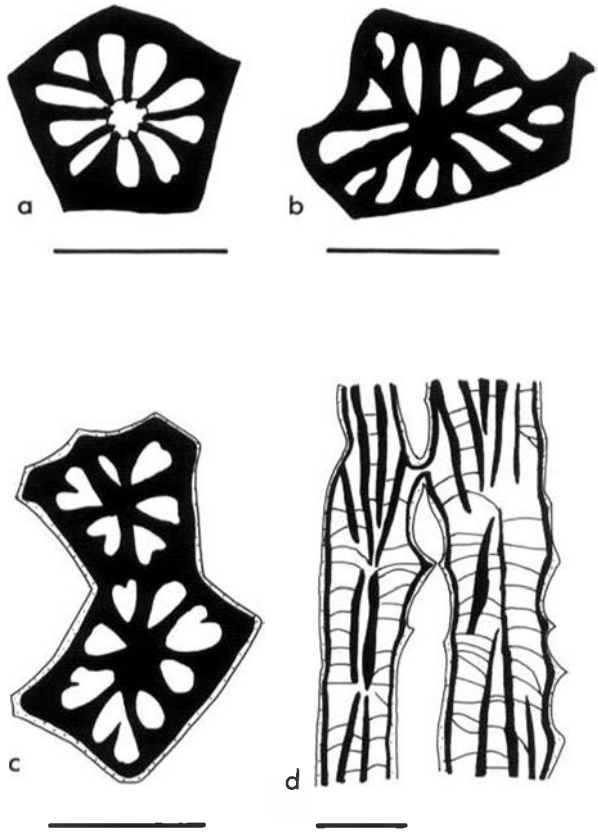
Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	30.0 - 56.0

the corallites is septothecal/parathecal with traces of a thin epitheca. Endothecal dissepiments are mostly subtabular, rarely vascular. Therefore, the diagnosis of the genus *Lochmaeosmilia* had to be amended accordingly.

WELLS (1943, 1956), ALLOITEAU (1958), and BENDUKIDZE (1982) assigned *Lochmaeosmilia* to the family Amphiastreidae OGILVIE 1896. The members of this family are characterized by a distinct epitheca, by the lack of a columella (its place being occupied by one large septum projecting into the axial space), and the aphroid nature of septa. Many specimens in the present collection show auricula along the inner edges of the septa which eventually fuse together and give the appearance of a columella. Specimens illustrated by GREGORY (1900) also show a columella. However, GREGORY (1900: 47) mentioned that the columella is "not very prominent; variable in size in cross sections of corallites". This character, together with the septothecal/parathecal wall and the uniform distribution of endothecal subtabular dissepiments, refers *L. trapeziformis* GREGORY to the family Stylinidae to which GREGORY originally had assigned the species. WELLS (1956: F398) also mentioned *Lochmaeosmilia* belonging possibly to the Stylinidae.



Text-fig. 9. *Lochmaeosmilia trapeziformis* (GREGORY 1900). a: Cross-section through corallite showing auricula but absence of a columella. RUC1992I 289. b: Cross-section through corallite where fused auricula occupy the central space thereby creating a pseudocolumella. RUC1992I 14. c: Cross-section through corallite showing intratentacular budding. RUC1992I 318. d: Longitudinal section showing cross tubules. RUC1992I 14. Dotted area represents epitheca. Scale: 1 mm.

Lochmaeosmilia trapeziformis (GREGORY 1900)

Plate 1, Figs. 4, 9, Text-fig. 9

1900 *Stylosmilia trapeziformis* sp. nov. - GREGORY: 47, pl. 11, figs. 5-14.
1958 *Lochmaeosmilia trapeziformis* (GREGORY) - ALLOITEAU: 68, pl. 16, fig. 10, pl. 22, fig. 1, pl. 30, fig. 2.
1958 *Lochmaeosmilia trapeziformis* (GREGORY) var. *subregularis* nov. var. - ALLOITEAU: 69, pl. 16, fig. 11, pl. 22, fig. 2.
1982 *Lochmaeosmilia trapeziformis* (GREGORY) - BENDUKIDZE: 79, pl. 28, fig. 2.

Material. 62 specimens, mostly fragmented (RUC1992I 13-14, 289, 318); 30 specimens (BMNH R5274) from the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Description. Corallum hemispheroidal and phaceloid. Corallites dichotomizing, angular, trigonal, quadrangular, hexagonal, or elliptical in cross-section. Corallite walls septothecal/parathecal with thin epitheca. Corallites occasionally connected by cross tubules and apophyses (Text-fig. 9). Septa 4 to 17 in numbers, simple and very irregular. Endothecal dissepiments subtabular, rarely vascular. Columella absent (Text-fig. 9a); central space of corallites often occupied by irregularly developed auricula, which are fused together to form a pseudocolumella (Text-fig. 9b).

Remarks. The specimens agree well with *Stylosmilia trapeziformis* GREGORY (1900: 47, pl. 11, figs. 5-12) and have hence been assigned to this species. As mentioned above *L. trapeziformis* does not exhibit a strong styliform columella, one of the diagnostic features of *Stylosmilia* MILNE-EDWARDS & HAIME (1848: 274; 1850: xxvii; WELLS 1956), but has a fascicular columella. The subprismatic corallites with apophyses also differentiates *L. trapeziformis* from *Stylosmilia*.

ALLOITEAU (1958) distinguished *L. trapeziformis* var. *subregularis* from this species on the basis of small and subcircular corallites and a slightly larger number of septa. Our material shows, that these features are part of a continuous morphological range.

Genus *Goniocora* MILNE-EDWARDS & HAIME 1851

Type species. *Lithodendron sociale* ROEMER 1836.

Remarks. The genus was established by MILNE-EDWARDS & HAIME (1851: 92) with *Lithodendron sociale* ROEMER as type species for forms in which mode of polyp formation always takes place by means of lateral gemmation like in *Pleurocora* MILNE-EDWARDS & HAIME 1848 and *Cladocora* EHRENBERG 1834. It differs from the latter two genera by the rudimentary state of the columella and the complete absence of pali. Furthermore, *Lithodendron sociale* lacks a styliform columella (see ROEMER 1836: 19), in contrast to the description of *Goniocora* given by WELLS (1956: F404).

cf *Goniocora socialis* (ROEMER 1836)

Plate 1, Fig. 2

cf. 1836 *Lithodendron sociale* sp. nov. - ROEMER: 19, pl. 1, fig. 5.
cf. 1851 *Goniocora socialis* (ROEMER) - MILNE-EDWARDS & HAIME: 92, pl. 15, fig. 2.
cf. 1886 *Goniocora socialis* (ROEMER) - KOBY: 306, pl. 90, figs. 10-16.
cf. 1985 *Goniocora socialis* (ROEMER) - ROSENDAHL: 42, pl. 4, fig. 4.

Material. 1 small fragment (RUC19921 7).

Horizon and locality. Patcham Formation of Jumara Dome.

Description and remarks. The specimen is only a small fragment with a height of 7.4 mm and a diameter of 3.5 mm. It is tubular, little curved, circular in cross-section with 24 septa arranged in three perfect cycles; the first cycle reaches up to three-fourth of the radius, the second cycle is somewhat shorter, while thin, short septa represent the third cycle. Costae corresponding to the septal cycles are well developed in the upper part of the corallite and gradually fade in the lower part. Form, cross-section, septa and costae closely correspond to the type species of *Goniocora*, *G. socialis* (ROEMER) (MILNE-EDWARDS & HAIME 1851: 92, pl. 15, fig. 2; see also KOBY 1886: 306, pl. 90, figs. 10-16; WELLS 1956: F404, fig. 301, 4a-b). It is also comparable to *Goniocora* cf. *socialis* (ROEMER) as described by LAUXMANN (1991a: 128, pl. 2, fig. 5) from Württemberg (SW-Germany). Due to the fragmentary nature of the specimen, the branching pattern and the angles of branching are not known.
One specimen of *Goniocora turbinata* GREGORY from the GREGORY Collection of the Natural History Museum, London (BMNH R5272) is comparable to our specimen with regard to circular cross-section and 24 septa arranged in three cycles, but shows a columella and prominent auricula along the inner edge of the septa.

Suborder **Astraeoida** ALLOITEAU 1952

Family **Heliastraeidae** ALLOITEAU 1952

Genus *Rhabdocora* FROMENTEL 1873

Type species. *Rhabdocora cretacea* FROMENTEL 1873.

Rhabdocora sp.

Plate 1, Fig. 3

Material. 1 incomplete specimen (RUC19921 8).

Horizon and locality. Patcham Formation of Jumara Dome.

Description and remarks. Corallum phaceloid. Corallites circular in cross-section, branching dichotomously laterally. Septa simple, numbering 22. Septal ends free; longest septa nearly extend to the centre. Columella very small, elongated in cross-section; costae well developed.

The specimen exhibits the diagnostic features of *Goniocora turbinata* GREGORY (1900: 43, pl. 4, figs. 4a-d) (= *Cladophyllia turbinata* (GREGORY); see LATHUILIÈRE 1989), except for the columella, which in *turbinata* is rudimentary. The elongated columella refers the present specimen to the genus *Rhabdocora* FROMENTEL 1873 (WELLS 1956: F404). Because of the incomplete nature, only generic identification is possible.

Genus *Cladocora* EHRENBERG 1834

Type species. *Madrepora caespitosa* LINNÉ 1767; subsequently designated by MILNE-EDWARDS & HAIME 1850 (= *Procladocora* ALLOITEAU 1952).

Cladocora sp.

Plate 2, Fig. 8

Material. 2 fragmentary specimens (RUC19921 21).

Horizon and locality. Patcham Formation of Jumara Dome.

Description and remarks. Corallum dendroid, branching rapidly. Corallites circular to oval in cross-section. Septa simple, numbering 37. Paliform lobes and fine costae are like those of *Cladocora* (ALLOITEAU 1952:

621, pl. 2, fig. 8). The irregular pattern of the paliform lobes in the centre of the calice does not allow to draw any inferences about the columella. Thus only a generic assignment is possible.

Family **Montlivaltiidae** DIETRICH 1926

Genus *Montlivaltia* LAMOUROUX 1821

Type species. *Montlivaltia caryophyllata* LAMOUROUX 1821.

Montlivaltia cornutiformis GREGORY 1900

Plate 2, Figs. 1-3

1900 *Montlivaltia cornutiformis* sp. nov. - GREGORY: 85, pl. 4, figs. 5-8, pl. 5, figs. 1-3, pl. 9, fig. 11.
1958 *Montlivaltia cornutiformis* GREGORY, var. *elliptica* GREGORY - ALLOITEAU: 41, pl. 6, fig. 4, pl. 37, fig. 15, pl. 38, fig. 6.
1972 *Montlivaltia cornutiformis* GREGORY - BEAUVAIS: 49, pl. B, fig. 1.

Material. 10 specimens (RUC1992I 15-17); 18 specimens (BMNH R5286-R5292) of the Gregory Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).	H	D Long.	D Trans.	D at base
RUC1992I 15	22.6	22.8	19.5	11.0
RUC1992I 16	21.0	20.5	18.3	12.0
RUC1992I 17	24.8	25.8	22.5	13.0

Description. Coral solitary, turbinate to trochoid, occasionally only slightly curved, tapering down to small base where it may expand to some extent. Cross-section circular to subcircular at the base but elliptical, suboval to subquadrangular along the upper margin. Calice almost flat to deep with sharp to acutely rounded upper margin. Septa simple, numbering about 90. Upper margin smooth to very faintly denticulate, sides with rows of spines or ridges corresponding to trabeculae arranged in a single fan system. Rarely, spines of adjacent septa join to resemble synapticulae. Costae correspond to septa; denticles along the upper margin of the septa rare and inconspicuous. Endothecal dissepiments abundant. Epitheca very thin and fragile, covering costae at places in impersistent rings.

Remarks. Morphological features of the Jumara specimens are well within the range of variation of *M. cornutiformis* GREGORY (1900). GREGORY (1900: 85), while describing this species from the Upper Patcham Formation of northwestern Jumara, recognized seven different 'members' (viz. *typica, crassa, spissiradiata, obliquata, cordata, elliptica*, and *vasiformis*) which are closely related by their shape and number and nature of septa. Most of the specimens in the present collection show overlapping characters. For example one specimen has a blunt and small base like *crassa*. However, the outline of the upper margin and calice is not elliptical as in *crassa*, but heart-shaped like in *cordata*. Another specimen has the shape and cross-section of *obliquata* but in contrast to the very shallow calice and costae that are thicker than septa (which are characteristic of that 'member'), depth of calice is like in *elliptica*. A third specimen agrees in its shape and transverse section with *typica*, but costae are not coarsely crenulated. This specimen also shows intracalicular budding in the centre of the calice.

The overlapping morphological features in the present specimens and the wide range of variation of features such as number of septa, depth of calice, transverse section, shape and width of columnar space, occurrence of epitheca, thickness of costae, etc. make it impossible to keep the seven members distinct. We therefore agree with BEAUVAIS (1972: 49) to merge all the 'members' of GREGORY (1900) with the species *M. cornutiformis*.

Montlivaltia frustriformis GREGORY 1900

Plate 3, Figs. 1-7; Plate 4, Figs. 1-5, 8-10, Text-figs. 10-11

1900 *Montlivaltia frustriformis* sp. nov. - GREGORY: 98, pl. 5, figs. 4-10, pl. 6, figs. 8-9, pl. 8, fig. 12.
1900 *Montlivaltia kachensis* sp. nov. - GREGORY: 106, pl. 6, figs. 1-7, 10-12, pl. 9, figs. 6-7 [both *depressa* and *patelliformis* varieties].
1900 *Montlivaltia culullus* sp. nov. - GREGORY: 111, pl. 7, figs. 1-9, pl. 8, figs. 1-5, pl. 9, figs. 8-10.
1958 *Montlivaltia frustriformis* GREGORY - ALLOITEAU: 41, pl. 37, figs. 10-11.
1958 *Montlivaltia kachensis* GREGORY, var. *depressa* GREGORY - ALLOITEAU: 42, pl. 36, figs. 7-10, pl. 38, figs. 7-8.
1972 *Montlivaltia kachensis* GREGORY - BEAUVAIS: 48.
1972 *Montlivaltia frustriformis* GREGORY - BEAUVAIS: 48.

Material. 84 specimens (RUC1992I 26-34, 36-40, 112-137); 101 specimens (BMNH R5295-R5300) of the GREGORY Collection, 1 specimen (BMNH R18918) from the BLAKE Collection at the Natural History Museum, London.

Horizon and locality. Khavda Formation, north of Andhou, Pachchham 'Island'; Patcham Formation of Jumara Dome; Chari Formation of Habo Dome, Keera Dome, Jumara Dome, and Jhura Dome.

Dimensions (in mm).	H	D long	D transv.	N septa
RUC1992I 26	22.6	20.9	19.0	75
RUC1992I 27	25.0	35.0	34.0	114
RUC1992I 28	20.0	-	~23.0	-
RUC1992I 29	25.6	28.8	28.4	112
RUC1992I 30	19.3	28.6	25.4	102
RUC1992I 31	24.4	31.0	27.9	129

RUC1992I 32	25.8	23.5	-	118
RUC1992I 33	36.3	24.0	20.5	-
RUC1992I 34	14.0	25.5	-	102
RUC1992I 37	13.7	21.0	18.5	89
RUC1992I 38	13.9	28.3	26.0	110
RUC1992I 39	23.0	48.0	43.0	121
RUC1992I 40	26.0	34.0	32.8	115
RUC1992I 112	20.0	22.0	20.0	-
RUC1992I 113	15.0	23.5	20.8	99
RUC1992I 114	17.3	27.3	25.0	92
RUC1992I 115	19.0	25.0	24.8	115
RUC1992I 116	19.0	23.0	-	-
RUC1992I 117	43.0	44.0	39.0	86
RUC1992I 118	38.0	44.3	45.0	112
	at22.5	48.5	46.0	-
RUC1992I 119	14.7	23.0	21.9	93
RUC1992I 120	14.7	27.6	25.4	-
RUC1992I 121	15.5	26.4	-	-
RUC1992I 122	10.6	23.0	22.0	-
RUC1992I 123	17.0	27.4	25.0	-
RUC1992I 124	14.3	31.0	28.0	95
RUC1992I 125	13.5	23.0	22.8	101
RUC1992I 126	9.0	17.4	17.0	>55
RUC1992I 127	15.0	22.5	20.8	-
RUC1992I 128	2.7	7.3	-	48
RUC1992I 129	7.4	12.5	-	64
RUC1992I 130	9.8	14.3	13.9	67
RUC1992I 131	11.9	21.0	18.6	-
RUC1992I 132	~23.8	19.0	15.0	-
RUC1992I 133	~30.5	29.3	27.9	120
RUC1992I 134	6.0	11.5	9.9	50
RUC1992I 135	18.4	25.5	-	-
RUC1992I 136	15.4	22.8	-	-

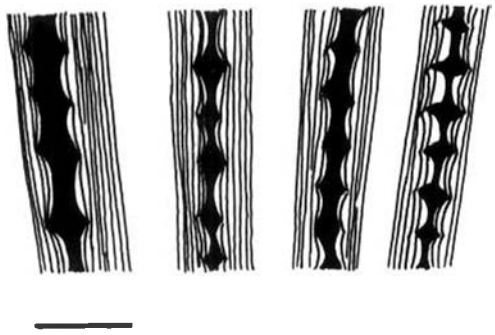
Description. Corallum ranging from conical to patelliform, discoid, subtympanoid, or massive with shallow constrictions and/or irregular change of diameter with height. Base pointed or truncated with small to large, planar to convex attachment area. Transverse section always circular at the base but circular, subcircular, subelliptical to elliptical along the upper margin. Calice very shallow to moderately deep with well marked, acute to rounded upper margin. Septa simple, laminar, thin to thick, prominent, ranging in numbers from 48 to 129; primary septa and a few secondary septa are almost alike: thick, long and reaching up to the axial space; those in oblique position with regard to the long dimension of the axial space have curved free ends. The remaining septa are successively thinner and shorter. The septa may be smooth or bear tiny to coarse, sharp to blunt, sparse to dense, persistent to impersistent spines, granules, striae and/or ridges on the lateral surfaces corresponding to trabeculae arranged in a single fan system (Text-fig. 10). Denticles inconspicuous to absent, in few specimens well developed. Endothecal dissepiments abundant. Costae correspond to septa, may be slightly coarser and blunt. Some specimens show very fine costae independent of septa. The centre of calice shows a widely elongated or narrow linear to almost non-existing axial space. Epitheca thin, fragile, covering the costae in patches or in rings. One of the specimens (RUC1992I112) shows beginning of calicular budding.

Text-fig. 10. *Montlivaltia frustriformis* GREGORY 1900. Lateral surface of septum showing granules (dotted) arranged along trabeculae. The trabeculae exhibit traces of the arrangement of sclerodermites. RUC1992I 36. Scale: 1 mm.

Remarks. GREGORY (1900) regarded the shape of *Montlivaltia* as a diagnostic feature and consequently recognized three species: (1) *M. frustriformis*, corresponding to an inverted frustrum; either low with large base resulting in a discoid shape or high, resembling a truncated cone. (2) *M. kachensis*, of patelliform shape, becoming discoid with pointed base, and (3) *M. culullus*, a massive and cup-shaped form with narrow base. On the other hand GREGORY (1900: 109) mentioned that "just as *Montlivaltia kachensis* shades off into *M. frustriformis* on the one side, so it passes into *M. culullus* on the other, by the gradual increase in the size of the corallum and the development of various collateral variations". He also illustrated (1900: pl. 8, figs. 1-5, pl. 9, figs. 8-9) a few specimens intermediate between *M. kachensis* and *M. culullus*. Specimens gradational between these species (especially RUC19921 129, 127, 135) are also found in our material.

Furthermore, the three species of GREGORY show, according to him, circular to slightly elliptical cross-sections along the upper margin, a shallow or shallow to deep calice, laminar septa in six to sixteen cycles, abundant endothecal dissepiments, a very narrow to widely elongated axial space, a fragile epitheca, and costae corresponding to septa. Thus they correspond

in their range of variation to that of our material. GREGORY did not use the septal elements such as spines, granules, striae and ridges (carinae) on the lateral surface for specific identification, features which show extreme variations in persistence, prominence and distribution in these three species. The smoothness of the septa is due to deposition of laminar layers (GILL & LAFUSTE 1971) as evident in cross-sections of specimens from Habo Dome (Text-fig. 11). In these specimens laminar layers have been deposited layer by layer to such an extent that inter-septal space has become narrower than the thickness of the septa. This character is diagnostic but gradational irrespective of other features and therefore cannot be used for defining species. According to GILL (1970; pers. comm. 1993) the laminar layers of the septa are thickest at the proximal end and become thinner towards the distal end.



Text-fig. 11. Schematic drawing of cross-section of parts of four septa of *Montlivaltia frustriformis* GREGORY showing deposition of laminar layers on the septal surfaces. RUC1992I 118. Scale bar: 1 mm.

Some of the specimens are juvenile and therefore show only 48 septa. One of the specimens (RUC1992I 137) is slightly distorted and accordingly appears to be bevelled along one side of the upper margin; it still shows, however, the other diagnostic characters of the species.

The morphological range of the present specimens and the diagnostic characters of the three species distinguished by GREGORY suggest that *M. kachensis*, *M. culullus* and *M. frustriformis* should be merged, the latter having page priority.

Three specimens included here differ from those reported by GREGORY; two of them (RUC1992I 26, 132) are similar in shape to *Montlivaltia pirum* MILASCHEWITSCH (1875: 204, pl. 48, fig. 8), the third (RUC1992I 33) is trochoid up to the middle and then becomes cylindrical after a little reduction in diameter.

M. cornutiformis differs from *M. frustriformis* by being more elongate and having fewer septa at the same height.

It is interesting to note here that, on the basis of the conical form of a single specimen from northern Chile, PRINZ (1991: 169, pl. 2, fig. 11) considered *Montlivaltia culullus* GREGORY (1900: pl. 7, figs. 1-4, pl. 8, figs. 1-5, pl. 9, figs. 14, 15 only) as junior synonym of *Montlivaltia* cf. *dilatata* (MICHELIN 1857) of KOBY (1884: 120, pl. 39, fig. 4, pl. 40, figs. 1-8). PRINZ did not include GREGORY's specimens figured on pl. 7, figs. 5-9 and pl. 9, figs. 8-10 in the synonymy. However, these specimens only differ in shape and are consequently regarded as ecophenotypes. The specimen from northern Chile is conical with a maximum diameter of 41 mm, 5 complete septal cycles and a sixth incomplete one. The septal ends are dentate near the calice centre and enclose a 10 mm long fossula (PRINZ 1991). In comparison to the specimen from northern Chile, the specimens from India attained maturity much earlier as evidenced by the ratio between the number of septal cycles and diameter. In addition, *M. culullus* has a small fossula and inconspicuous dentition along the septal margin, thus differing clearly from *M.* cf. *dilatata*.

Montlivaltia chariensis GREGORY 1900

Plate 5, Fig. 1

1900 *Montlivaltia chariensis* sp. nov. - GREGORY: 97, pl. 8, figs. 6-10.

Material. 6 specimens (RUC1992I 35); 2 specimens (BMNH R5293) in the Gregory Collection.

Horizons and locality. Chari Formation of Jhura Dome; Chari Formation of 'near Wanda' (GREGORY 1900).

Description. Corallum simple, subturbinate to subtrochoid, calice centre deep with flat periphery, elliptical and broadly rounded margin. About 71 thin septa, the sides of which bear tiny, pointed granules along the growth margins; inner margin conspicuously denticulated. Dissepiments common; axial space linear. Epitheca conspicuous (thickness 1 mm), covering entire lateral surface in form of prominent tranverse rings.

Remarks. The present specimens exhibit the morphological features of *Montlivaltia chariensis* GREGORY (1900) from the upper Chari Formation (Dhosa Oolite) and have therefore been assigned to this species. *M. chariensis* differs from other species of *Montlivaltia* from Kachchh by possessing the characteristic features enumerated above, such as an elliptical calice

with deep centre, and thin and fewer septa carrying tiny, blunt spines along the growth margins.

Montlivaltia obconica (MÜNSTER 1829)

Plate 4, Figs. 6-7

1829 *Anthophyllum obconicum* sp. nov. - MÜNSTER in GOLDFUSS: 107, pl. 37, fig. 14.
1875 *Montlivaltia obconica* (MÜNSTER) - BECKER & MILASCHEWITSCH: 196, pl. 44, figs. 1a-c.
1985 *Montlivaltia obconica* (MÜNSTER) - ROSENDAHL: 45, pl. 4, fig. 6.

Material. 2 specimens (RUC19921 44-45).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).	H	D long.	D transv.	N septa
RUC19921 44	~12	34.0	30.0	215
RUC19921 45	~19	45.5	43.0	225

Description. Corallum simple, discoidal, suboval in cross-section. Calice flat with broadly rounded upper margin. Septa thin, crowded, with rare and minute spines along the sides. Primary septa and few of the secondary septa are long and alike, the remaining septa being shorter. Costae correspond to septa and are even more crowded. Columellar space ill-defined or very narrow.

Remarks. The two specimens can be easily differentiated from other species of *Montlivaltia* on the basis of their numerous and crowded septa, and a broadly rounded upper margin associated with a flat calice. In these respects, they closely match *Montlivaltia obconica* (MÜNSTER) (e. g. BECKER & MILASCHEWITSCH 1875, ROSENDAHL 1985). The two specimens from Jumara differ from other figured *M. obconica* by being discoidal rather than cone-shaped. However, we do not regard the height of the corallum as a diagnostic feature, but rather as an ecophenotypic feature (see LAMBELET 1968, ERRENST 1990), and therefore assign our specimens to *M. obconica*.

Genus *Complexastraea* D'ORBIGNY 1849

Type species. *Astraea rustica* DEFRANCE 1826.

Complexastraea kachensis GREGORY 1900

Plate 5, Figs. 5, 8

1900 *Complexastraea kachensis* sp. nov. - GREGORY: 120, pl. 10, figs. 7-10, pl. 11, figs. 1-4.

Material. 3 specimens (RUC19921 42-43); 9 specimens (BMNH R5301) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome and Chari Formation of Habo Dome.

Description. Corallum patelliform, massive, plocoid, becoming compound either by fission or by extracalicular budding. Corallites shallow, subcircular to polygonal, separated from each other by parathecal wall. Septa (103-180 in number) with faint granules on the sides. Septo-costae confluent. Endothecal dissepiments abundant. Columellar space narrow. Epitheca rare.

Remarks. The specimens match *Complexastraea kachensis* GREGORY (1900) in all respects. The radial elements are similar to *Montlivaltia* from which the specimens are differentiated by their colonial growth. GREGORY (1900: 119) separated *Complexastraea* from *Isastrea* by its large and rounded corallites, which are small and polygonal in *Isastrea*.

One of the specimens (RUC19921 43) differs by a polygonal calice outline.

Genus *Isastrea* MILNE EDWARDS & HAIME 1851

Type species. *Astrea helianthoides* GOLDFUSS 1826.

Isastrea limitata (LAMOUROUX 1846)

Plate 2, Fig. 10

1846 *Astrea limitata* sp. nov. - LAMOUROUX in MICHELIN: 229, pl. 94, fig. 10.
1851 *Isastrea limitata* (LAMOUROUX) - MILNE-EDWARDS & HAIME: 114, pl. 23, fig. 2, pl. 24, figs. 4-5.
1967 *Isastrea limitata* (LAMOUROUX in MICHELIN) - BEAUVAIS: 22, pl. 22, fig. 5.
1972 *Isastrea limitata* (LAMOUROUX in MICHELIN) - BEAUVAIS: 51 [see for extensive synonymy].

Material. 1 specimen (RUC19921 18).

Horizon and locality. Khavda Formation of Kunwar Bet.

Description. Corallum massive, cerioid; corallites small (3-5.9 mm in diameter), bounded by septotheca. Calices deep, pentagonal, hexagonal, suboval or subcircular in plan view. Septa (23-35) little exsert, generally confluent, but in few cases alternating with those of adjoining corallites. The longest septa reach the axial cavity where, in few cases, they touch each other. Septa bear lateral granulations, inner margin denticulate. Endothecal vascular and tabular dissepiments common.

Remarks. The Kunwar Bet specimen exhibits the diagnostic features of *Isastrea limitata* (LAMOUROUX) as described by MILNE-EDWARDS & HAIME (1851) from the Great Oolite of England. *Isastraea parva*

GREGORY (1900: 129, pl. 15, figs. 4-5) is the closest comparable Indian form, but differs in possessing a parietal columella. Due to the absence of a columella the centre of calices is deeper in the present specimen. *Isastrea oblonga* (FLEMING) of MILNE-EDWARDS & HAIME (1851: 73, pl. 12, fig. 1) is another comparable form, but has been differentiated on the basis of a thicker wall and strong lateral granulations of the septa. *Isastrea salinensis* KOBY (1885: 280, pl. 83, figs. 1-3; see also BEAUVAIS 1966: 1004, pl. 9, fig. 1, pl. 10, fig. 1) has similar corallite shape and depth of the calices, but differs by the large size of its corallites and a higher number of septa.

Isastrea propinqua ETALLON 1864

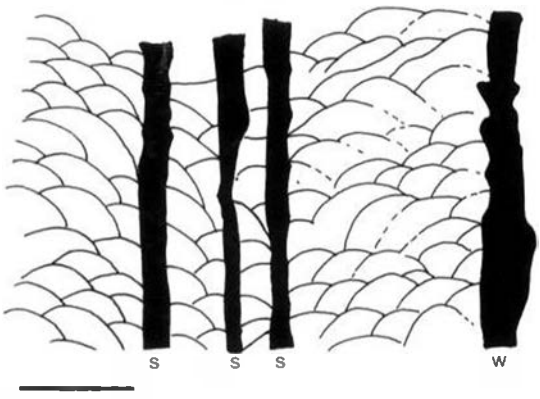
Plate 5, Figs. 2-3, 7, Text-fig. 12

1864 *Isastrea propinqua* sp. nov. - ETALLON in THURMANN & ETALLON: 392, pl. 55, fig. 13.
1885 *Isastrea propinqua* THURMANN - KOBY: 285, pl. 81, figs. 3-4.
1900 *Isastraea propinqua* THURMANN & ETALLON 1864 var. *kachensis* var. nov. - GREGORY: 126, pl. 16, figs. 5-6.

Material. 19 specimens (RUC1992I 155-156, 400).

Horizon and locality. Patcham Formation of Jumara Dome and Chari Formation of Keera Dome.

Dimensions (in mm).	RUC1992I 155	1992I 156
Diameter of corallites	5.0>9.0	2.5-3.0
Distance between corallite centers	5.5-10.5	2.8
Density of septa per 2 mm	3-5	6
Number of septa in corallites	24-39	19-29



Text-fig. 12. *Isastrea propinqua* ETALLON 1864. Longitudinal section exhibiting abundant vascular dissepiments, septa (S) and a wall (W). RUC1992I 400. Scale bar: 1 mm.

Description and remarks. *I. propinqua* differs from other species of *Isastrea* by its dimensions, the presence of a rudimentary wall, and by the arrangement of septa with respect to those of adjacent corallite Superficially, the species resembles a thamnasteriid but the presence of vascular dissepiments and of wall (Text-fig. 12) places it firmly into *Isastrea*.

One of the specimens (RUC1992I 156) is poorly preserved, but the type of colony, calices, nature and number of septa and the endothecal elements are similar to *Isastrea propinqua* and clear enough for specific designation. The diameters of corallites recorded by THURMANN & ETALLON (1864), KOBY (1885), and GREGORY (1900) are a little larger (6-8 mm) than in this specimen. In our opinion this reflects ecophenotypic variation.

Isastrea hemisphaerica GREGORY 1900

Plate 11, Fig. 10

1900 *Isastraea hemisphaerica* sp. nov. - GREGORY: 127, pl. 16, figs. 2-4.

Material. 4 specimens (RUC1992I 360-361).

Horizon and locality. Patcham Formation of Jumara Dome

Description and remarks. All four specimens are fragmentary and poorly preserved. They differ from *Isastrea propinqua* THURMANN & ETALLON and agree with *I. hemisphaerica* by possessing branching septa (at times four secondary septa are joined to primary septum) and a pseudocolumella due to extention of primary septa into the centre of the calices. In this case also the diameters of the corallites are smaller (3-6 mm) than those described by GREGORY (8 mm).

Suborder **Meandriida** ALLOITEAU 1952

Family **Dendrogyriidae** ALLOITEAU 1952

Genus *Melikerona* ALLOITEAU 1958

Type species. *Isastraea parva* GREGORY 1900 p.p., var. *madagascariensis* ALLOITEAU 1958.

Melikerona parva (GREGORY 1900)

Plate 2, Figs. 5-6

1900 *Isastraea parva* sp. nov. - GREGORY: 129, pl. 15, figs. 4-5.
1958 *Melikerona* (?) *parva* GREGORY sp. 1900 p.p., var. *madagascariensis* var. nov. - ALLOITEAU: 65, pl. 1, fig. 8, pl. 7, fig. 4.
1978 *Melikerona parva* GREGORY - BEAUVAIS: 49, pl. 1, fig. 2.

Material. 11 specimens (RUC19921 19, 326-334, 346); topotype (BMNH R5303); 1 specimen (BMNH R5303) in the GREGORY Collection.

Horizon and locality. Khavda Formation NE of Sadhara, Pachchham 'Island' and Kunwar Bet; Washtawa Formation N of Washtawa, Wagad.

Dimensions (in mm).	RUC19921 19	RUC19921 326-327
Diameter of corallum	250	21-28
Diameter of corallites	3.0-8.5	1.5-3.5
Distance between corallite centres	3.0-7.5	1.5-2.4
Number of septa	24-28	19-22
Density of septa per 2 mm	4	6

Description. Corallum massive, cerioid; corallites small, separated by thin to thick septotheca/paratheca; occasionally with coenosteum. Corallites hexagonal, pentagonal, quadrangular or subcircular in outline. Calice moderately deep, septa simple and of varying length. Lateral surfaces of septa with spines. The major septa join in the centre to form a conspicuous columellar structure of variable shape and thickness; the minor septa are short. Vascular and tabular endothecal dissepiments common. Septo-costae either confluent or alternating.

Remarks. Our specimens show extreme variations in size of the corallum. Two of them (RUC 19921 18-19) from the Bathonian of NE of Sadhara, Pachchham Island, and from Kunwar Bet, are large in size and exhibit a low septal density, the remaining nine from the Callovian of Wagad (RUC 19921 326-334) are small and exhibit comparatively dense septa. The other dimensions are overlapping. In general the specimens closely match *Isastraea parva* as described by GREGORY (1900) from the Patcham Formation of Jumara as well as the variety *madagascariensis* described by ALLOITEAU (1958) from Madagascar.

ALLOITEAU (1958: 57, 65) erected two new genera, *Pseudisastraea* and *Melikerona*, to accommodate *I. parva* without having seen GREGORY's type material. According to him *Pseudisastraea* differs from *Isastrea* by lacking lateral carinae, by septa exhibiting 'heterodont' distal ends, and by having a substyliform columella. *Isastraea parva* of GREGORY (1900) also does not show septal carinae, the distal margin is denticulate and the columella is not styliform (according to GREGORY (1900: 129), his figure of *I. parva* on pl. 15, fig. 4c "exaggerates this character"). Consequently, the creation of *Pseudisastraea* on the basis of the above mentioned characters is unfounded. Judging from the figures of the Madagascan specimens of *Pseudisastraea parva* ALLOITEAU (1958: 57, pl. 1, fig. 10, pl. 6, fig. 11, pl. 7, fig. 4, pl. 24, fig. 2, pl. 29, figs. 7-9) they are very similar to *Isastraea parva* of GREGORY (1900). Without having seen ALLOITEAU's material, it is, however, impossible to comment on its precise relationship to the specimens from Kachchh. *Melikerona* bears septal ornamentation similar to *Isastrea*. The presence of a columella, however, is certainly a diagnostic feature, which differentiates *parva*, or for that matter *Melikerona*, from *Isastrea* (see LATHULIERE 1988).

In the topotype (BMNH R5303) of *M. parva* GREGORY described by BEAUVAIS (1978) the columella is only occasionally thickened by one or two primary septa.

Suborder **Pachythecalina** ELIASOVA 1976

Family **Amphiastraeidae** OGILVIE 1897

Genus *Amphiastraea* ETALLON 1859

Type species. *Amphiastraea basaltiformis* ETALLON 1859.

Amphiastraea piriformis GREGORY 1900

Plate 5, Figs. 10-11, Text-fig. 13

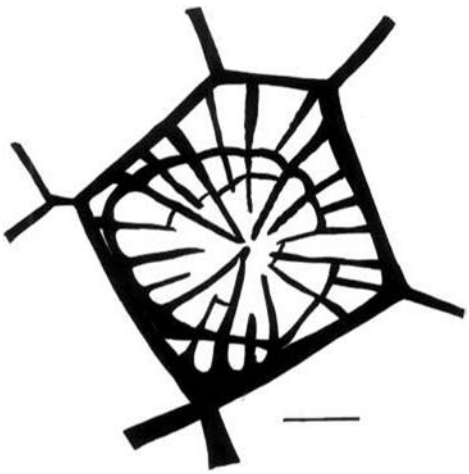
1900 *Amphiastraea piriformis* sp. nov. - GREGORY: 71, pl. 14, fig. 14, pl. 15, figs. 1-2.
1985 *Amphiastrea piriformis* GREGORY - ROSENDAHL: 54, pl. 5, fig. 9.
1990 *Amphiastraea piriformis* GREGORY - ERRENST: 163, pl. 1, fig. 4.

Material. 5 specimens (RUC19921 25, 335-336); 6 specimens (BMNH R5281) in the GREGORY Collection.

Horizon and locality: Khavda Formation of Kunwar Bet and Chari Formation of Habo Dome.

Description. Corallum massive, cerioid; corallites small (3-5.8 mm in diameter), hexagonal, pentagonal, subquadrangular or subrounded in outline, separated from each other by septotheca (RUC19921 25) or septotheca/paratheca, occasionally by thin coenosteum (RUC19921 335-336). Calices shallow. Septa numbering 13-37, simple and of varying length, with smooth lateral surfaces and smooth to faintly denticulated distal margins. The inner edges of the septa show three variable features: (1) in few cases, one of the primary septa reaches the small, subcentral columellar cavity; (2) in some corallites they join and form a pseudocolumella which in few cases is quite conspicuous; (3) in the remaining corallites the septa are free all along the inner edge or at least at the distal end, forming a pseudocolumella only during early ontogenetic stages. In the third category adjacent

septa occasionally join together at their free ends. Endothecal ring (Text-fig. 13) well developed only in few corallites, in others either incomplete or completely absent. Vascular and tabular endothecal dissepiments common.



Text-fig. 13. *Amphiastraea piriformis* GREGORY 1900. Cross-section through corallite showing endothecal ring. RUC1992I 335. Scale bar: 1 mm.

Remarks. GREGORY (1900) differentiated *A. piriformis* from the type species *A. basaltiformis* ETALLON 1859 on the basis of the small size of corallites (5-10 mm in the latter), a less eccentric calicinal centre, a more conspicuous pseudocolumella, and a less complete endothecal ring. ROSENDAHL (1985: 54) distinguished *A. basaltiformis* (characterized by asymmetric septa with endothecal dissepiments often forming bud-like structures on the inner margin of the calices and a paratheca along the periphery, and by the presence of a thin epitheca between the calices; see also BEAUVAIS 1964: 200, fig.43) from *A. piriformis* (characterized by dissepiments forming a round "inner wall" around the centre of the calice and a paratheca).

In the present specimens the size of corallites ranges from that of *A. piriformis* to that of *A. basaltiformis*, the axial part of the corallites varies from a conspicuous pseudocolumella to a less conspicuous one, to lacking a pseudocolumella, and also the endothecal ring varies from undeveloped, incompletely developed, to well developed. *A. basaltiformis* as illustrated by ROSENDAHL (1985: 54, pl. 5 fig. 9) and BEAUVAIS (1964: 200, text-fig. 3, pl. 22, fig. 1) exhibits an eccentricity of the calice centres of more or less the same degree as in *A. piriformis* from Kachchh. Moreover, the presence of a thin epitheca is not a persistent character in our material. Thus, the only difference between *A. piriformis* and *A. basaltiformis* appears to be the presence of bud-like structures in the latter. Whether this feature is diagnostic enough to warrant separation of the two species can be decided only after a thorough study of the type material.

Genus *Axosmilia* MILNE-EDWARDS & HAIME 1848

Type species. *Caryophyllia extinctorum* MICHELIN 1840.

Axosmilia kachensis (GREGORY 1900)

Plate 2, Fig. 7

1900 *Placosmilia kachensis* sp. nov. - GREGORY: 76, pl. 10, figs. 3, 6.

Material: 1 specimen (RUC1992I 20).

Horizon and locality. Khavda Formation, north of Andhou, Pachchham 'Island'.

Description. Corallum solitary, discoidal with broad base. Calice deep and oval in plan view. Septa (48) thick, smooth with sharp and rarely dentate upper margin. Endotheca absent. Columella elongated, thickened by joining major septa.

Remarks. *Axosmilia kachensis* was referred to *Placosmilia* by GREGORY (1900: 76, pl. 10, figs. 3, 6). GREGORY (1900: 74) defined *Placosmilia* MILNE-EDWARDS & HAIME 1848, with *P. parkinsoni* MILNE-EDWARDS & HAIME 1848 as type species, as Isastraeidae with simple, free or subpedunculate form, with numerous, subequal, laterally granular septa, a lamellar columella and abundant endotheca. Later on WELLS (1956: F400) taking *Turbinolia cymbula* MICHELIN 1846 as the type species, included *Placosmilia* in the family Montlivaltiidae and defined it as a flabellate coral with well developed lamellar columella. Accordingly, *P. kachensis* has to be assigned to another genus. LAUXMANN (1991: 158, 159) has already grouped the other two species of *Placosmilia* described from Kachchh (viz. *P. sessilis* and *P. caeliformis*) with the genus *Axosmilia*. Agreeing with LAUXMANN and on the basis of the morphological features of the present specimen and those of *P. kachensis* we feel that *P. kachensis* should be placed with *Axosmilia*.

Axosmilia aff. *sessilis* (MILASCHEWITSCH 1875)

Plate 2, Fig. 9

Material. 3 specimens (RUC1992I 24).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	24.5-22.0
Height of corallum	~10
Number of septa	49-83
Density of septa per 2 mm	1-3

Description. Corallum solitary, turbinate. Calice subcircular, shallow; septa sparse, of varying thickness and length, sides either smooth or with short spines. Dissepiments thick and steep near the periphery. Columella large, lamellar, very well developed, projecting distinctly beyond the calice surface.

Remarks. The specimens are very close to *Axosmilia sessilis* (MILASCHEWITSCH in BECKER & MILASCHEWITSCH 1875: 191, pl. 49, fig. 7; see also GREGORY 1900: 75, pl. 10, figs. 1, 4; LAUXMANN 1991a: 159, pl. 7, fig. 7) which differs by possessing a small, deep columella. As all three specimens are incomplete, a precise identification was not possible.

Axosmilia benoisti (KOBY 1907: 14, pl. 1, figs. 20-25; see also BEAUVAIS 1972: 40, pl. A, figs. 3-5) is another comparable form, but differs by its cylindrical and tall shape and in the ornamentation of the radial elements.

Suborder **Caryophylliida** VAUGHAN 1943

Family **Caryophylliidae** GRAY 1847

Genus *Coelosmilia* MILNE-EDWARDS & HAIME 1850

Type species. *Parasmilia poculum* MILNE-EDWARDS & HAIME 1848.

Remarks. *Coelosmilia* was established by MILNE-EDWARDS & HAIME (1850: XXV) to accommodate forms such as *Parasmilia* but without columella. Features shared with *Parasmilia* are: a solitary, subturbinate corallum; calice circular, not very deep; septa exsert, very granular laterally, wall naked or with rudimentary epitheca; costae straight and simple. Later, WELLS (1956: F426) merged *Coelosmilia* with *Desmophyllum* EHRENBERG 1834, an Oligocene-Miocene form, with *Desmophyllum dianthus* (non *Madrepora dianthus* ESPER 1797) as type species. *Desmophyllum* is, on the other hand, also similar to *Coelosmilia* with regard to shape (trochoid), costae (well developed near calice), exsert septa, absence of columella and nature of the wall. It can, however, easily be distinguished by the absence of any septal elements which are very granular in *Parasmilia* and *Coelosmilia*. We therefore retain *Coelosmilia* as a separate genus. It is worth mentioning, that according to ALLOITEAU (1952: 652) all Cretaceous to Eocene species of *Desmophyllum* should be assigned to a different genus. LATHUILIÈRE (1989) has also not included *Desmophyllum* in the list of Jurassic corals.

Coelosmilia indica GREGORY 1900

Plate 2, Fig. 4

1900 *Coelosmilia indica* sp. nov. - GREGORY: 40, pl. 8, fig. 11.

Material. 1 specimen (RUC1992I 23).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).	H	D long.	D transv.	N septa
RUC1992I 23	20.0	20.0	8.0	48

Description. Corallum solitary, turbinate, with moderately large attachment area; calice circular in plan view. 48 septa which project slightly beyond the the calicular rim. Primary septa thick, extending nearly to the columellar cavity; remaining septal cycles successively thinner and shorter, sides bearing sharp to blunt granules or spines. Costae developed only along the uppermost part, rest covered with layers of thin epitheca.

Remarks. Species of *Coelosmilia* from the Jurassic of England such as *Coelosmilia laxa* MILNE-EDWARDS & HAIME (1850: 52, pl. 8, fig. 4) differ by distinct costae extending from base to calice. The type species *Parasmilia poculum* MILNE-EDWARDS & HAIME (1848: 244, pl. 5, fig. 5) has five complete cycles of septa.

Genus *Lophosmilia* MILNE-EDWARDS & HAIME 1848

Type species. *Caryophyllia cenomana* MICHELIN 1845.

Lophosmilia tenuicaulata GREGORY 1900

Plate 6, Figs. 1-5

1900 *Lophosmilia tenuicaulata* sp. nov. - GREGORY: 37, pl. 3, figs. 4-6, pl. 4, fig. 2.
1900 *Lophosmilia magnocaulata* sp. nov. - GREGORY: 38, pl. 3, fig. 3, pl. 4, figs. 1, 3.

Material. 14 specimens (RUC1992I 46-50); 4 specimens (BMNH R5270-R5271) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Description. Corallum solitary, subturbinate to subcylindrical, base subpedunculate, narrow to considerably expanded. Calice shallow to moderately deep,

circular to oval in cross-section. Septa (numbering 32-43) thick, laterally granulated, upper margin arched and occasionally with auricula along inner edge. Primary septa thickest and nearly reaching columella. Remaining septa successively thinner and shorter. Endothecal dissepiments present only near the proximal end. Columella elongated in cross-section and deeply set. Septotheca present with tiny granules on the external surface. Some costae thick, others inconspicuous or confined to the calicular rim.

Remarks. GREGORY (1900) distinguished an elongated form (*L. tenuicaulata*) from a short, blunt and thick form (*L.magnocaulata*). The present specimens show, that the degree of elongation cannot be used as a specific character, because the two species of GREGORY represent end members of a continuous spectrum. In the present collection three morphotypes can be recognized; one with narrow, contracted peduncle and thick, well marked costae (= typical *L. tenuicaulata*), a second morphotype with large, expanded base and costae confined to the upper margin (= *L. magnocaulata*), and a third morphotype with overlapping characters such as base not very expanded, but costae inconspicuous. GREGORY (1900: 38) himself has opinioned that "The two 'species' are certainly modification of one form". In view of no substantial difference *L. magnocaulata* is merged with *L. tenuicaulata* giving page priority to latter.

In LATHUILIÈRE's (1989) list of Jurassic corals *L. tenuicaulata* has been assigned to *Cymosmilia* KOBY 1894 which is characterized by low colonies produced by extratentacular budding from the edge zone. However, among the eighteen specimens available for study and also in those illustrated by GREGORY none of them shows any trace of budding. GREGORY (1900: 36) has also differentiated *Lophosmilia* with a simple corallum from *Cymosmilia* which is branching.

Suborder **Fungiida** DUNCAN 1885

Family **Astraraeidae** BEAUVAIS 1982

Genus *Kobya* GREGORY 1900

Type species. *Kobya crassolamellosa* GREGORY 1900.

Remarks. GREGORY (1900: 169) established the genus *Kobya* for forms with features intermediate between those of the family Ethmotidae GREGORY (Fungiida in which the septa are lamellar and cribriform) and Microsolenidae KOBY (GREGORY 1900: 170). The genus is characterized by thick and doubly serrated septa with numerous perforations, formed by trabeculae so closely united into series that they appear lamellar in tranverse section. WELLS (1956: F386) merged *Kobya* with *Dimorphoseris* DUNCAN (1872: 22) and grouped it with the family Synastraeidae ALLOITEAU (1952: 664). BEAUVAIS (1970b: 1124; 1978: 50), after examination of the topotype, concluded that *Kobya* GREGORY merits separation at the generic level, because the characters do not allow its placement within the Synastraeidae and the presence of divergent trabeculae suggest its placement within the family Haplaraeidae. We follow LÖSER (1992) in grouping *Kobya* with the family Astraraeidae.

Kobya crassolamellosa GREGORY 1900

Plate 6, Figs. 6, 8-9, 11, Text-fig. 14

1900 *Kobya crassolamellosa* sp. nov.- GREGORY: 170, pl. 21, figs. 15-17, pl. 22, figs. 2, 5-8, pl. 23, fig. 1, pl. 2A, fig. 7.

1900 *Kobya cancellata* sp. nov. - GREGORY: 171, pl. 23, fig. 2.

1970b *Kobya crassolamellosa* GREGORY - BEAUVAIS: 1123, pl. 3, fig. 4, pl. 4, fig. 1.

1978 *Kobya crassolamellosa* GREGORY - BEAUVAIS: 50, pl. 2, fig. 1 (non pl. 7, fig. 1).

Material. 15 specimens (RUC1992I 51-54); 6 specimens (BMNH R51721-R51726) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome and Chari Formation of Keera Dome.

Dimensions (in mm).

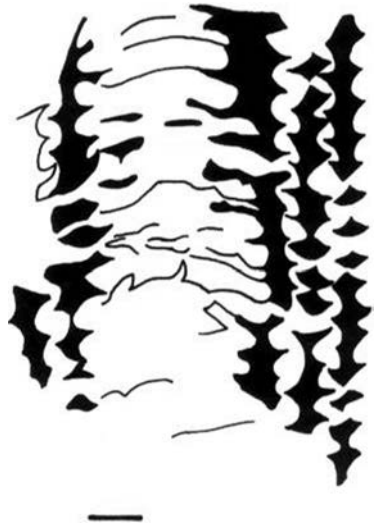
Diameter of corallum	29.2-23.0
Height of corallum	16.0
Diameter of central corallite	4.9
Diameter of smallest corallite	4.5
Density of septa	5-6 per 2 mm
Number of septa in individual corallites	34-36
Maximum distance between corallite centers	5.0

Description and remarks. The specimens recorded here are characterized by a massive corallum surrounded by a zone of septa, shallow and not very well marked calices, thick, subconfluent, irregularly perforated septo-costae with divergent trabeculae. Carinae arched, convex towards distal margin (Text-fig. 14). Synapticulae and endothecal dissepiments common; columella parietal.

The specimens closely correspond to the species founded by GREGORY (1900) and redescribed by BEAUVAIS (1970b: 1123). GREGORY (1900) differentiated *Kobya cancellata* from the type species *K. crassolamellosa* on the basis of its smaller number of septa, trochoid shape, and pointed base. However, these characters are highly variable and thus cannot be used for separation at the species level. The num-

ber of septa, as shown by BEAUVAIS (1970) and as seen in the specimens of the present collection, ranges from 20-40. The shape also varies from subpedunculate, conical to patelliform. The irregular topography of the upper surface of the corallum in *K. cancellata* is due to localized cessation of growth as can be seen in some specimens of the present collection.

BEAUVAIS (1978: 50, pl. 7, fig. 1) included tentatively *Thamnasteria mayeri* KOBY, var. *indica* GREGORY (1900: 136, pl. 21, fig. 13) in the synonymy of *Kobya crassolamellosa*. In *T. mayeri* var. *indica* the calices are deep, appearing as pits on the upper surface, and the septa are much more numerous (in five to eight cycles). In our opinion, the poorly preserved specimen (BMNH R5305) figured by BEAUVAIS (1978: pl. 7, fig. 1) as *K. crassolamellosa* belongs to *Kobya*, but not to *crassolamellosa*.



Text-fig. 14. *Kobya crassolamellosa* GREGORY 1900. Longitudinal section through five septa showing carenae and irregularly distributed pores. Notice that the two septa at the right are cut perpendicular, whereas the third and fourth septum towards the left are cut at an oblique angle to the septal surface. RUC1992I 53. Scale bar: 1 mm.

Kobya lenticulata GREGORY 1900

Plate 6, Fig. 7

1900 *Kobya lenticulata* sp. nov. - GREGORY: 172, pl. 22, figs. 3-4.

Material. 4 specimens (RUC1992I 62); 2 specimens (BMNH R51720, R5320) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

	RUC 1992I 62	BMNH R51720	BMNH R5320
Diameter of corallum	~50	30/27	31.4/28.2
Height of corallum	15	10	11.5
Diameter of central corallite	9.5	10	5.3
Distance between calice centres with respect to central calice	6.5 - 9	6.4	6.5
Distance between calice centres within rings	3.5-5	5.0	4.5
Number of septa in central corallite	40	67	45
Density of septa per 2 mm	5	6	7

Remarks. *Kobya lenticulata* differs from other species of the genus from Kachchh in being low and discoidal with a large central corallite, deep calices, more numerous septa, and a greater distance between corallite centres.

One specimen in the GREGORY Collection (BMNH R5320) identified by him as *K. lenticulata* has been re-identified as *Thamnoseris crickleyensis* (TOMES) by BEAUVAIS (1978: 53, pl. 3, fig. 3).

Kobya sp. A

Plate 11, Fig. 9

Material. 1 specimen (RUC1992I 347).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	84.0
Height of corallum	~45.0
Diameter of attachment area	35.0
Diameter of central corallite	9.0
Diameter of other corallites	7.0-8.0
Density of septa per 2 mm	5
Number of septa in central corallite	~51
Number of septa in other corallites	26-36
Maximum distance between corallite centers	13.0

Description. Corallum massive, thamnasterioid, hemispherical, circular in plan view with small attachment area in the centre, lower surface covered with thin zone of fine septa. Corallites concentrically arranged around slightly larger central corallite; calices subcircular, moderately deep; area between calices convex. Septo-costae confluent, composed of closely packed compound trabeculae, irregularly porous with granules along the sides. Synapticulae rare. Columella trabecular.

Remarks. The interior of the poorly preserved specimen is mostly recrystallized; details of the internal characters cannot therefore be observed. The morphological features seen on the external surface and locally down to a depth of 2 to 3 mm suggest the genus *Kobya*. The shape does not match that of any

other species of *Kobya*. Considering the poor state of preservation of the single specimen we refrain from designating a new species.

Family **Andemantastraeidae** ALLOITEAU 1952

Genus *Ampakabastraea* ALLOITEAU 1958

Type species. *Ampakabastraea exserta* (GREGORY 1900) (=*Ampakabastraea ampakabensis* ALLOITEAU 1958).

Ampakabastraea exserta (GREGORY 1900)

Plate 11, Figs. 4-6, Text-fig. 15

1900 *Isastraea exserta* sp. nov. - GREGORY: 128, pl. 17, figs.1, 3.
1958 *Ampakabastraea ampakabensis* sp. nov. - ALLOITEAU: 83, pl. 9, fig. 3, pl. 14, figs.4, 5.
1978 *Ampakabastraea ampakabensis* ALLOITEAU - BEAUVAIS: 51, pl. 2, fig 2.

Material. 116 specimens (RUC1992I 348-354).

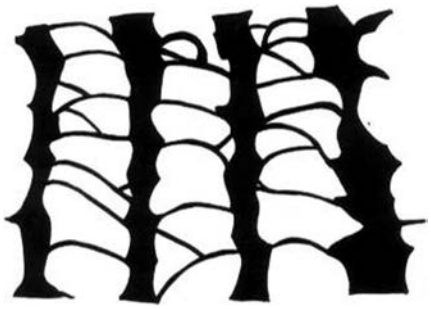
Horizon and locality. Chari Formation of Keera Dome.

Dimensions (in mm).

Diameter of colony	21.0 - 90.0
Height of colony	9.0-23.0
Diameter of calices	3.5-9.0
Distance between calice centres	2.5-8
Number of septa	24-33
Density of septa per 2 mm	4

Description. Corallum low, massive, sub-thamnasterioid, calices medium-sized, superficial, subcircular in outline, wall indistinct. Septa thick, distinct, lamellar, numbering 24-33. Distal margin of septa denticulated, lateral surface bearing fine, angular granules arranged either subvertically or subhorizontally and sometimes giving the appearance of a reticulate pattern. Septo-costae sometimes confluent with those of adjacent corallites resulting in a thamnasterioid pattern. Tabular and vascular endothecal dissepiments abundant (Text-fig. 15), columella absent. Holotheca thin and in rings, but mostly eroded.

Remarks. GREGORY (1900) assigned this species to *Isastrea* stressing the compact and imperforate nature of the septa, absence of a columella, rarity of synapticulae, and presence of vascular dissepiments. He mentioned, however, its thamnasterioid appearance. On the basis of GREGORY's description and figures ALLOITEAU (1958: 84), proposed that *Isastrea exserta* should be assigned to *Ampakabastraea* instead of *Isastrea*. BEAUVAIS (1978: 51), after studying the topotype (BMNH R5302) of the species, found it to be similar to *Ampakabastraea ampakabensis* ALLOITEAU from Madagascar but not having seen the holotype she put *I. exserta* with doubt in synonymy with that species. The thamnasterioid aspect of the colony, the very faint walls of the corallites, the irregular radial nature of the septa, septal ornamentation, well developed endothecal dissepiments and the holotheca clearly place *I. exserta* into *Ampakabastraea* ALLOITEAU.



Text-fig. 15. *Ampakabastraea exserta* (GREGORY 1900). Longitudinal section showing shape of dissepiments. RUC1992I 352. Scale bar: 1 mm.

The dimensions, number of septa, superficial calices, absence of a columella (which is also sometimes absent in the topotype studied by BEAUVAIS) and other characteristic features of our specimens match those of *I. exserta* (GREGORY 1900: 128). Consequently, *A. exserta* is a senior synonym of *A. ampakabensis* and has priority. Accordingly, *A. exserta* replaces *A. ampakabensis* as type species of *Ampakabastraea* ALLOITEAU 1958.

Genus *Vallimeandropsis* BEAUVAIS 1966

Type species. *Vallimeandropsis davidsoni* (MILNE-EDWARDS & HAIME 1851).

Vallimeandropsis davidsoni (MILNE-EDWARDS & HAIME 1851)

Plate 11, Fig. 1

1851 *Latomeandra davidsoni* sp. nov. - MILNE-EDWARDS & HAIME: 137, pl. 27, fig. 10.
1965 *Vallimeandropsis davidsoni* (MILNE-EDWARDS & HAIME) - BEAUVAIS: 873, pl. 36, fig. 1, pl. 37, fig. 3.
1970a *Vallimeandropsis davidsoni* (MILNE-EDWARDS & HAIME) - BEAUVAIS: 61.

Material. 1 fragment (RUC1992I 355).

Horizon and locality. Chari Formation of Keera Dome.

Dimensions (in mm).

Diameter of colony	?
Height of colony	> 9.0
Diameter of calices	5.3-8.5
Distance between calice centres within series	3.3-4.5
Distance between calice centres across series	4.5-5.5
Number of septa	24-33
Density of septa per 2 mm	4-6

Description. Corallum colonial, massive; submeandroid; corallites small, distinct, moderately deep, up to three in a series bounded by short, acute collines. Corallite wall incomplete, synapticulothecal or parathecal. Septa lamellar, generally thin, closely spaced, subconfluent. Distal border of septa denticulated, lateral surface almost smooth near the distal end but bearing fine granulae towards the proximal end. Endothecal elements composed of abundant tabular dissepiments in the central part of the corallites and of vascular dissepiments in the outer part. Synapticulae rare, columella either very small and rudimentary or indistinct.

Remarks. The fragmentary but well preserved specimen is identical to *Vallimeandropsis davidsoni* (MILNE-EDWARDS & HAIME) (BEAUVAIS 1965, 1970a) in all essential respects. It differs, however, in less abundant and more irregular granules and carinae on the lateral surfaces of the septa. MILNE-EDWARDS & HAIME (1851) and KOBY (1886: 248, pl. 73, fig. 2) assigned this species to *Latomeandra*, while ALLOITEAU (1958: 44, pl. 5, fig. 6, pl. 16, fig. 1, pl. 19, fig. 5, pl. 23, fig. 5) referred it to *Isastrea*. BEAUVAIS (1965) assigned *L. davidsoni* to a new genus, *Vallimeandropsis*. According to her, features such as dentition along the distal septal margin, granulated lateral septal surfaces, abundant endotheca, and less numerous synapticulae of the neotype of *L. davidsoni* are characteristic of the family Andemantastraeidae ALLOITEAU. The Madagascan *L. davidsoni* of ALLOITEAU (1958) differs from the neotype of *V. davidsoni* in having isolated and numerous calices, prominent vallies and a roof-shaped wall (BEAUVAIS 1965: 874). BEAUVAIS consequently assigned the Madagascan specimens to a new species, *Vallimeandropsis vongohensis*.

Latomeandra davidsoni of KOBY (1885) was referred to *Microphyllia* D'ORBIGNY by BEAUVAIS (1966: 1019).

ALLOITEAU (1952: 659) considered the family Andemantastraeidae to be derived from *Isastrea* in the Lower Jurassic. It should be noted that one of the genera of the family, *Andemantastraea* ALLOITEAU, is now regarded as a junior synonym of *Isastrea* (LATHUILIÈRE 1988). The lamellar septa, prominent vascular dissepiments along the periphery which become tabular towards the centre, the synapticulothecal or parathecal wall of the Kachchh specimen also point to *Isastrea*, but the submeandroid corallite formation and acute collines easily distinguish it from *Isastrea* and refer it to *Vallimeandropsis*.

Family **Thamnasteriidae** REUSS 1864

Genus *Thamnasteria* LESAUVAGE 1823

Type species. *Thamnasteria concinna* (GOLDFUSS 1826) (see RONIEWICZ 1982: 168).

Thamnasteria nicoleti KOBY 1887

Plate 6, Figs. 10, 13, Text-fig. 16

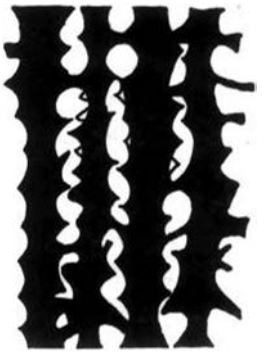
1887 *Thamnasteria nicoleti* sp. nov. - KOBY: 374, pl. 103, fig. 1.

1964 *Thamnasteria nicoleti* KOBY - BEAUVAIS: 214, pl. 25, fig. 6, pl. 27, fig. 3.

Material. 2 specimens (RUC19921 60-61).

Horizon and locality. Patcham Formation of Jumara Dome.

Description. Corallum crustose, thamnasterioid; corallites small (4-5 mm in diameter), without regular arrangement. Calices superficial, with prominent central calicular pit. 40-51 septa, thin (density 8-9 per 2 mm), with tiny granulae along the sides (Text-fig. 16). Septa short to long and confluent with those of adjoining corallites; columella trabecular and very small in cross-section. Epitheca present.



Text-fig. 16. *Thamnasteria nicoleti* KOBY 1887. Longitudinal section showing granulated septa. Granules not inked in occupy slightly different sectional planes. RUC19921 60. Scale bar: 1 mm.

Remarks. The very small calicular pit and the super-

ficial calices differentiate *T. nicoleti* KOBY from *Thamnasteria crateriformis* GREGORY (1900: 135, pl. 17, figs. 4, 5, 7). GREGORY (1900) described varieties of two further species of *Thamnasteria* from Kachchh, *T. mayeri* KOBY (1888: 354, pl. 97, fig. 1) and *T. valfinensis* KOBY (1888: 370, pl. 103, fig. 3). GREGORY's T. *mayeri* var. *indica* (1900: 136, pl. 21, fig. 13; now assigned to *Kobya* by BEAUVAIS 1978: 50) has large and deep calices and *T. valfinensis* var. *kachensis* (GREGORY 1900: 137) has smaller corallites and inconspicuous and less numerous septa.

Genus *Dimorphastrea* D'ORBIGNY 1850

Type species. *Dimorphastrea grandiflora* D'ORBIGNY 1850.

Remarks. There have been many changes regarding the placement of *Dimorphastrea* in a suitable family. GREGORY (1900: 138) described it as thamnasterioid and mentioned that it "includes corals in which the corallites are individually constructed as in *Thamnastraea*, but in which the corallites are arranged concentrically, usually around a larger central corallite". WELLS (1956: F398) assigned *Dimorphastrea* to the family Montlivaltiidae, and compared it with the genus *Dimorphosmilia* TOMES 1902. RONIEWICZ (1976: 95, 100) separated *Dimorphastrea* from the Thamnasteriidae and assigned it to the family Latomeandridae and, at the same time, emended the characters of the family. ERRENST (1991: 25) agreed with RONIEWICZ. BEAUVAIS initially (1972: 65) referred *Dimorphastrea* to the Synastracidae and later on (1978: 54) to the Thamnasteriidae adopting ALLOITEAU's (1952: 659) amended definition of the family.

The main diagnostic features which separate Latomeandridae from Thamnasteriidae are the subphaceloid colony and evenly distributed, numerous septal perforations. On the other hand, the genus *Dimorphastrea* D'ORBIGNY 1850 has confluent septa, lacks corallite walls (thamnasterioid) (KOBY 1886: 345; GREGORY 1900: 30, 138; WELLS 1956: F398; ERRENST 1991: 25), and the septa are lamellar or only little perforated (GREGORY 1900; see also WELLS 1956: F371). These two characters do not permit *Dimorphastrea* to be grouped with the family Latomeandridae. Secondly, endothecal dissepiments are distinctly less abundant than in members of the Montlivaltiidae. The specimen of *Dimorphastrea* described below has diagnostic features which support placement of the genus within the Thamnasteriidae REUSS 1864.

Dimorphastrea sigillum GREGORY 1900

Plate 10, Fig. 1

1900 *Dimorphastraea sigillum* sp.nov. - GREGORY: 139, pl. 18, figs. 1-3.
1978 *Dimorphastraea sigillum* GREGORY - BEAUVAIS: 54, pl. 3, fig. 4.

Material. 1 specimen (RUC19921 369).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	13.4-12.8
Height of corallum	6.8
Diameter of central calice	8.3
Number of septa in central calice	41
Number of septa in other calices	19
Distance between calice centers with respect to central calice	4.0
Distance between calice centers within series	3.0
Density of septa along the margin per 2 mm	5-6

Description and remarks. The single corallum is a small colony with a distinct central corallite, which is characterized by thick and conspicuous septa surrounded by a zone of thinner and more crowded septa. The septa are granulated along the lateral surface; endothecal dissepiments are common. These features correspond closely with the description and the figures of *D. sigillum* by GREGORY (1900) and BEAUVAIS (1978).

Dimorphastrea paeninsulae (GREGORY 1900)

Plate 10, Fig. 2

1900 *Stibastraea paeninsulae* sp. nov. - GREGORY: 148, pl. 18, figs. 14, 17-18.
1978 *Dimorphastraea paeninsulae* (GREGORY) - BEAUVAIS: 55, pl. 3, fig. 5.

Material. 2 specimens (RUC19921 370).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	17.8-14.4
Height of corallum	9.4
Diameter of corallites	4.2-5.6
Number of septa in central calice	28
Number of septa in other calices	16-20
Distance between calice centers with respect to central calice	3.2
Distance between calice centers within the series	3.0
Density of septa along the margin per 2 mm	7

Description and remarks. Corallum small, thamnasterioid, upper surface flat, plan view irregular, base pointed. The corallites are arranged concen-

trically around a central corallite showing circumoral budding. Septa composed of trabeculae, conspicuous, little sinuous and porous. Synapticulae present. Columella trabecular.

The two specimens from Jumara exhibit the characteristic features of the topotype (BMNH R5308) of the species in the GREGORY Collection (BEAUVAIS 1978) and of the material figured by GREGORY (1900). The thamnasterioid colony and the concentric arrangments of corallites around the central corallite suggest its assignment to the genus *Dimorphastrea* and support the observation made by BEAUVAIS (1978).

Dimorphastrea sp. A

Plate 9, Fig. 3

Material. 1 specimen (RUC1992I 92).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	37.5/26.5
Height of corallum	20.0
Diameter of central corallite	7.0
Diameter of smallest corallite	3.5
Density of septa per 2 mm	3-4
Number of septa in central corallite	35
Number of septa in other corallites	19-30
Maximum distance between corallite centers	8.5

Description. Corallum massive, conical, elliptical in plan view; upper surface flat in the centre but slightly convex towards the periphery; lower surface tapering to small peduncle and covered with fine, crowded costae. Corallites arranged concentrically around a central, larger corallite, the smallest corallite situated along the margin. Calices slightly depressed towards centers and circular to subelliptical in outline. Septa confluent, with many spines and few perforations. The longest septa stop short of the centre, where they form, together with rare synapticulae, a ring around the trabecular columella.

Remarks. The specimen does not match any of the species of *Dimorphastrea*. *D. concentrica* BECKER (in BECKER & MILASCHEWITSCH 1875: 177, pl. 41, fig. 4) is very close, but differs by a greater number of septa (60-65) in the central corallite. *Dimorphastrea sigillum*, described by GREGORY (1900: 139, pl. 18, figs. 1-3) from Kachchh differs in its sharply defined corallites and by thick septa which are joined to the columella. *Stibastraea paeninsulae* GREGORY (1900: 148, pl. 18, figs. 14, 17-18) assigned to *Dimorphastrea* by BEAUVAIS (1978: 55, pl. 3, fig. 5) is more densely septate and more closely packed. Among comparable species from Europe, *D. conica* KOBY (1886: 349, pl. 95, fig. 3; see also ERRENST 1991: 25, pl. 19, fig. 2) has more septa (90-100) and no columella. The general dimensions and the pattern of the septo-costae of *Dimorphastrea* sp. A is similar to *Thamnastrea gillieroni* KOBY (1887: 360, pl. 100, fig. 3), but the latter does not show the concentric arrangement of corallites. For want of more material only provisional assignment has been made.

Family **Agariciidae** GRAY 1847

Genus *Craterastraea* BEAUVAIS 1978

Type species. *Thamnastraea crateriformis* GREGORY 1900.

Craterastraea crateriformis (GREGORY 1900)

Plate 6, Fig. 12, Plate 7, Figs. 10, 12, 15, Text-fig. 17

1900 *Thamnastraea crateriformis* sp. nov. - GREGORY: 135, pl. 17, figs. 4-5, 7.
1978 *Craterastraea crateriformis* (GREGORY) - BEAUVAIS: 56, pl. 4, fig. 1.

Material. 20 specimens (RUC1992I 56-59).

Horizon and locality. Patcham Formation of Jumara Dome.

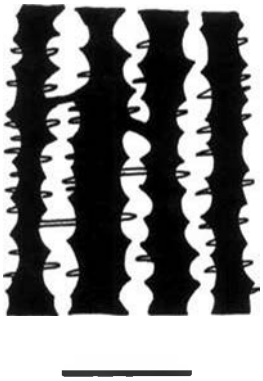
Dimensions (in mm).

Diameter of corallum	16.9/10.0 - 43.0/26.8
Height of corallum	4.8-15.6
Diameter of calices	2.0-5.0
Distance between corallite centers	3.0-5.0
Number of septa	22-45
Density of septa per 2 mm	10

Description. Colony massive, plocoid, fungiform, upper surface plane or convex; corallites closely packed, calice shallow to moderately deep and circular, subcircular or subquadrangular in outline. Septa irregular in length, the longest sometimes arranged in pairs and reaching the columella; remaining septa short and incomplete. Distal margin of septa denticulated, laterally granulated (Text-fig. 17). Septo-costae of adjacent corallites confluent. Columella trabecular and distinct. Synapticulae abundant along the periphery of the calices. Dissepiments common. Epitheca distinct along lower surface, with concentric folds or wrinkles.

Remarks. *Craterastraea crateriformis* derives its name from its circular, deep crater-shaped calices. The specimens from Jumara show all diagnostic features of the species except crater-shaped calices. The specimen (BMNH R5304) described by BEAUVAIS (1978) also does not show this character.

GREGORY (1900) referred this species to *Thamnasteria* LESAUVAGE. BEAUVAIS (1978) established a new genus to receive this species, realizing that the features of GREGORY's specimens do not match those of *Thamnasteria*. The allied genus *Astraeofungia* ALLOITEAU differs by its abundance of synapticulae.



Text-fig. 17. *Craterastraea crateriformis* (GREGORY 1900). Longitudinal section of granulated septa. Granulae not inked in occur at slightly different sectional planes. RUC19921 57. Scale bar: 1 mm.

The Jumara specimens are very close to *T. delemontana* KOBY (1887: 357, pl. 103, fig. 7) from the Swiss Jurassic, especially with respect to the shape of the calices and septal pattern on the upper surface. Other European forms with which GREGORY (1900) has compared *crateriformis* and which are also similar to our specimens, are *Thamnasteria scita* MILNE-EDWARDS & HAIME (1851: 119, pl. 23, fig. 4) and *T. terquemi* MILNE-EDWARDS & HAIME (1851: 140, pl. 30, fig. 2). *T. scita* differs in having small calices (less than 2 mm in diameter), *T. terquemi* in having fewer septa (only 12-16).

Family **Funginellidae** ALLOITEAU 1952

Genus *Gregorycoenia* BEAUVAIS 1978

Type species. *Stephanocoenia magna* GREGORY 1900.

Remarks. GREGORY (1900: 65) assigned *G. magna* to the genus *Stephanocoenia* MILNE-EDWARDS & HAIME, referred by WELLS (1956: F371) to the family Astrocoeniidae KOBY. BEAUVAIS (1978: 57) observed that the diagnostic features of *S. magna* do not match those of *Stephanocoenia* but correspond to those of the Funginellidae ALLOITEAU (1952: 662). Consequently, she created the genus *Gregorycoenia* to accommodate *S. magna*.

The intertentacular mode of colony formation in *G. magna* resembles that of the genus *Stephanocoenia* MILNE-EDWARDS & HAIME and the family Astrocoeniidae KOBY which, according to MILNE-EDWARDS & HAIME (1850: XXX) and WELLS (1956: F370) show extratentacular gemmation. However, *Stephanocoenia* is characterized by a styliform columella, while in *G. magna* the columella is lamellar. The assignment of *Gregorycoenia* BEAUVAIS to the family Funginellidae is debatable, because *G. magna* does not exhibit a flabello-meandroid colony formation (see BEAUVAIS 1978).

Gregorycoenia magna (GREGORY 1900)

Plate 8, Figs. 1-5

1900 *Stephanocoenia magna* sp. nov. - GREGORY: 65, pl. 13, figs. 9-12, pl. 14, figs. 1-13.
1978 *Gregorycoenia magna* (GREGORY) - BEAUVAIS: 57, pl. 4, fig. 2.

Material. 17 specimens (RUC19921 63-67); 6 specimens (BMNH R5279) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of colony	16.4/15.0 - 28.9/27.0
Height of colony	10.5 - 16.4
Diameter of calices	5.0 - 13.5
Distance between the calices centres	5.5 - 13.0
Number of septa	22 - 49
Number of pali	8 - 14

Description. Corallum massive, cerioid, subhemispherical, with very small to moderately large, circular to subcircular attachment area. Corallites show intertentacular budding. Calices shallow, hexagonal, pentagonal or subcircular in outline bounded by septotheca and paratheca. The wall is sometimes thickened by coenosteum. Septa distinct with angular, subrounded to papillose granules along the lateral surface. Pali conspicuous, but incomplete. Septo-costae at times confluent. Endothecal dissepiments tabular, common, mostly confined to lower part. Columella suboval to lamellar in cross-section. Holotheca thin and in concentric rings.

Remarks. See genus.

Family **Microsolenidae** KOBY 1890

Genus *Trochoplegma* GREGORY 1900

Type species. *Trochoplegma tenuilamellosa* GREGORY 1900.

Remarks. The status of this genus has changed from time to time. GREGORY (1900: 179) erected *Trochoplegma* to receive his new species *tenuilamellosa* from

Kachchh, as well as some European forms referred to *Leptophyllia* or *Cyclolites*. VAUGHAN & WELLS (1943: 148) merged *Trochoplegma* with *Trocharea* ETALLON 1864. Similarly, ALLOITEAU (1952: 669) and WELLS (1956: F391) regarded *Trochoplegma* as a junior synonym of *Trocharea*. FLÜGEL (1966) adapted this view and transferred the type species *tenuilamellosa* to *Trocharea*. BEAUVAIS (1964: 228; see also 1978), having studied the holotype of the type species of *Trocharea*, differentiated *Trocharea* with synapticulotheca and without epitheca, from *Trochoplegma* with epitheca and without synapticulotheca, and retained *tenuilamellosa* within *Trochoplegma*. Later on, BEAUVAIS (1972: 69) described additional species of *Trochoplegma*, but this time she was doubtful about the presence of wall and synapticulae in *Trocharea*. However, she distinguished *Trochoplegma*, characterized by a fascicular columella, the presence of synapticulae, and absence of endotheca, from *Trocharea* in which the columella is indistinct or rudimentary parietal, and endothecal elements are not abundant. However, according to GREGORY (1900) *Trochoplegma* does not have a columella and according to BEAUVAIS (1972: 70) *Trochoplegma moneta*? (KOBY) possesses a small rudimentary parietal columella.

Thus, the morphological features of *Trochoplegma* are very similar to those of *Trocharea*, but colonial forms of the former are easily distinguished by the mode of colony formation. It is good to recall here the diagnostic part from the original description of *Trochoplegma* GREGORY which states "Microsolenidae, in which corallum is simple or composed of few corallites" (GREGORY 1900: 179; also pl. 23, fig. 8a). *Trocharea* ETALLON is known to represent microsolenids which are solitary. About twenty specimens in the present collection match *Trochoplegma* GREGORY and show intratentacular circumoral gemmation. Therefore, in concordance with BEAUVAIS (1964) *Trochoplegma* GREGORY has been retained as a separate genus.

The only comparable genus of the family is *Dimorpharaea* FROMENTEL 1861, which is characterized by intratentacular circumoral gemmation, but has a much higher number of corallites, a greater density of trabeculae and thin and densely packed septa.

Trochoplegma tenuilamellosa GREGORY 1900

Plate 8, Figs. 11-16

1900 *Trochoplegma tenuilamellosa* sp. nov. - GREGORY: 180, pl. 23, figs. 3-10, pl. IIA, fig. 8.
1966 *Trocharea tenuilamellosa* (GREGORY) - FLÜGEL: 67, pl. 17, figs. 3-4.
1978 *Trochoplegma tenuilamellosa* GREGORY - BEAUVAIS: 61.

Material. 60 specimens (RUC1992I 72-77); 2 specimens (BMNH R5324a, b) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	7.4/7.2 - 34.0
Height of corallum	4.5 - 16.0
Number of septa	70 - 376
Number of septa per 2 mm	8 - 10
Number of trabeculae per 2 mm	9 - 10
Percentage diameter of calicular fossa with respect to maximum diameter of corallum	8.8 - 15.2

Description and remarks. The Jumara specimens agree well with *Trochoplegma tenuilamellosa*. Most of them are solitary, some show very few cases of intratentacular circumoral gemmation. They are characterized by a discoid to pedunculate shape, by crowded, more or less flexuous, regularly perforated septa, and a moniliform upper margin. The trabeculae are pennular with continuous menianae, sometimes covered by stereoplasm. Synapticulae common, calicular fossa slightly elongated; a columella and endothecal dissepiments are absent. The epitheca is very thin, fragile and is easily eroded. As a rule, only small patches remain.

Trochoplegma aff. *fungiformis* GREGORY 1900

Plate 7, Fig. 1

Material. 1 specimen (RUC1992I 99).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).	RUC1992I 99
Diameter of corallum	14.7/14.0
Height of corallum	12.0
Number of septa	186
Number of septa per 2 mm	10
Number of trabeculae per 2 mm	10

Description. Corallum solitary, biconvex, with distinct growth constriction along the equatorial region. Calice convex, circular in plan view; central fossa moderately deep. Septa thin, crowded, strongly perforated, consisting of closely spaced trabeculae forming a moderately open fan-system. Pennulae well developed, occurring at regular vertical intervals; menianae are denticulate forming continuous series. Synapticulae common. Epitheca thin, almost eroded.

Remarks. *Anabacia fungiformis* GREGORY (1900: 176, pl. 21, figs. 9-12) is the closest comparable species,

differing by having a peduncle which often expands towards its base. FLÜGEL (1966: 63) discussed in detail the nomenclatural history of the genus *Anabacia* (see also BEAUVAIS 1967: 40) and merged it (including both species from Kachchh, *A. acaulis* and *A. fungiformis*) with *Chomatoseris* THOMAS 1935. BEAUVAIS (1972: 70, pl. D, fig. 9) referred *fungiformis* to *Trochoplegma* GREGORY 1900. However, *Chomatoseris* is characterized by a concentric growth pattern and lack of epitheca (GILL 1967, GILL & COATES 1977). The septal structures, synapticulae, and calicular fossa in our specimen suggest that it belongs to *Trochoplegma*.

Trochoplegma fungiformis (GREGORY) described by BEAUVAIS (1972) differs in having fewer septa (72) with a density of 6-8 per 2 mm.

Genus *Trocharea* ETALLON 1864

Type species. *Trocharea actiniformis* ETALLON (in THURMANN & ETALLON 1864).

Trocharea patelliformis GREGORY 1900

Plate 7, Figs. 2-4, Plate 8, Fig. 9

1900 *Trocharea patelliformis* sp. nov. - GREGORY: 178, pl. 2A, figs. 15-20.

Material. 39 specimens (RUC19921 82-85); 7 specimens (BMNH R5323) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	11.0/10.5 - 14.0/13.0
Height of corallum	5.4 - 7.7
Number of septa	104 - 120
Number of septa per 2 mm	7 - 8
Number of trabeculae per 2 mm	7 - 9
Percentage diameter of calicular fossa with respect to maximum diameter of the corallum	12 - 27

Description and remarks. *Trocharea patelliformis* is a solitary, low microsolenid, easily distinguished from the solitary *Trochoplegma tenuilamellosa* GREGORY by its low density of septa and trabeculae, shallow to deep circular calicular fossa and very small, indistinct columella. Ecophenotypic variations include patellate forms with a narrow base and those with a sub-pedunculate base. One small specimen (RUC19921 82) with 74 septa has a septal density of 7 per 2 mm, but a trabecular density of 10 per 2 mm and a flat calicular centre. A second specimen (RUC19921 40) has 73 septa, a septal density of 5-6 and a trabecular density of only 7.

Genus *'Anabacia'* D'ORBIGNY 1849

Type species. *Fungia orbulites* LAMOUROUX 1821.

'Anabacia' acaulis GREGORY 1900

Plate 7, Figs. 5-6, Text-fig. 18

1900 *Anabacia acaulis* sp. nov. - GREGORY: 175, pl. 21, figs. 5-8.

Material. 2 specimens (RUC19921 100, 323).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).	RUC19921 100	RUC19921 323
Diameter of corallum	11.3	15.7
Height of corallum	5.4	5.0
Number of septa	75	76
Number of septa per 2 mm	5	4 - 5
Number of trabeculae per 2 mm	5 - 6	5 - 6

Description. Corallum solitary, cupolate. Calice convex with depressed calicular centre, circular in plan view. Septa thin, laterally granulated and perforated (Text-fig. 18); trabeculae forming a moderately open fan system. Synapticulae between septa common. Epitheca thin, almost eroded.

Remarks. GREGORY (1900) assigned his new species *acaulis* to the genus *Anabacia* D' ORBIGNY 1849. The genus is characterized by a simple and lenticular corallum, extremely numerous, thin septa projecting on the lower side of the corallum without forming a distinct wall and by a shallow fossula (MILNE-EDWARDS & HAIME 1850: xlvii). According to GREGORY (1900: 175) a columella is lacking and an attachment area is present only in some pedunculate specimens.

Text-fig. 18. *'Anabacia' acaulis* GREGORY 1900. Longitudinal section through half of calice cutting septa (black) at right to oblique angles. The granulated septa have pores (p). Stippled: sedimentary matrix; white: recrystallized areas. RUC19921 100. Scale bar: 1 mm.

WELLS (1956: F437) was unable to incorporate *Anabacia* in his classification scheme and listed the genus with other unrecognizable genera. As mentioned above, FLÜGEL (1966: 63; see also THOMAS 1935: 429; BEAUVAIS 1967: 40) discussed in detail the nomenclatural history of the genus *Anabacia* and merged it with *Chomatoseris*. According to FLÜGEL (1966: 66) the dimensions of his new species *Chomatoseris iranensis* FLÜGEL (1966: 63, pl. 16, fig. 7, pl. 17, figs. 1-2, 6) are similar to those of *A. acaulis* GREGORY, but the latter differs by possessing a basal epitheca. However, *C. iranensis* exhibits more septa (170-340) and an elongated calicular fossa.

LATHUILIÈRE (1989), in contrast, listed *acaulis* under *Anabacia*. LÖSER (1992: 30) also listed *Anabacia* as a valid genus of the family Microsolenidae. The morphological features of *acaulis* such as the cupolate shape of the corallum, common synapticulae, as well as the free-resting mode of life of the animal are very similar to those of members of the genus *Chomatoseris* (WELLS 1956: F390; GILL & COATES 1977). However, the absence of a concentric growth pattern and the presence of an epitheca in topotypes of *A. acaulis* do not allow us to group our specimens with *Chomatoseris*. Until the holotype of *acaulis* (preserved in the Museum of the Geological Survey of India in Calcutta) and additional material has been studied, we provisionally refer the species to '*Anabacia*'.

GREGORY (1900) compared *A. acaulis* with *Anabacia orbulites* (LAMOUROUX) and *A. buchardi* MILNE-EDWARDS & HAIME, but both these European forms have been referred to *Chomatoseris* (BEAUVAIS 1972: 67-68; LATHUILIÈRE 1989).

Genus *Microsolena* LAMOUROUX 1821

Type species. *Microsolena porosa* LAMOUROUX 1821.

Remarks. *Microsolena* and *Dimorpharaea* are two closely related genera. WELLS (1956: F392) distinguished *Dimorpharaea* from *Microsolena* solely by circumoral colony formation. However, specimens of *Microsolena* occasionally also show a concentric arrangement of corallites similar to that of *Dimorpharaea* which makes it very difficult to tell the genera apart. Our material of *Microsolena* never exhibited a large, central corallite. The apparent concentric pattern of corallites along the periphery is a result of marginal budding and not of circumoral budding. In *Dimorpharaea*, in contrast, the corallites are concentrically arranged around the large, central parent corallite.

Microsolena subturbinata GREGORY 1900

Plate 9, Figs. 9-10

1900 *Microsolena subturbinata* sp. nov. - GREGORY: 183, pl. 25, figs. 5-9, pl. 2A, fig. 9.
1900 *Microsolena variolata* sp. nov. - GREGORY: 184, pl. 25, figs. 10-13, pl. 26, figs. 2-3.
1966 *Microsolena variolata* GREGORY - FLÜGEL: 69, pl. 18, figs. 3-4.
1978 *Microsolena variolata* GREGORY - BEAUVAIS: 62, pl. 5, fig. 4.

Material. 23 specimens (RUC1992I 14, 16); 12 specimens (BMNH R5325-R5326) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	18.5/17.0 - 26.4/24.6
Height of corallum	10.0 - 11.8
Diameter of corallites	3.5 - 5.0
Distance between calice centres	3.0 - 4.4
Number of septa	32 - 49
Density of septa per 2 mm	8 - 9
Density of trabeculae per 2 mm	9 - 10

Dimensions of specimen (RUC1992I 139) which is similar in shape to *M. variolata* GREGORY 1900:

Diameter of corallum	13.4/13.9
Height of corallum	11.4
Diameter of central corallite	3.4
Diameter of other corallites	2.5
Distance between calice centres	2.3 - 3.0
Number of septa	33 - 44
Density of septa per 2 mm	8 - 9
Density of trabeculae per 2 mm	9

Description. Corallum thamnasterioid, massive, biconvex, subturbinate, subpatellate or conical with flat base, circular or subcircular in plan view. Calices small, distinct with circular calicular fossa. Septa fenestrate, composed of pennular trabeculae. Synapticulae common. Epitheca very thin and fragile.

Remarks. GREGORY (1900: 185) differentiated *Microsolena subturbinata* from *M. variolata* on the basis of shape, which is not turbinate in latter. BEAUVAIS (1978) observed that *M. subturbinata* has larger and more distant calices. The coral layers at Jumara contain both species. They correspond to each other in all essential respects except for their shape, which, as mentioned elsewhere, is not necessarily a diagnostic feature. *M. variolata* has therefore been merged with *M. subturbinata*, the latter having page priority.

According to GREGORY (1900: 184) the concentric arrangement of corallites is one of the diagnostic features of *M. subturbinata*. However, both the 11 specimens (BMNH R5325) in the GREGORY Collection at the Natural History Museum and the specimens figured by GREGORY (1900: pl. 25, figs.5-9) show irregu-

larly arranged corallites of more or less uniform size.

Microsolena ornata KOBY (1887: 399, pl. 107, figs. 1-2), *M. regularis* MILNE-EDWARDS & HAIME (1851: 122, pl. 25, fig. 6) and *M. piriformis* BEAUVAIS (1972: 72, pl. D, fig. 8) are comparable European taxa, but the septa and trabeculae in *M. ornata* are less dense, while in *M. regularis* and *M. piriformis* calices are quite superficial and have a shallower fossa.

GREGORY distinguished *Microsolena subturbinata* from the genotype *Microsolena porosa* LAMOUROUX (1821: 65, pl. 74, figs. 24-26) on grounds of twice as large corallites (7 to 8 mm in diameter) and a more conspicuous calicular fossa. In these respects the present specimens occupy a position intermediate between *M. porosa* and *M. subturbinata*. Thus, *M. subturbinata* may, in fact, be a junior synonym of *M. porosa*. However, until the type material of *M. porosa* has been investigated the specific status of *M. subturbinata* is retained.

Specimens from eastern Iran assigned to *Microsolena subturbinata* GREGORY by FLÜGEL (1966: 68, pl. 18, figs. 1-2) appear to be different, because of a flat calicular fossa, a lower density of septa, and the absence of synapticulae.

Microsolena amorpha (GREGORY 1900)

Plate 9, Figs. 11-13

1900 *Thamnaraea amorpha* sp. nov. - GREGORY: 194, pl. 26, figs. 1, 4-7, pl. 27, fig. 3.
1978 *Microsolena ornata* ? KOBY - BEAUVAIS: 62, pl. 5, fig. 5.

Material. 125 specimens (RUC19921 93-95); 1 specimen (BMNH R5334) in the GREGORY Collection.

Horizon and locality. Patcham Formation and Chari Formation of Jumara Dome.

Description. Corallum massive, subcircular to subelliptical in plan view, biconvex, conical. Some specimens with conspicuous hummock on the upper surface. Calices superficial; septa (numbering 9-11) fenestrate, generally inconspicuous or structureless on the upper surface, composed of widely separated pennular trabeculae. Synapticulae common. Longitudinal sections give the appearance of mesh-like pattern. Septo-costae between adjoining corallites with irregular pattern. Epitheca thin and fragile, rarely preserved.

Remarks. The specimens show the characteristic features of *Thamnaraea amorpha*. In *Microsolena ornata* ? KOBY of BEAUVAIS (1978) the septa are more similar to those of *Thamnaraea amorpha* as figured by GREGORY (1900) on pl. 27, fig. 3 rather than to *Microsolena ornata* KOBY (1887: 399, pl. 107, figs. 1-2). In the latter the septa are more regular, subparallel and join with adjoining corallite centres which are arranged in short, parallel series.

The genus *Thamnaraea* ETALLON 1864 has been merged with *Dendraraea* D'ORBIGNY 1849 of the family Actinacididae VAUGHAN & WELLS (WELLS 1956: F393). BEAUVAIS (1978), however, found the dimensions of *T. amorpha* resembling those of the holotype of *Microsolena ornata* KOBY (1887) and therefore placed the specimens from Kachchh into *Microsolena* rather than *Dendraraea*.

Genus *Dimorpharaea* DE FROMENTEL 1861

Type species. *Microsolena koechlini* MILNE-EDWARDS & HAIME 1860.

Dimorpharaea stellans GREGORY 1900

Plate 9, Fig. 1-2, 4-7, Text-figs. 19-20

1900 *Dimorpharaea stellans* sp. nov. - GREGORY: 189, pl. 24, figs. 2-5.
1900 *Dimorpharaea distincta* sp. nov. - GREGORY: 190, pl. 24, figs. 6-8.
1900 *Dimorpharaea continua* sp. nov. - GREGORY: 191, pl. 24, fig. 9.
1978 *Dimorpharaea stellans* GREGORY - BEAUVAIS: 63, pl. 5, fig. 6, pl. 7, figs. 2-3.

Material. 100 specimens (RUC19921 86-91, 411); 25 specimens (BMNH R5329-R5332, R51699-R51719) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

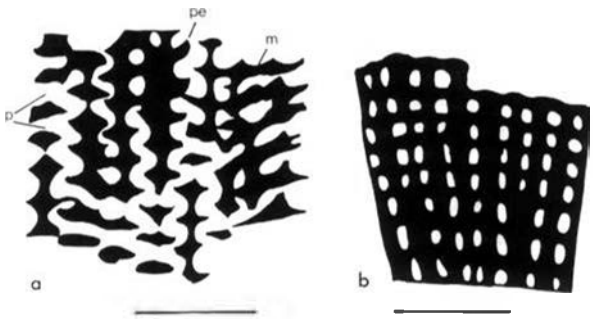
Diameter of colony	20.9/19.0 - 37.4/37.0
Height of colony	7.8 - 15.0
Diameter of central corallite	5.0 - 6.0
Distance between centres of central corallite and corallites of inner ring	4.0 - 5.0
Distance between centres of corallites of same ring	2.0 - 4.0
Number of septa in the central corallite	27 - 53
Number of septa in other corallites	26 - 38
Density of septa per 2 mm	8 - 9
Density of trabeculae per 2 mm	8 - 9

Description. Corallum about 20.0/19.0 to 37.4/37.0 mm in diameter and 7.8 to 15.0mm in height, massive, thamnasterioid, biconvex to discoidal, with pedunculate to subpedunculate base. The notched edge and lower surface bears one to fifteen long, narrow, radial grooves of varying depth. Corallites grouped around central corallite. Calices shallow to superficial with distinct shallow to deep central columellar pits. Septa (numbering 27 to 53) thin,

fenestrate (Text-fig. 20b), composed of pennular trabeculae. Menianae continuous and evenly distributed (Text-figs. 19, 20a). Distal margin of septa finely beaded, those of alternating septa often united by stereoplasm. Synapticulae common. Epitheca with growth rugae on the lower surface.

Text-fig. 19. *Dimorpharaea stellans* GREGORY 1900. Longitudinal section of septa with evenly distributed pennulae. RUC1992I 91. Scale bar: 1 mm.

Remarks. BEAUVAIS (1978) regarded the morphological differences between *D. stellans, D. distincta* and *D. continua* as intraspecific variations of a single species, *D. stellans*. As our material exhibits gradational variation of the features regarded by GREGORY as diagnostic at the species level, we agree with BEAUVAIS' conclusion.



Text-fig. 20. *Dimorpharaea stellans* GREGORY 1900. a: Longitudinal section cutting septal planes at right to oblique angles. The septa exhibit pores (p), pennulae (pe), and menianae (m). RUC1992I 411. b: Longitudinal section through septal plane showing distribution of pores. RUC1992I 576. Scale bar: 1 mm.

Dimorpharaea orbica GREGORY (1900: 191, pl. 25, figs. 3-4) differs from *D. stellans* by its more numerous septa and by fewer but large corallites.

Specimen RUC1992I 86 closely resembles *Genabacia kachensis* GREGORY (1900: 177, pl. 2A, fig. 10) in having only two rings of small corallites, the outer one being incomplete. *G. kachensis* differs, however, by possessing larger calicular fossae in the central corallites and by having numerous septa which project on the lower surface.

Dimorpharaea cf. *orbica* GREGORY 1900

Plate 9, Fig. 8

cf. 1900 *Dimorpharaea orbica* sp. nov. - GREGORY: 191, pl. 25, figs. 3-4.
cf. 1978 *Dimorpharaea orbica* GREGORY - BEAUVAIS: 63, pl. 5, fig. 7.

Material. 3 specimens (RUC1992I 375).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of colony	12.0/11.5 - 30.0/~25.0
Height of colony	~6.0 - 15.0
Diameter of central corallite	4.5 - 8.8
Distance between centres of central corallite and corallites of inner ring	3.0 - 9.0
Distance between centres of corallites of same ring	1.3 - 6.3
Number of septa in the central corallite	50 - 67
Number of septa in other corallites	14 - 46
Density of septa per 2 mm	7 - 12
Density of trabeculae per 2 mm	8 - 14

Description and remarks. Corallum low, thamnasterioid, subpedunculate, subcircular in plan view; margin slightly notched because of broad, moderately deep and short radial sulci developed along the periphery of the lower surface; upper surface slightly convex. Corallites few, distinct, concentrically arranged around larger central corallite. Calicular fossa distinct. Septa composed of trabeculae, with moniliform distal margin; synapticulae common. Lower surface partly covered with very thin, fragile epitheca. As mentioned above, *Dimorpharaea orbica* GREGORY (1900: 191, pl. 25, figs. 3-4; see also BEAUVAIS 1978: 63, pl. 5, fig. 7) differs from *D. stellans* by having fewer and larger corallites, dense septa and trabeculae and a deep, elongated calicular fossula. In the present specimens the size and number of corallites correspond to that of *D. orbica*, while the number of septa in the central corallite is closer to that of *D. stellans*. The septal density and the distances between calice centres in both species are the same. Thus the few specimens available for study are more or less intergradational between *D. orbica* and *D. stellans* with a closer relationship to *D. orbica*. Whether both species should be merged, with *D. stellans* having page priority, cannot be decided on the basis of our limited and

poorly preserved material. For the moment, the specimens are tentatively assigned to *D. orbica*.

Family **Procyclolitidae** VAUGHAN 1943

Genus *Tricycloseris* TOMES 1878

Type species. *Tricycloseris anningi* TOMES 1878.

Tricycloseris triangularis GREGORY 1900

Plate 7, Figs. 7-9, 11, 13-14

1900 *Tricycloseris triangularis* sp. nov.- GREGORY: 186, pl. 23, figs. 11-12.

Material. 27 specimens (RUC19921 78-81, 372-374, 408); 8 specimens (BMNH R5327-R5328) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	13.8/16.5 - 23.0/23.90
Height of corallum	7.0 - 11.5
Number of septa	17 - 184 (usually 17-50)
Distance between corallite centers	4.7 - 7.0
Number of septa per 2 mm	5 - 7
Number of trabeculae per 2 mm	5 - 7

Description. Corallum compound, patelliform, circular to subtriangular in outline. Upper surface convex, base either pedunculate or convex; lower surface marked by few radial grooves. Corallites few (2-7), small, formed by intratentacular circumoral gemmation along the periphery of the large central corallite. Parent corallite with distinct, circular, small to large fossa. Septa numerous, perforated, occasionally with beaded distal margins; septa confluent with those of daughter corallites. Trabeculae pennular, projecting slightly outward. Synapticulae common; columella small, trabecular. Epitheca thin, mostly eroded.

Remarks. The characters of the specimens agree well with *T. triangularis* GREGORY, one of those species showing highly variable morphological features. In the topotypes the size of the calicular fossa varies from distinct and large to indistinct and small. The number of septa depends upon, how early during growth additional corallites develop. Three specimens (RUC19921 79, 81, and 408) of moderate size exhibit either no daughter corallites or just rudimentary ones. The number of septa in these three examples is unusually high (126-184).

Another specimen (RUC19921 374) bears 17 calices arranged concentrically in two rings with a range of septa from 18 to 33.

A few specimens in our collection and also in the GREGORY collection of the Natural History Museum, London, exhibit numerous septa with beaded distal margins. They show affinity with *Trochoplegma tenuilamellosa* GREGORY (1900: 180, pl. 23, figs. 3-10, pl. IIA, fig. 8) and *Trocharea patelliformis* GREGORY (1900: 178, pl. 2A, figs. 15-20) but differ from the former by coarser trabeculae and a lower septal density and from the latter by exhibiting intratentacular circumoral gemmation.

The type species *T. anningi* TOMES (1878: 90, pl. 9, fig. 1; THOMAS 1935: 425) differs only by the absence of a columella. *Tricycloseris* sp. (MONTANARO et al. 1979: 143, pl. 3, figs. 3a, b, 4) from the Upper Triassic of North America is comparable to *T. triangularis* but for its low density of septa.

Family **Dermosmiliidae** KOBY 1889

Genus *Protethmos* GREGORY 1900

Type species. *Protethmos oldhami* GREGORY 1900.

Remarks. *Protethmos* and *Metethmos* are two closely allied genera, distinguished by GREGORY (1900: 165) mainly on the basis of a well developed papillary columella in the latter, compared to a parietal, spongy columella in the former. VAUGHAN & WELLS (1943: 118) and also WELLS (1956: F379) considered both genera as synonyms of *Epistreptophyllum* MILASCHEWITSCH 1875. In this genus the septa are ornamented with tiny spines in the upper part, the deep part of the interseptal chambers bear dissepiments and numerous synapticulae, and the columella is spongy. FLÜGEL (1966: 58-59) retained only one species, *Protethmos oldhami*, with *Epistreptophyllum*, and re-established *Metethmos* differentiating it from *Epistreptophyllum* again on the basis of the columella. According to him, *Protethmos* has a spongy columella, whereas in *Metethmos* the columella is in most cases parietal. This statement differs from what GREGORY (1900) has observed. BEAUVAIS (1972: 56; 1978: 59) regarded *Protethmos* and *Metethmos* as closely related genera, differing from *Epistreptophyllum* in the ornamentation along the distal and lateral parts of the radial elements. The lower endothecal parts of the corallum of the present specimens show massive deposition of skeletal material and no trace of dissepiments or synapticulae; in addition, they have pores and granules along the upper and inner free parts of the septa and a papillary columella. These features agree well with those of the *Protethmos-Metethmos* group. As mentioned above, in this particular case the type of columella is not a

diagnostic feature for generic identification.

Protethmos blanfordi (GREGORY 1900)

Plate 8, Figs. 6-8, 10

1900 *Metethmos blanfordi* sp. nov. - GREGORY: 165, pl. 18, figs. 4-6, 11.
1900 *Metethmos griesbachi* sp. nov. - GREGORY: 166, pl. 18, fig. 9.
1966 *Metethmos griesbachi* GREGORY - FLÜGEL: 59, pl. 16, figs. 5-6.
1972 *Protethmos griesbachi* (GREGORY) - BEAUVAIS: 57, pl. B, figs. 7-8.
1978 *Protethmos blanfordi* (GREGORY) - BEAUVAIS: 60, pl. 5, figs. 1-2 only.

Material. 40 specimens (RUC1992I 68-71); 4 specimens (BMNH R46320-R46323) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Description. Corallum solitary, trochoid, sharply narrowing down to a tubular peduncle, which is sometimes curved and pointed. Calice flat to very shallow, margin sharp, plan view subcircular with a small central pit. Septa (numbering 78-110) thin, lamellar, partly perforated, densely covered with tiny spines, distal margin denticulated. Costae fine, corresponding to septa, growing more and more inconspicuous towards base. Columella papillary. Epitheca thin.

Remarks. GREGORY (1900: 164-167) erected four species to accommodate specimens comparable to our material. *Protethmos oldhami* and *P. duncani* have been referred to *Epistreptophyllum* by FLÜGEL (1966; see also LATHUILIÈRE 1989).

Metethmos griesbachi is regarded as a junior synonym of *M. blanfordi* (BEAUVAIS 1978: 60). Although, based on GREGORY's description and figures, we agree with her conclusion, the only specimen (BMNH R5318) of *Metethmos griesbachi* in the GREGORY Collection of the Natural History Museum, London, figured by BEAUVAIS (1978: pl. 5, fig. 3) is partly covered with matrix so that the nature of the columella cannot be observed. Moreover the septa do not appear to be perforated and the tiny spines, so common on the septal surfaces of *P. blanfordi*, are rare. It is therefore highly doubtful, whether this particular specimen belongs to *P. blanfordi*.

Genus *Stibastraea* KOBY 1885

Type species. *Stibastraea etalloni* KOBY 1885.

Remarks. BEAUVAIS' (1978: 65) and our observations of large, subelliptical denticles along the distal margins of the septa, of sparsely and irregular perforations, and of a spongy or papillose columella in *S. structa* from Jumara support the systematic placement of *Stibastraea* by ALLOITEAU (1958) in the family Dermosmiliidae.

Stibastraea structa GREGORY 1900

Plate 10, Figs. 3-4

1900 *Stibastraea structa* sp. nov. - GREGORY: 147, pl. 18, figs. 15-16.
1958 *Stibastraea ? structa* GREGORY - ALLOITEAU: 91, pl. 6, fig. 10, pl. 7, figs 8-9.
1978 *Stibastraea ? structa* GREGORY - BEAUVAIS: 64, pl. 6, fig. 1.

Material. 16 specimens (RUC1992I 378-380); 1 specimen (BMNH R5309) in the GREGORY Collection.

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	15.5/10 - 27.0/20
Height of corallum	14.6 - 12.0
Diameter of corallites	3.0 - 3.5
Distance between corallite centers	2.0 - 3.3
Number of septa	19 - 28
Density of septa per 2 mm	7

Remarks. The two specimens from the Upper Bathonian and Lower Callovian of Madagascar placed by ALLOITEAU (1958: 91) in this species have twice as many septa as GREGORY's specimens. ALLOITEAU (1958: 92) referred his and the specimens from Kachchh only with doubt to the genus *Stibastraea* KOBY. Reservations were also expressed by BEAUVAIS (1978: 65) who suggested that the Kachchh specimens might represent juveniles. However, neither ALLOITEAU (1958) nor BEAUVAIS (1978) explain their reservations. As our specimens exhibit the characteristic features of the genus *Stibastraea*, including distinct lobes, we refer *structa* without doubt to that genus.

Genus *Epistreptophyllum* MILASCHEWITSCH 1876

Type species. *Epistreptophyllum commune* MILASCHEWITSCH 1876.

Remarks. MILASCHEWITSCH (1876: 210, pl. 50, fig. 2.) placed *Epistreptophyllum* in the family Fungiidae. VAUGHAN & WELLS (1943: 117), WELLS (1956: F379), FLÜGEL (1966: 58) and LÖSER (1992: 29) assigned it to the family Calamophylliidae. BEAUVAIS (1964: 238; 1972: 74), RONIEWICZ (1966: 238; 1976: 70), ROSENDAHL (1985: 66) and ERRENST (1990: 199) in contrast referred the genus to the Dermosmiliidae KOBY. The diagnostic features of *Epistreptophyllum* (GILL 1982b) such as septa with sparse and irregular

perforations, laterally ornamented with granules and simple synapticulae, a strongly jagged inner margin, the presence of endotheca, a synapticulothecal wall, and a spongy or papillary columella suggest the placement of *Epistreptophyllum* with the Dermosmiliidae. The family Fungiidae, in contrast, is characterized by septa which are only fenestrate in early stages, by stout compound synapticulae, a trabecular columella, and by lack of an endotheca (WELLS 1956: F388). The family Calamophylliidae differs also with regard to having fenestrate septa with beaded upper margins, either a thin or no endotheca, and a trabecular columella (WELLS 1956: F379)

Epistreptophyllum cornutiformis (GREGORY 1900)

Plate 11, Fig. 3

1900 *Frechia cornutiformis* sp. nov. - GREGORY: 168, pl. 21, figs. 1-3.

Material. 1 specimen (RUC1992I 395).

Horizon and locality. Chari Formation of Keera Dome.

Dimensions (in mm).

Height of corallum	~21.0
Diameter of corallum at the top	16.0
Diameter of corallum at 14 mm height	17.0
Number of septa	86
Density of septa per 2 mm	5

Description. Corallum solitary, proximal part turbinate, distal part cylindrical, subcircular in plan view. Septa moderately thick and perforated; perforation irregular and sparse, increasing towards the axis. Due to uneven thickening along the periphery the primary septa sometimes unite with septa of higher order. Dissepiments rare and seen only along the outer margin. Synapticulate along the periphery. Columella spongy.

Remarks. The genus *Frechia* GREGORY (1900: 167) to which GREGORY assigned this species, is now regarded as a junior synonym of *Epistreptophyllum* MILASCHEWITSCH (VAUGHAN & WELLS 1943: 117; see also WELLS 1956: F379; LATHUILIÈRE 1989).

Family **Latomeandriidae** FROMENTEL 1861

Remarks. RONIEWICZ (1982) discussed the family Latomeandriidae in detail. Her statement that synapticulae have not been recorded from members of the family contradicts the presence of synapticulae in genera such as *Periseris* and *Collignonastrea* which are generally regarded as members of the family (ALLOITEAU 1958, BEAUVAIS 1978, LATHUILIÈRE 1990).

Genus *Fungiastraea* ALLOITEAU 1952

Type species. *Astrea laganum* MICHELIN 1841.

Fungiastraea arachnoides (PARKINSON 1808)

Plate 11, Figs. 11-12, Text-fig. 21

1808 *Madrepora arachnoides* sp. nov. - PARKINSON: 54, pl. 6, figs. 4, 6, pl. 7, fig. 11.
1851 *Thamnastrea arachnoides* PARKINSON - MILNE-EDWARDS & HAIME: 97, pl. 18, fig. 1a-f, h-i (non fig. 1g, j, k).
1887 *Thamnastrea arachnoides* PARKINSON - KOBY: 358, pl. 97, figs. 5-7, pl. 99, figs. 6, 7.
1966 *Fungiastraea arachnoides* (PARKINSON) - RONIEWICZ: 237, pl. 26, fig. 4.
1976 *Fungiastraea arachnoides* (PARKINSON) - RONIEWICZ: 98, pl. 29, fig. 2.
1985 *Fungiastraea arachnoides* (PARKINSON) - ROSENDAHL: 62.
1991 *Fungiastraea arachnoides* (PARKINSON) - ERRENST: 24, pl. 18, fig. 8a, b [see for extensive synonymy].

Material. 5 specimens (RUC1992I 364-365).

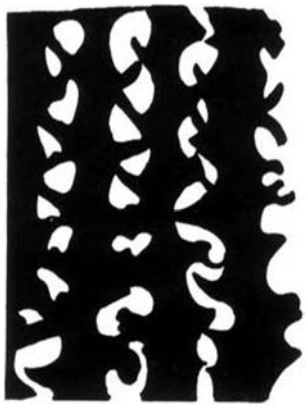
Horizon and locality. Chari Formation of Jumara Dome.

Dimensions (in mm).

Diameter of colony	~68.0
Height of colony	~14.0
Diameter of calices	3.0-4.0
Distance between calice centres	2.8-3.5
Number of septa	22-24
Density of septa per 2 mm	6

Description. Corallum thamnasterioid, platy; upper surface planar. Calices superficial, with depressed central region, arranged concentrically. Septa thin, irregularly perforate; the largest septa are only short of the columella; distal margins denticulate; menianae transverse to the growth direction. The pennulae are variable in shape and symmetry in sections at right angle to the septal plane, ranging from well developed shoulder-like bilateral symmetrical to alternating and truncated branch-like (Text-fig. 21). Synapticulae and dissepiments common.

Remarks. The thamnasterioid and concentric arrangement of corallites, the little perforated septa, number of synapticulae, nature of dissepiments, and presence of a columella place the Kachchh specimens firmly into *Fungiastraea arachnoides* (PARKINSON) of the family Latomeandriidae (see also RONIEWICZ 1966, 1976; ERRENST 1991).



Text-fig. 21. *Fungiastraea arachnoides* (PARKINSON 1808). Longitudinal section through septa with variably shaped septal ridges. RUC1992I 364. Scale bar: 1 mm.

Genus *Periseris* FERRY 1870

Type species. *Agaricia elegantula* D'ORBIGNY 1850.

Periseris elegantula (D'ORBIGNY 1850)

Plate 11, Fig. 2, Text-fig. 22

1850 *Agaricia elegantula* sp. nov. - D'ORBIGNY: I, 293.
1990 *Periseris elegantula* (D'ORBIGNY 1850) - LATHUILIERE: 38, pl. 1, figs. 1-2, pl. 2, figs. 1-4, pl. 3, figs. 1-6, pl. 4, figs. 1-7, pl. 5, figs. 1-6 [see for extensive synonymy].

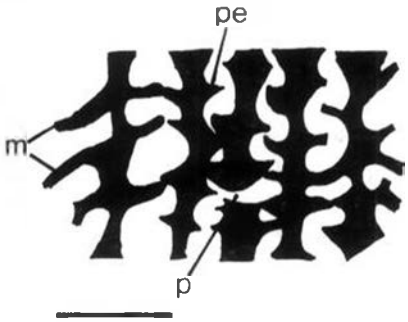
Material. 3 fragments (RUC1992I 356).

Horizon and locality. Patcham Formation of Jumara Dome.

Description. Corallum compound, thamnasterioid, low and subcircular in outline; lower surface almost flat, bearing thick epitheca with concentric folds or wrinkles, upper surface slightly convex. Corallites show irregular pattern, closely packed (distance between calice centres 2.0-3.0 mm) with calices superficial. Septa thin (numbering 25-27), dense (9 per 2 mm), irregularly confluent with those of adjacent corallites, bearing closely spaced (9 per 2 mm) equidistant pennulae with continuous menianae; septa commonly perforated (Text-fig. 22). Synapticulae common. Columella very small, fused with inner edge of septa, usually not visible.

Remarks. The specimens resemble in shape, epitheca, endothecal elements and course of septa *Thamnasteria mettensis* MILNE-EDWARDS & HAIME (1851: 141, pl. 30, fig. 3; see also KOBY 1887: 383, pl. 103, fig. 4; BEAUVAIS 1966: 1011, pl. 10, fig. 3) and *T. terquemi* MILNE-EDWARDS & HAIME (1851: 140, pl. 30, fig. 2; see also KOBY 1887: 382, pl. 104, figs. 4-6; BEAUVAIS 1966: 1012, pl. 11, figs. 1-3, pl. 12, fig. 1). According to MILNE-EDWARDS & HAIME (1851: 140) the latter two species resemble each other but for thick, "irregular and rude appearance of septa" in *terquemi*.

BEAUVAIS (1970: 44; 1978: 52), when revising types of the GREGORY collection from the Middle Jurassic of Kachchh (kept in the Natural History Museum, London) and material from the Bajocian of Morocco, regarded *T. mettensis* as junior synonym of *Thamnasteria lyelli* MILNE-EDWARDS & HAIME (1851: 118, pl. 21, fig. 4) without further comments. A detailed septal study by LATHUILIÈRE (1990), based on a numerical population approach, revealed that one of the species, *T. terquemi*, does not belong to *Thamnasteria* but rather to *Periseris* FERRY. He regarded *T. terquemi* as a junior synonym of *Periseris elegantula* (D'ORBIGNY 1850).



Text-fig. 22. *Periseris elegantula* (D'ORBIGNY 1850). Longitudinal section showing septa with pore (p), pennulae (pe), and menianae (m). RUC1992I 356. Scale bar: 1 mm.

Periseris cf. *renevieri* (KOBY 1887)

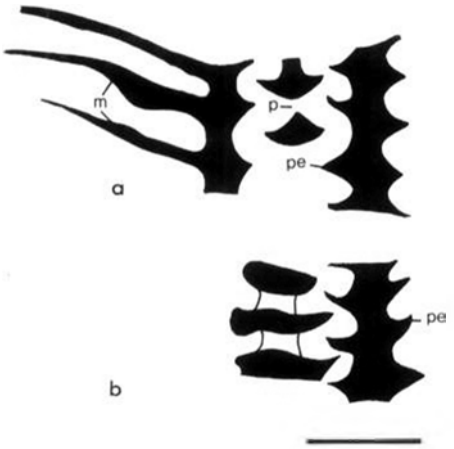
Plate 6, Fig. 14, Text-fig 23

cf. 1887 *Thamnastrea renevieri* sp. nov. - KOBY: 379, pl. 3, fig. 2.

Material. 2 specimens (RUC1992I 55).

Horizon and locality. Patcham Formation of Jumara Dome.

Description. Corallum thamnasterioid, massive, upper surface slightly convex. Calices subequal (4.0-6.2mm in diameter), subcircular and slightly depressed. Septa (numbering 25-30) with a density of 5 per 2mm, confluent, bearing trabeculae with collar-like pennulae forming continuous menianae, which alternate with those of adjacent septa (Text-fig. 23). Septal perforations rare; synapticulae common, mostly along the periphery. Columella small, circular in cross-section. Lower surface exhibiting very fine radial striations.



Text-fig. 23. *Periseris* cf. *renevieri* (KOBY 1887). a, b: Longitudinal section showing septa with pores (p), pennulae (pe) and continuous menianae (m). RUC19921 55. Scale bar: 1 mm.

Remarks. KOBY (1887: 379, pl. 103, fig. 2) referred *renevieri* to *Thamnastrea* LESAUVAGE 1823. However, based on septal morphology, *renevieri* has been transferred to *Periseris* FERRY (LATHUILIÈRE 1989, 1990).

The septal pattern and morphology of the Kachchh specimens correspond to that of *Periseris*. As the density of septa in *renevieri* is higher (7 per 2mm) and our material is fragmentary in nature, only a provisional assignment has been made.

Periseris ? aff. *gillieroni* (KOBY 1887)

Plate 11, Figs. 7-8

aff. 1887 *Thamnastrea gillieroni* sp. nov. - KOBY: 360, pl. 100, fig. 3.

Material. 4 specimens (RUC19921 357-358).

Horizon and locality. Patcham Formation of Jumara Dome.

Description. Corallum thamnasterioid, discoid; upper surface slightly convex, lower surface showing radial grooves. Calices subequal, 3-9 mm in diameter, subcircular, slightly depressed and not showing any definite pattern. Septa numbering 18-31, confluent, more or less moniliform along the distal margin; septal perforations rare, menianae inconspicuous, alternating with those of adjacent septa. Synapticulae common, especially along the periphery. Columella trabecular, generally small and nodular. Epitheca developed on the lower surface and exhibiting very fine radial striations.

Remarks. *Thamnastrea gillieroni* KOBY (1887: 360, pl. 100, fig. 3) is the closest comparable form. This species has now been assigned to *Fungiastraea* ALLOITEAU 1951 (LATHUILIÈRE 1989). ALLOITEAU (1952: 661; see also BEAUVAIS 1964: 221) grouped *Fungiastraea*, characterized by a pancake-like shape with almost continuous and horizontal carinae along the septal sides and a spongy columella, with the Thamnasteriidae. WELLS (1956: F380) transferred it to the Calamophylliidae VAUGHAN & WELLS 1943 and regarded the genus as questionable junior synonym of *Periseris* FERRY 1870.

Both *Fungiastraea* and *Periseris* are now referred to the family Latomeandriidae ALLOITEAU 1952 emend. RONIEWICZ (1976: 95; see also ERRENST 1991: 24; LATHUILIÈRE 1990: 37).

The septal morphology of the present specimens suggests that they should be grouped with *Periseris*. Since we have not seen KOBY's type material, only doubtful reference to *Periseris* has been made. Calices, septal pattern and presence of synapticulae along the periphery of the calices are very similar to *Andemantastraea michelini* BEAUVAIS (1964: 210, pl. 24, fig. 2), but the genus *Andemantastraea* ALLOITEAU 1951 (ALLOITEAU 1952: 659) as well as BEAUVAIS' species differ by subequal, acute dentitions along the upper margin of the septa, subconfluent to confluent septo-costae and abundant synapticulae along the periphery of the calices. *Thamnasteria defranciana* (MICHELIN) (MILNE-EDWARDS & HAIME 1851: 139, pl. 29, figs. 3-4) is another comparable form with concentrically arranged calices and a small central fossula.

Genus *Collignonastraea* ALLOITEAU 1958

Type species. *Comoseris jumarense radiata* GREGORY 1900.

Remarks. GREGORY (1900: 30, 157) assigned *C. jumarense* to the genus *Comoseris* and the family Thamnasteriidae. Both designations were incorrect, because *Comoseris* is a microsolenid (KOBY 1889: 569; WELLS 1956: F392; see also LÖSER 1992: 30). Our specimens exhibit, in contrast to members of the Thamnasteriidae, much fewer septal perforations which are not evenly distributed. In addition, the septo-costae are not confluent but the calices are bounded by a distinct synapticulotheca.

ALLOITEAU (1958: 99, pl. 10, fig. 5) selected *Comoseris jumarense* var. *radiata* GREGORY 1900 as type species of his new genus *Collignonastraea* which he referred to the family Latomeandriidae ALLOITEAU 1951 (BEAUVAIS 1972: 80; 1978: 65). The placement

of *Collignonastraea* in the Latomeandriidae seems to be justified, although the original definition says "perforations septales nombreuses, éparses, régulières" (ALLOITEAU 1952: 672).

Collignonastraea jumarensis (GREGORY 1900)

Plate 10, Figs. 5-6, 8-13, 15-16

1900 *Comoseris jumarense radiata* sp. et var. nov. - GREGORY: 157, pl. 19, figs. 1-8.
1900 *Comoseris jumarense irregularis* sp. et var. nov. - GREGORY: 158, pl. 19, figs. 9-15, pl. 20, fig. 1.
1900 *Comoseris plana* sp. nov. - GREGORY: 160, pl. 20, figs. 6-8, non fig. 9.
1978 *Collignonastraea plana* (GREGORY) - BEAUVAIS: 67, pl. 6, fig. 3.
1978 *Collignonastraea jumarense* (GREGORY) - BEAUVAIS: 65, pl. 6, fig. 4.
1978 *Collignonastraea grossouvrei* BEAUVAIS - BEAUVAIS: 66, pl. 6, fig. 2.

Material. 58 specimens (RUC19921 102-111); 56 specimens (BMNH R5310-R5315, R51666-R51682, R51690-R51698) in the GREGORY Collection

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	9.5/12.8 - 43.0/44.0
Height of corallum	5.0 - 19.5
Diameter of calices	2.4 - 6.8
Distance between calice centres	2.2 - 6.0
Maximum length of collines	20.0
Number of septa in corallites	25 - 63
Density of septa per 2 mm	5-8

Description. Corallum low, massive, colonial, with intratentacular gemmation; plan view subcircular to subelliptical. Collines tectiform and prominent to weak. Calices distinct, bounded by synapticulotheca along the collines. Septa thin, dense, with rare perforations and with pointed to rounded granules along the sides. Synapticulae and dissepiments common; columella either not visible on the calicular surface or with trabecular-like appearance.

Remarks. The morphological characters of the present specimens correspond well to those of *Comoseris jumarensis* and *C. plana*. GREGORY (1900) differentiated two varieties in *C. jumarensis* on the basis of the colline pattern. In his var. *radiata*, the six primary collines radiate from the central corallite. With increase of size, secondary and tertiary collines either branch from primaries or independently develop towards the periphery. Transverse collines develop between the radial collines, producing a net-like appearance.

In his var. *irregularis*, juvenile specimens show a radial pattern, but with maturity this becomes indistinct due to an irregular development of collines.

In *C. plana*, the collines are weak and irregular.

The study of topotypes, including those (BMNH R5310, R5313, and R5315) figured by BEAUVAIS (1978) as *Collignonastraea jumarensis*, *C. grossouvrei*, and *C. plana*, revealed a high gradational variability of the collines, size of corallites, and number of septa. We therefore regard the three species as variants of a single species, *C. jumarensis*.

The specimen figured on Pl. 10, Fig. 8 exhibits an aberrant morphology in that some of the corallites are comparatively elevated. Apparently this feature has been caused by cessation of growth of the other corallites.

Collignonastraea aff. *jumarensis* (GREGORY 1900)

Plate 10, Fig. 17, Text-fig. 24

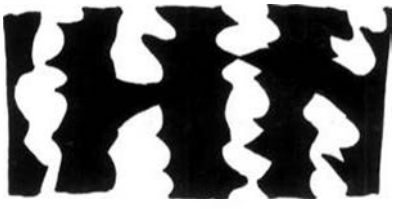
Material. 4 specimens (RUC19921 396-397).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Length of collines	12 - 25
Diameter of corallite	3.0 - 4.5
Distance between calice centres	2.5 - 4.3
Number of septa	19 - 29
Density of septa per 2 mm	5

Description. Corallum low, massive, colonial, formed by intratentacular gemmation; collines well developed, radial, discontinuous, enclosing one to three rows of corallites. Calices distinct, septo-costae confluent between the series, laterally granulated. Longest septa joined to columella. Synapticulae very common (Text-fig. 24); dissepiments rare and subhorizontal. Columella parietal.



Text-fig. 24. *Collignonastraea* aff. *jumarensis* (GREGORY 1900). Longitudinal section showing granulated septa connected by synapticulae. RUC19921 396. Scale bar: 1 mm

Remarks. All four specimens are fragmentary. They

correspond closely to *Collignonastraea jumarensis* (GREGORY) (1900: 160; see also BEAUVAIS 1978: 67) except for their discontinuous collines. The discontinuous collines resemble *Comoseris vermicularis* MILNE-EDWARDS & HAIME (1851: 122, pl. 24, fig. 1) (=*Edwardsomeandra vermicularis* (MILNE-EDWARDS & HAIME) of BEAUVAIS (1965: 873, pl. 36, fig. 4, pl. 37, fig. 4) but the species is easily distinguished by synapticulae and columella, which are absent from *Edwardsomeandra vermicularis*.

Collignonastraea microphyllioides (GREGORY 1900)

Plate 10, Fig. 14

1900 *Comoseris microphyllioides* sp. nov. - GREGORY: 160, pl. 21, fig. 14.

Material. 1 specimen (RUC19921 101).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	53.5/42.2
Height of corallum	32.0
Diameter of calices	16.0 - 11.5
Distance between calice centres	10.0 - 11.0
Maximum length of collines	>29.0
Number of septa in corallites	30 - 53
Density of septa per 2 mm	2

Description. Corallum massive; colony formed by intratentacular gemmation, collines almost radial, moderately well developed. Corallites follow the collines. Calices large, distinct, forming broad confluent series. The series are limited by a synapticulothecal wall along the collines. Septa moderately thick, irregular, sometimes in groups of three to five, granulated, with rare perforations. Primary and some secondary septa joined with prominent, parietal spongy or papillose columella. Dissepiments common.

Remarks. The present specimen is similar to *Comoseris microphylliodes* described and figured by GREGORY (1900). It exhibits all characteristic features of the genus *Collignonastraea* ALLOITEAU 1958 and therefore has been reassigned accordingly. It differs from *Collignonastraea jumarensis* by coarser and less dense septa and by larger corallites.

Genus *Brachyseris* ALLOITEAU 1947

Type species. *Latimeandra morchella* REUSS 1854.

Brachyseris ? cf. *discontinua* (GREGORY 1900)

Plate 10, Fig. 7

cf. 1900 *Comoseris discontinua* sp. nov. - GREGORY: 159, pl. 20, figs. 2-5.

Material. 2 specimens (RUC19921 96).

Horizon and locality. Patcham Formation of Jumara Dome.

Dimensions (in mm).

Diameter of corallum	26.0/27.5
Height of corallum	8.9
Diameter of calices	4.0 - 4.7
Distance between calice centres	4.0
Maximum length of collines	7.0
Number of septa in corallites	29 - 34
Density of septa per 2 mm	7

Remarks. Both specimens are poorly preserved, but their low discoidal form, the short collines, the maximum length of collines (as long as the diameter of two calices), the restriction of collines mostly to single corallites, the deep calices and the granulated septa are comparable with *Comoseris discontinua* GREGORY (1900: 159, pl. 20, figs. 2-5). After studying the syntype of this species preserved in the collections of the Geological Survey of India in Calcutta, BEAUVAIS (1978: 66) concluded that the species matches neither *Comoseris* nor *Collignonastraea*, and tentatively placed it with *Brachyseris* ALLOITEAU. *Brachyseris* was referred to the family Latomeandriidae by ALLOITEAU (1952: 673; see also LÖSER 1992: 30). WELLS (1956: 381) assigned it to the family Calamophylliidae VAUGHAN & WELLS 1943. Both these families have perforated septa. The longitudinal section of our specimens does not show any perforations, but only synapticulae and tiny spines along the septal sides. The generic assignment remains therefore doubtful. The poor preservation of the specimens precludes further comments.

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Plate 1

Figs. 1, 5-7. *Stylina kachensis* GREGORY 1900

Patcham Formation of Jumara Dome.
1. RUC1992I 1, x 1.7. a: View of upper surface. b: Side view. c: View of lower surface.
5. RUC1992I 4, x 8. Part of upper surface.
6. RUC1992I 2, x 1.7. View of upper surface.
7. RUC1992I 6, x 8. Longitudinal section.

Fig. 2. cf. *Goniocora socialis* (ROEMER 1836)

Patcham Formation of Jumara Dome.
RUC1992I 7, x 8. a: Cross-section. b: Side view.

Fig. 3. *Rhabdocora* sp.

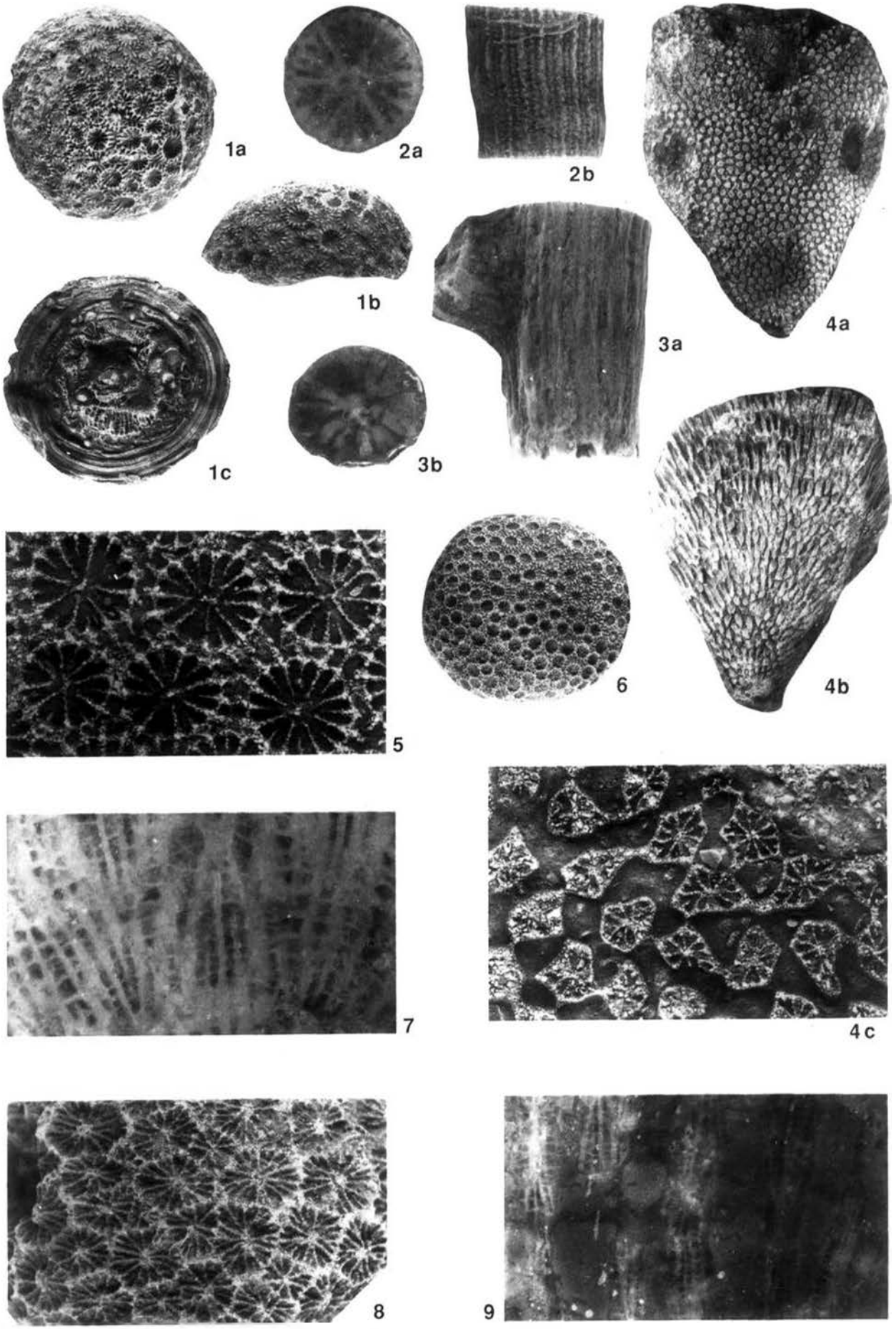
Patcham Formation of Jumara Dome.
RUC1992I 8, x 8. a: Side view showing branching. b: Cross-section.

Figs. 4, 9. *Lochmaeosmilia trapeziformis* (GREGORY 1900)

Patcham Formation of Jumara Dome.
4. RUC1992I 13. a: View of upper surface, x 1. b: View of lower surface along oblique broken plane, x 1. c: Part of upper surface, x 8.
9. RUC1992I 14, x 8. Longitudinal section.

Fig. 8. *Actinastrea bernensis* (GREGORY 1900)

Patcham Formation of Jumara Dome.
RUC1992I 9, x 8. Part of upper surface.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2b
4a
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1c
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4c
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Plate 2

Figs. 1-3. *Montlivaltia cornutiformis* GREGORY 1900

Patcham Formation of Jumara Dome.
1. RUC1992I 15, x 2. a: Side view. b: View of upper surface.
2. RUC1992I 16, x 2. Side view.
3. RUC1992I 17, x 2. a: Cross-section of the lower part. b: Cross-section of the upper part.

Fig. 4. *Coelosmilia indica* GREGORY 1900

Patcham Formation of Jumara Dome.
RUC1992I 23, x 2. Cross-section.

Figs. 5-6. *Melikerona parva* (GREGORY 1900)

5. RUC1992I 19, x 1.7. Khavda Formation, NE of Sadhara, Pachchham "Island". Part of upper surface.
6. RUC1992I 326, x 2.3. Washtawa Formation, N of Washtawa, Wagad. View of upper surface.
→ Ampiwastrea pirniformis

Fig. 7. *Axosmilia kachensis* (GREGORY 1900)

Khavda Formation, N of Andhou, Pachchham "Island".
RUC1992I 20, x 1. View of upper surface.

Fig. 8. *Cladocora* sp.

Patcham Formation of Jumara Dome.
RUC1992I 21, x 2.7. a: Cross-section. b: Side view of a fragment.

Fig. 9. *Axosmilia* aff. *sessilis* (MILASCHEWITSCH 1876)

Patcham Formation of Jumara Dome.
RUC1992I 24, x 2. a: View of upper surface. b: Cross-section.

Fig. 10. *Isastrea limitata* (LAMOUROUX 1846)

Patcham Formation of Kunwar Bet.
RUC1992I 18, x 1.7. Part of upper surface.


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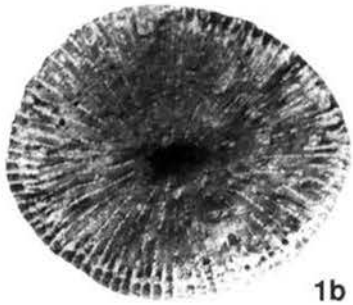
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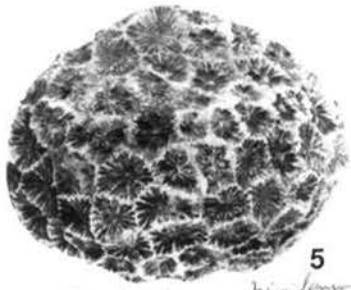
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Amphiastraea piriformis


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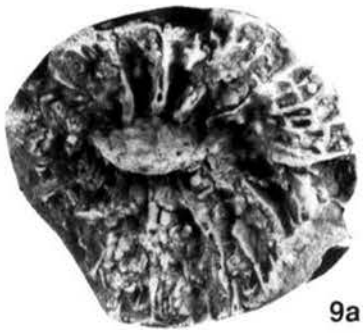
8b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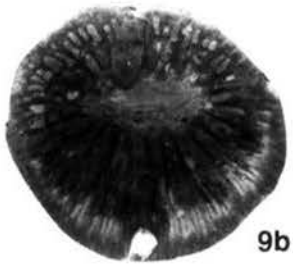
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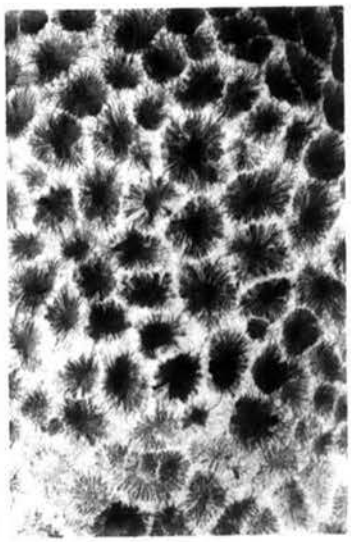

Plate 3

Figs. 1-7. *Montlivaltia frustriformis* GREGORY 1900

Patcham Formation of Jumara Dome, x 2.

1. RUC1992I 26. a: Side view. b: View of upper surface.
2. RUC1992I 27. Side view.
3. RUC1992I 28. a: View from lower side. b: Side view.
4. RUC1992I 29. Side view.
5. RUC1992I 30. a: View of upper surface. b: Side view.
6. RUC1992I 31. a: Side view. b: View of upper surface.
7. RUC1992I 32. a: Oblique longitudinal section. b: Side view.

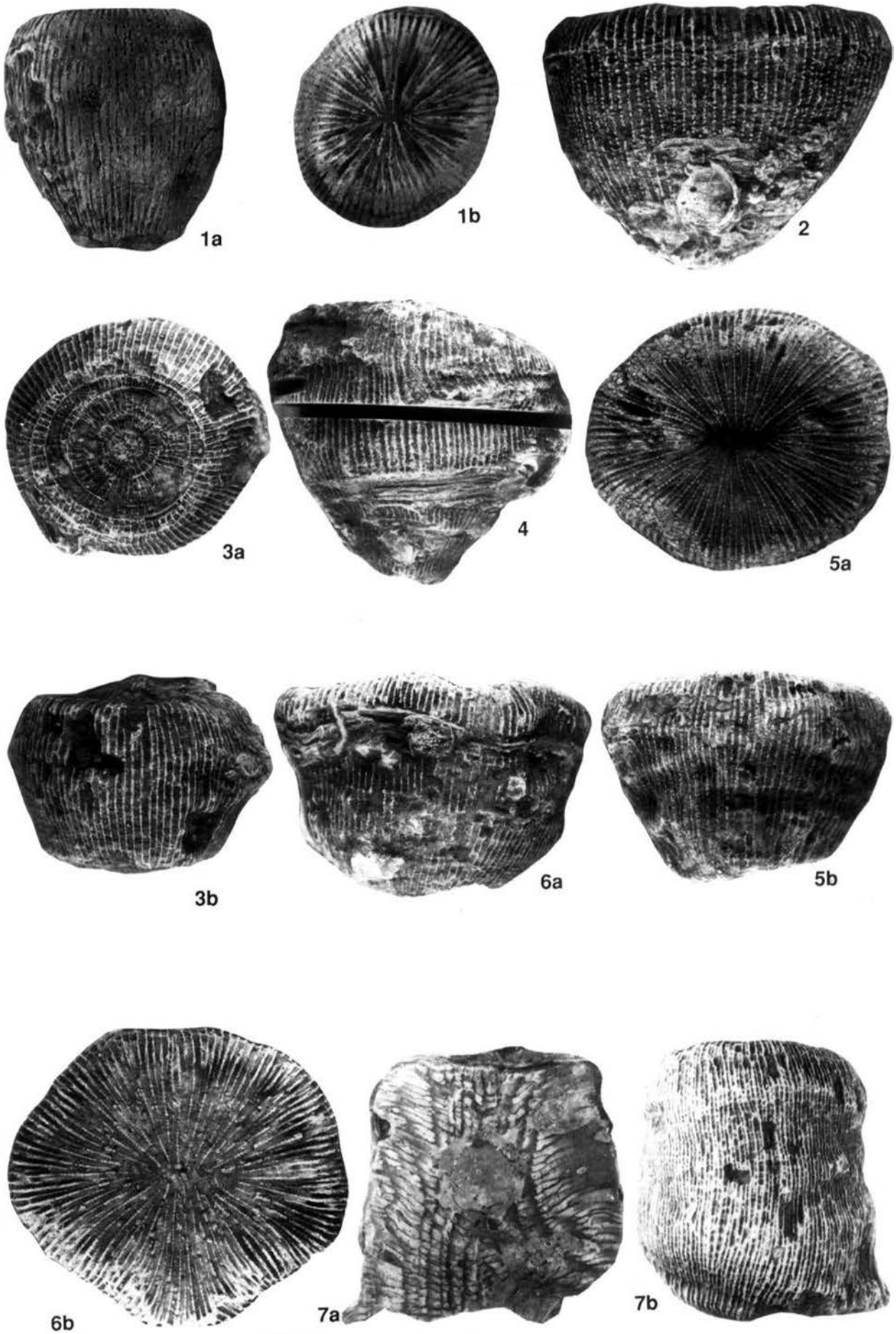

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Plate 4

Figs. 1-5, 8-10. *Montlivaltia frustriformis* GREGORY 1900

1. RUC1992I 33, x 2. Patcham Formation of Jumara Dome. Side view.
2. RUC1992I 37, x 1.7. Patcham Formation of Jumara Dome. a: View of upper surface. b: Side view.
3. RUC1992I38, x 1.7. Patcham Formation of Jumara Dome. a: Side view. b: View of upper surface.
4. RUC1992I 41, x 1.7. Patcham Formation of Jumara Dome. Longitudinal section along broken surface.
5. RUC1992I 39, x 1. Chari Formation of Habo Dome, x 1. a: Side view. b: View of upper surface.
8. RUC1992I 34. Patcham Formation of Jumara Dome. a: Side view, x 1.7. b: Part of upper surface, x 3.
9. RUC1992I 40, x 1.4. Patcham Formation of Jumara Dome. Cross-section through upper part.
10. RUC1992I 36, x 2. Patcham Formation of Jumara Dome. Lateral surface of a septum.

Figs. 6-7. *Montlivaltia obconica* (MÜNSTER 1829)

Patcham Formation of Jumara Dome.

6. RUC1992I 45, x 1. a: Cross-section. b: View of upper surface.
7. RUC1992I 44, x 1.4. a: Cross-section. b: View of upper surface.

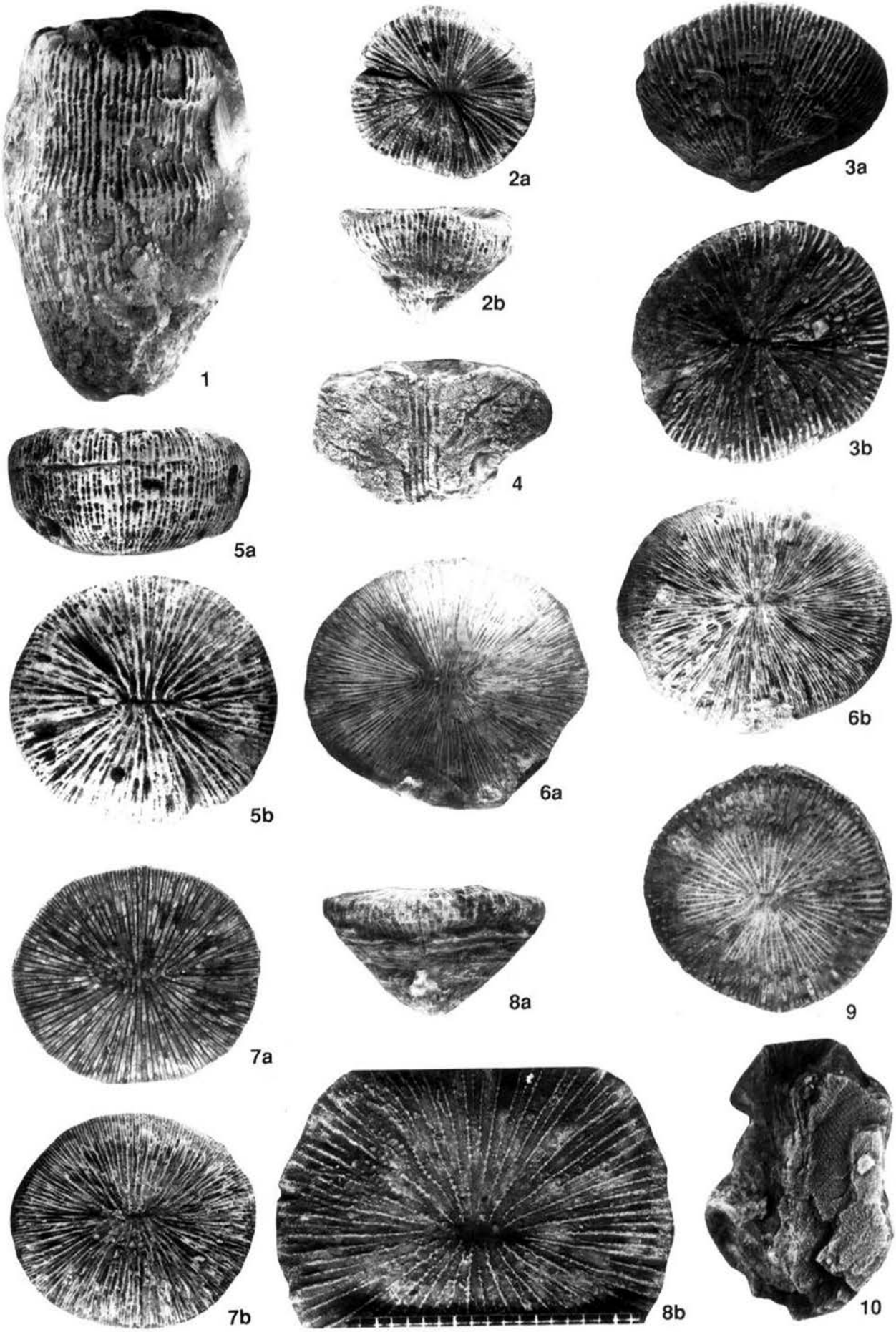

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Plate 5

Fig. 1. *Montlivaltia chariensis* GREGORY 1900

Patcham Formation of Jumara Dome.
RUC1992I 35, x 1. a: View of upper surface. b: Side view.

Figs. 2-3, 7. *Isastrea propinqua* THURMANN & ETALLON 1964

2. RUC1992I 155, x 1.6. Patcham Formation of Jumara Dome. Part of upper surface.
3. RUC1992I 400, x 1. Chari Formation of Keera Dome. a: Part of upper surface, x 1.3. b: Longitudinal section, x 3.3.
7. RUC1992I 156, x 1.6. Patcham Formation of Jumara Dome. Part of upper surface.

Figs. 4, 6, 9. *Cryptocoenia wegeneri* sp. nov.

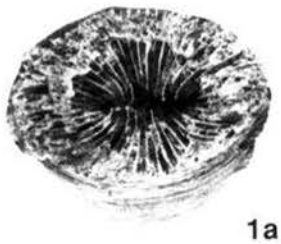
Patcham Formation of Jumara Dome.
4. RUC1992I 5 (paratype), x 1.7. Upper surface of a fragment.
6. RUC1992I 248 (holotype), x 1. View of upper surface.
9. RUC1992I 3 (paratype), x 1.7. Longitudinal section along broken surface.

Figs. 5, 8. *Complexastraea kachensis* GREGORY 1900

5. RUC1992I 43, x 1. Patcham Formation of Jumara Dome. View of upper surface.
8. RUC1992I 42, x 1. Chari Formation of Habo Dome. a: Side view. b: View of upper surface.

Figs. 10-11. *Amphiastraea piriformis* GREGORY 1900

10. RUC1992I 335, x 1.3. Chari Formation of Habo Dome. Part of upper surface.
11. RUC1992I 25, x 2.7. Khavda Formation of Kunwar Bet. Part of upper surface.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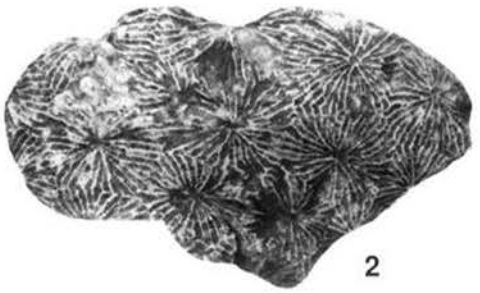
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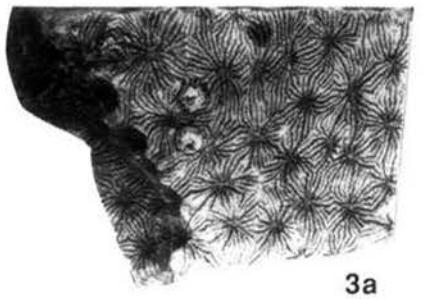
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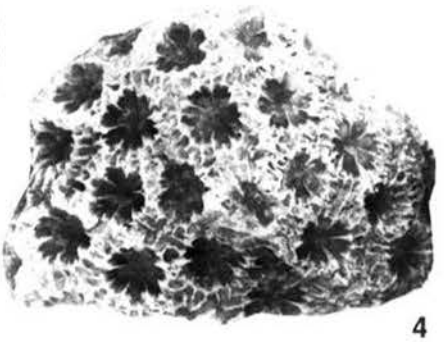
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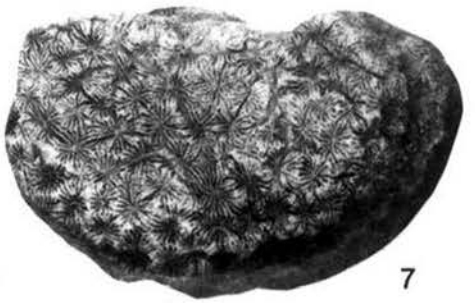
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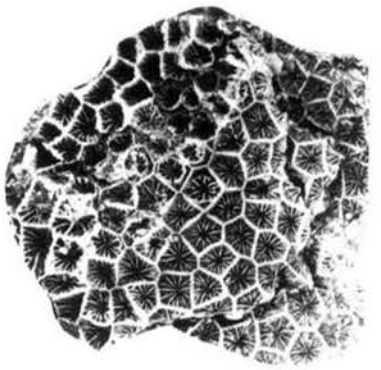
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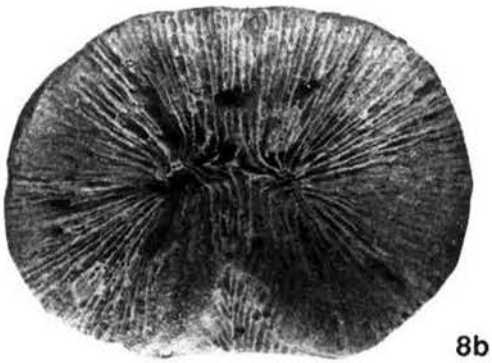
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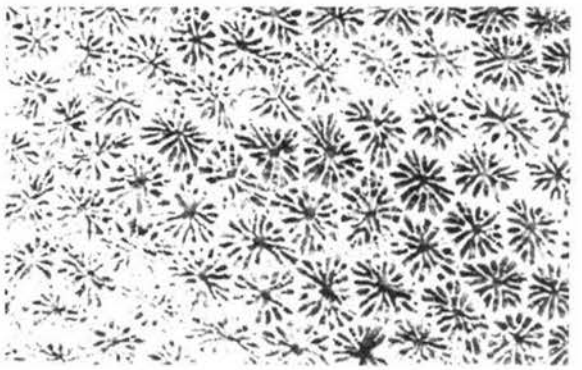
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Plate 6

Figs. 1-5. *Lophosmilia tenuicaulata* GREGORY 1900

Patcham Formation of Jumara Dome.
1. RUC1992I 46, x 2. a: Side view. b: View of upper surface.
2. RUC1992I 47, x 2. a: Side view. b: View of upper surface.
3. RUC1992I 50, x 2.7 Cross-section.
4. RUC1992I 48, x 2. a: Side view. b: View of upper surface.
5. RUC1992I 49, x 2. a: Side view. b: View of upper surface.

Figs. 6, 8-9, 11. *Kobya crassolamellosa* GREGORY 1900

Patcham Formation of Jumara Dome.
6. RUC 1992I 54, x 2. a: View of upper surface. b: View of lower surface.
8. RUC1992I 53, x 1.5. Longitudinal section.
9. UC1992I 51, x 2.3. a: View of upper surface. b: Side view.
11. RUC1992I 52. a: View of upper surface, x 1.5. b: Side view, x 1.7.

Fig. 7. *Kobya lenticulata* GREGORY 1900

Patcham Formation of Jumara Dome.
RUC1992I 62, x 1.2. View of upper surface.

Figs. 10, 13. *Thamnasteria nicoleti* KOBY 1887

Patcham Formation of Jumara Dome.
10. RUC1992I 61, x 2. View of upper surface.
13. RUC1992I 60. a: Longitudinal section, x 1.7. b: View of upper surface, x 1.5.

Fig. 12 *Craterastraea crateriformis* (GREGORY 1900)

Patcham Formation of Jumara Dome.
12. RUC1992I 56, x 2. View of upper surface.

Figs. 14. *Periseris* cf. *renevieri* (KOBY 1887)

Patcham Formation of Jumara Dome.
RUC1992I 55. a: View of upper surface, x 1.2. b: Longitudinal section, x 1.7.

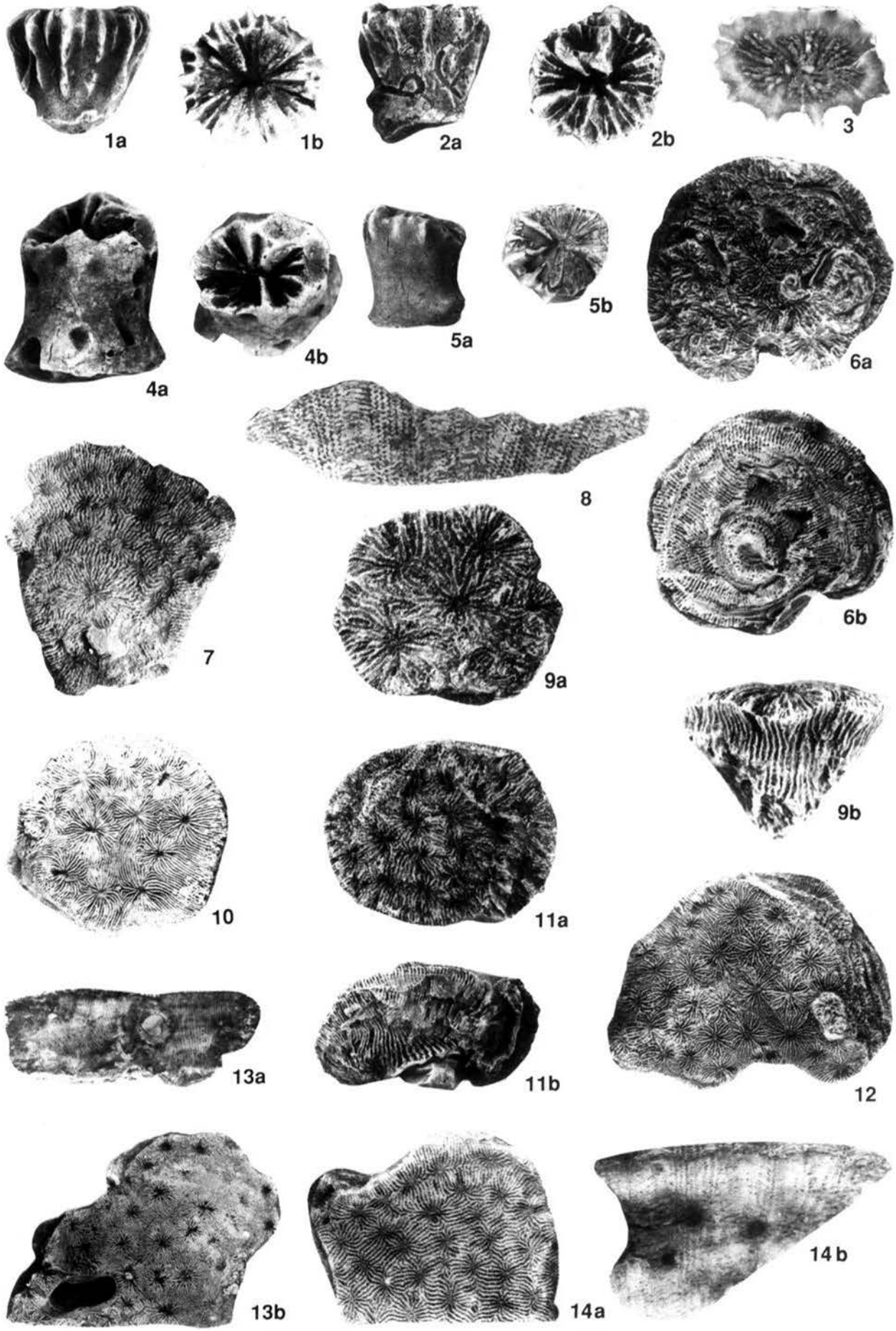

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Plate 7

Fig. 1. *Trochoplegma* aff. *fungiformis* (GREGORY 1900)

Patcham Formation of Jumara Dome.
RUC1992I 99, x 3. a: View of upper side. b: Side view.

Figs. 2-4. *Trocharea patelliformis* GREGORY 1900

Patcham Formation of Jumara Dome.
2. RUC1992I 84, x 3.4. Side view.
3. RUC1992I 83, x 3.4. View of upper surface.
4. RUC1992I 82, x 3.4. a: Side view. b: View of lower surface.

Figs. 5-6. *'Anabacia' acaulis* GREGORY 1900

Patcham Formation of Jumara Dome.
5. RUC1992I 323, x 4. View of upper surface.
6. RUC1992I 100, x 3.4. View of upper surface.

Figs. 7-9, 11, 13-14. *Tricycloseris triangularis* GREGORY 1900

Patcham Formation of Jumara Dome.
7. RUC1992I 79, x 2.4. a: View of upper surface. b: Side view. c: View of lower surface.
8. RUC1992I 81, x 2.4. View of upper surface.
9. RUC1992I 80, x 4. Longitudinal section.
11. RUC1992I 373, x 2.3. View of upper surface.
13. RUC1992I 78, x 2.7. View of upper surface.
14. RUC1992I 374, x 2.3. View of upper surface.

Figs. 10, 12, 15. *Craterastraea crateriformis* (GREGORY 1900)

Patcham Formation of Jumara Dome.
10. RUC1992I 58, x 1.5. a: View of upper surface. b: View of lower surface.
12. RUC1992I 59, x 2. View of upper surface.
15. RUC1992I 57, x 2. Longitudinal section.

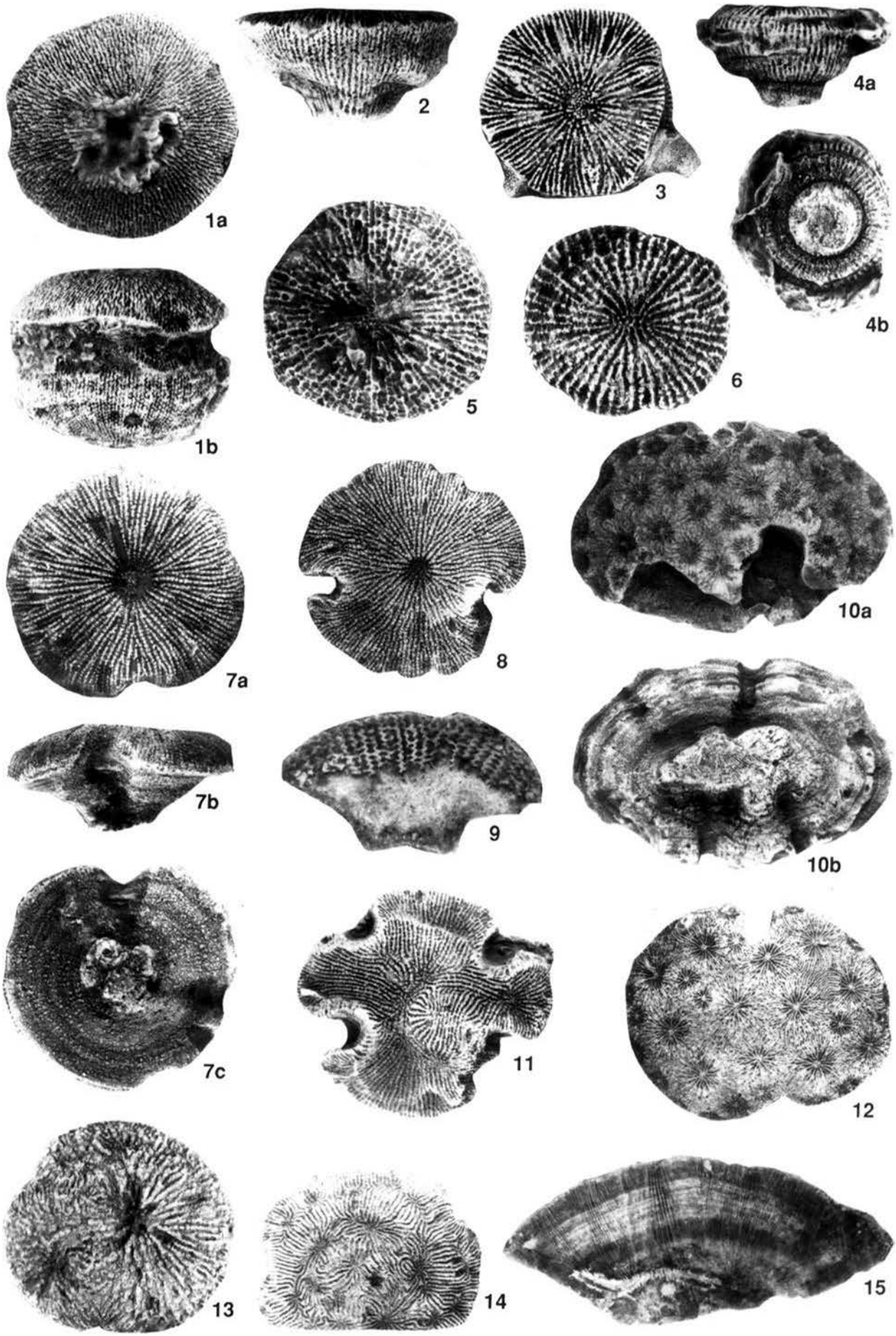

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Plate 8

Figs. 1-5. *Gregorycoenia magna* (GREGORY 1900)

Patcham Formation of Jumara Dome.
1. RUC1992I 63. a: View of upper surface, x 1.5. b: View of lower surface, x 2.
2. RUC1992I 67, x 2.7. Longitudinal section.
3. RUC1992I 66, x 2. Cross-section.
4. RUC1992I 64, x 2.7. a: View of upper surface. b: Side view.
5. RUC1992I 65, x 1.5. a: View of upper surface. b: Side view.

Figs. 6-8, 10. *Protethmos blanfordi* (GREGORY 1900)

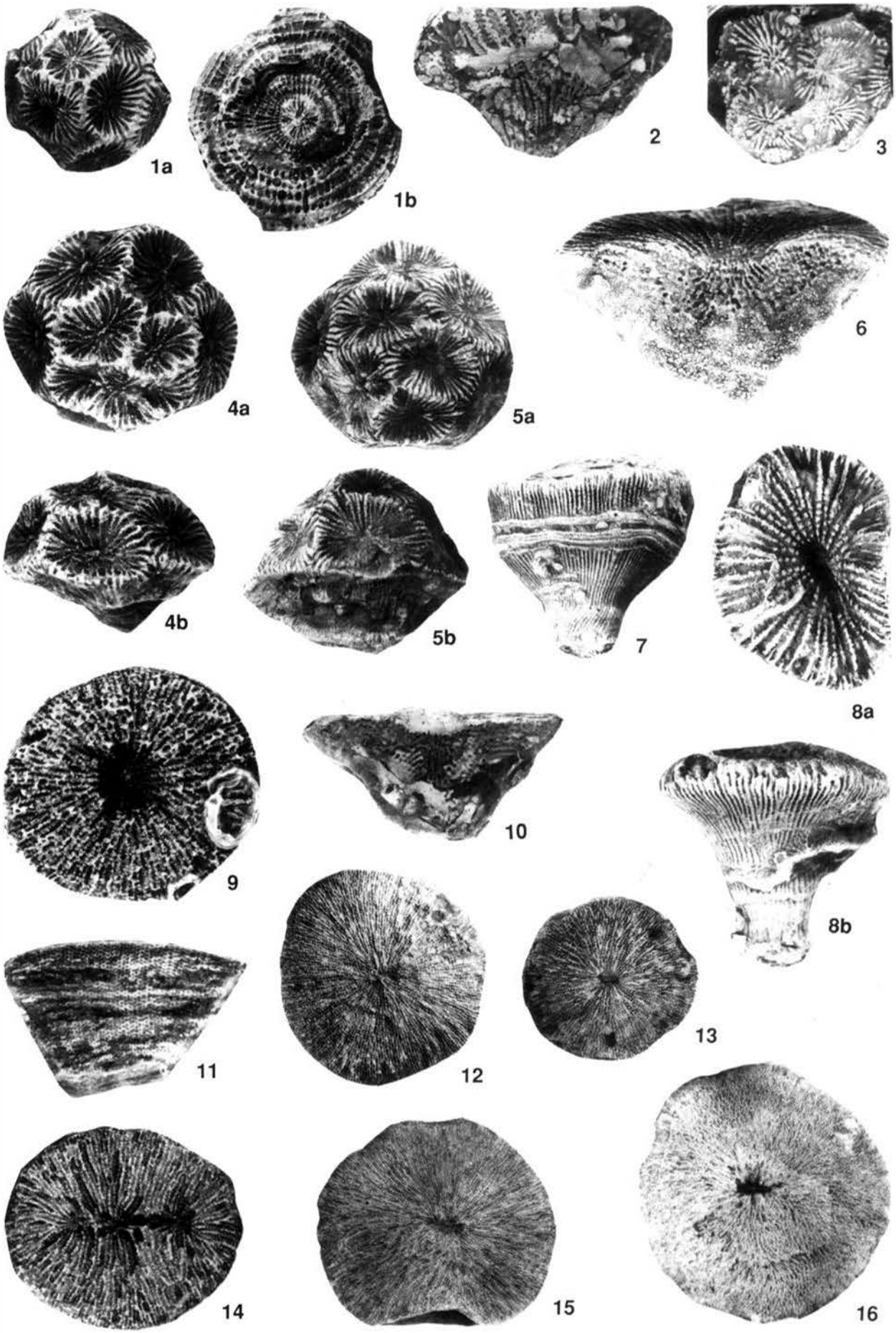
Patcham Formation of Jumara Dome.
6. RUC1992I 69, x 3.4. Longitudinal section along broken surface.
7. RUC1992I 68, x 2. Side view.
8. RUC1992I 71, x3 .4. a: View of upper surface. b: Side view.
10. RUC1992I 70, x 2.7. Longitudinal section.

Fig. 9. *Trocharea patelliformis* GREGORY 1900

Patcham Formation of Jumara Dome.
RUC1992I 85, x 3.4. View of upper surface.

Figs. 11-16. *Trochoplegma tenuilamellosa* GREGORY 1900

Patcham Formation of Jumara Dome.
11. RUC1992I 72, x 2.7. Longitudinal section.
12. RUC1992I 76, x 2. View of upper surface.
13. RUC1992I 73, x 2. View of upper surface.
14. RUC1992I 77, x 2.4. View of upper surface.
15. RUC1992I 75, x 1.5. View of upper surface.
16. RUC1992I 74, x 1.5. View of upper surface.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16

Plate 9

Figs. 1-2, 4-7. *Dimorpharaea stellans* GREGORY 1900

Patcham Formation of Jumara Dome.
1. RUC1992I 86, x 2.4. View of upper surface.
2. RUC1992I 87, x 1.7. View of upper surface.
4. RUC1992I 88, x 1.2. a: View of upper surface. b: View of lower surface.
5. RUC1992I 91, x 2. Longitudinal section.
6. RUC1992I 90, x 1.2. View of upper surface.
7. RUC1992I 89, x 1.5. View of upper surface.

Fig. 3. *Dimorphastraea* sp. A

Patcham Formation of Jumara Dome.
RUC 1992I 92, x 1.5. a: View of upper surface. b: Longitudinal section.

Fig. 8. *Dimorpharea* cf. *orbica* GREGORY 1900

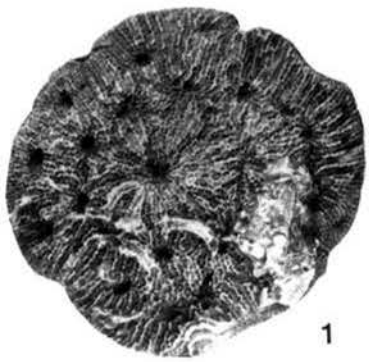
Patcham Formation of Jumara Dome.
RUC1992I 375, x 1.6. View of upper surface.

Figs. 9-10. *Microsolena subturbinata* GREGORY 1900

Patcham Formation of Jumara Dome.
9. RUC1992I 97, x 2.4. View of upper surface.
10. RUC1992I 98, x 2. View of upper surface.

Figs. 11-13. *Microsolena amorpha* (GREGORY 1900)

Patcham Formation of Jumara Dome.
11. RUC1992I 95, x 2. View of upper surface.
12. RUC1992I 93, x 2.7. Longitudinal section.
13. RUC1992I 94, x 1.4. a: View of upper surface. b: View of lower surface.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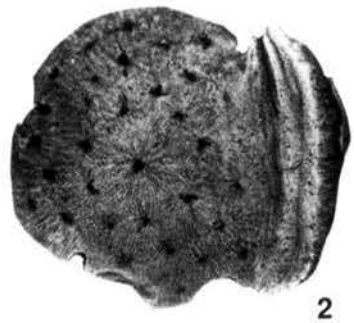
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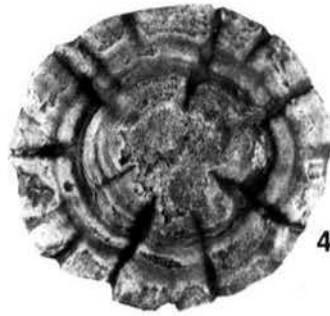
3a


3b


4a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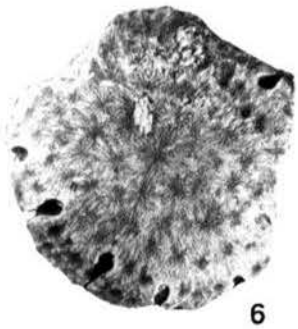
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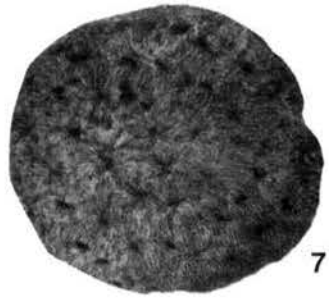
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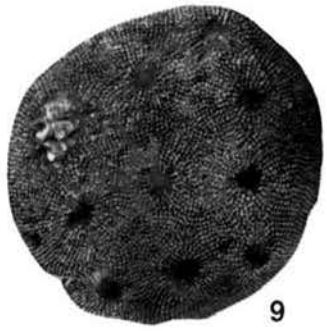
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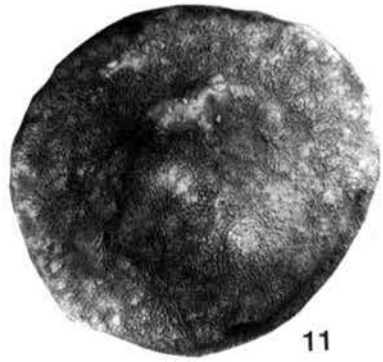
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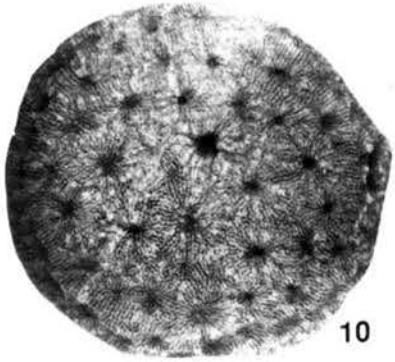
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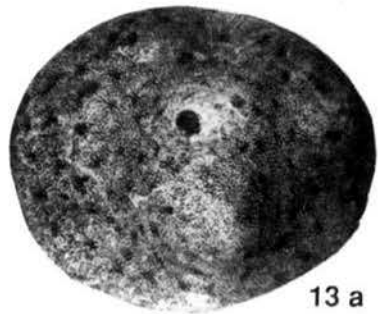
13 a

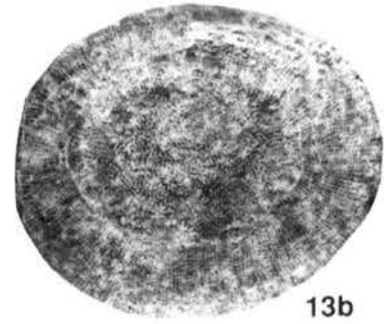
13b

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Plate 10

Fig. 1. *Dimorphastrea sigillum* GREGORY 1900

Patcham Formation of Jumara Dome.
RUC1992I 369, x 2.6. View of upper surface.

Fig. 2. *Dimorphastrea paeninsulae* (GREGORY 1900)

Patcham Formation of Jumara Dome.
RUC1992I 371, x 2.3. View of upper surface.

Figs. 3-4. *Stibastraea structa* GREGORY 1900

Patcham Formation of Jumara Dome.
3. RUC1992I 379, x 2.3. View of upper surface.
4. RUC1992I 378, x 2.3. Side view.

Figs. 5-6, 8-13, 15-16. *Collignonastraea jumarensis* (GREGORY 1900)

Patcham Formation of Jumara Dome.
5. RUC1992I 106, x 2.4. View of upper surface.
6. RUC1992I 108, x 1.7. Longitudinal section.
8. RUC1992I 111, x 1.7. a: View of uper surface. b: Side view.
9. RUC1992I 103, x 1.7. a: View of upper surface. b: Side view.
10. RUC1992I 104, x 2.7. Longitudinal section.
11. RUC1992I 109, x 3.4. View of upper surface.
12. RUC1992I 102, x 1.5. View of upper surface.
13. RUC1992I 107. a: View of upper surface, x 1.5. b: View of lower surface, x 1.4.
15. RUC1992I 105, x 1.5. View of upper surface.
16. RUC1992I 110, x 2.7. View of upper surface.

Fig. 7. *Brachyseris* ? cf. *discontinua* (GREGORY 1900)

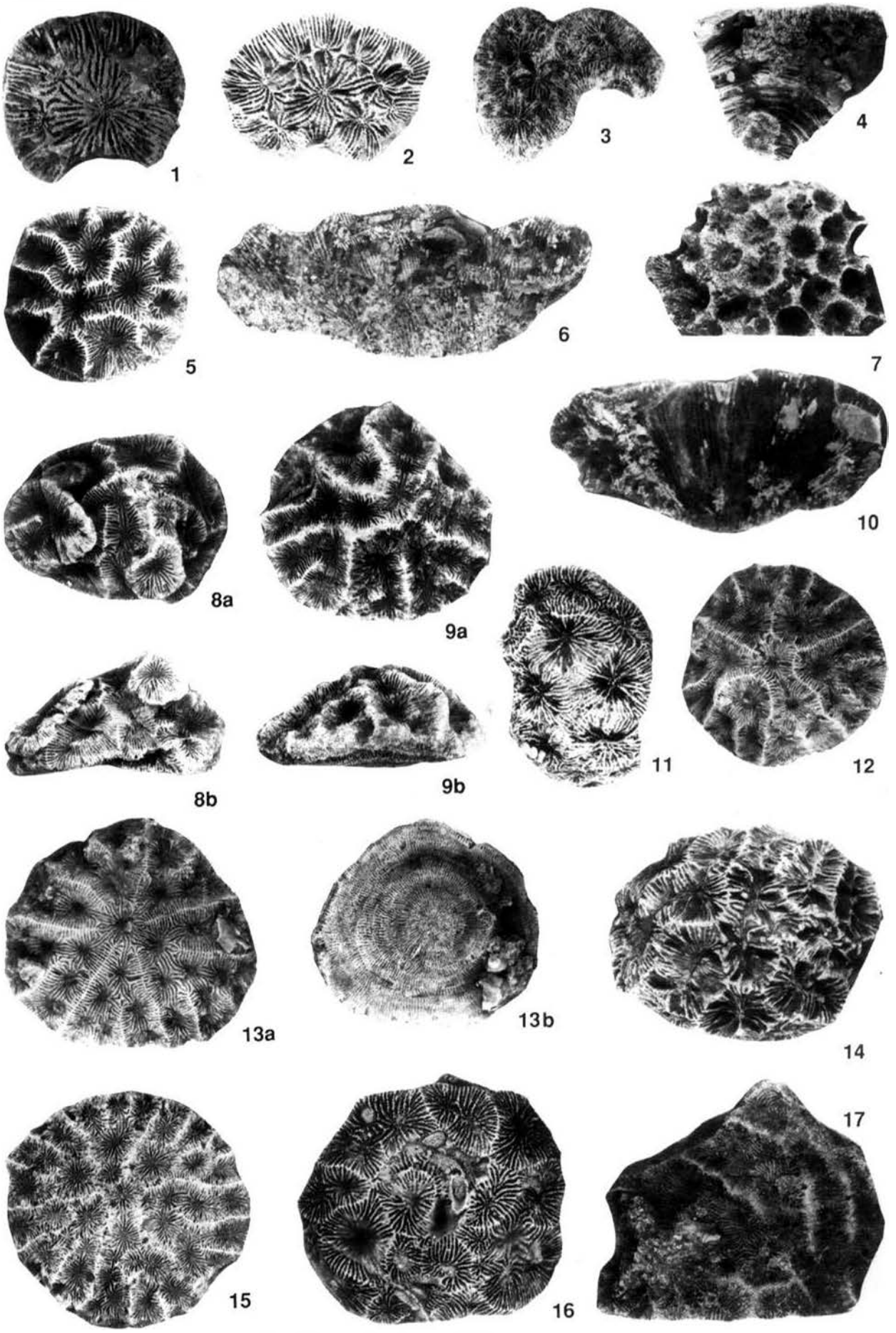
Patcham Formation of Jumara Dome.
RUC1992I 96, x 1.7. View of upper surface.

Fig. 14. *Collignonastraea microphyllioides* (GREGORY 1900)

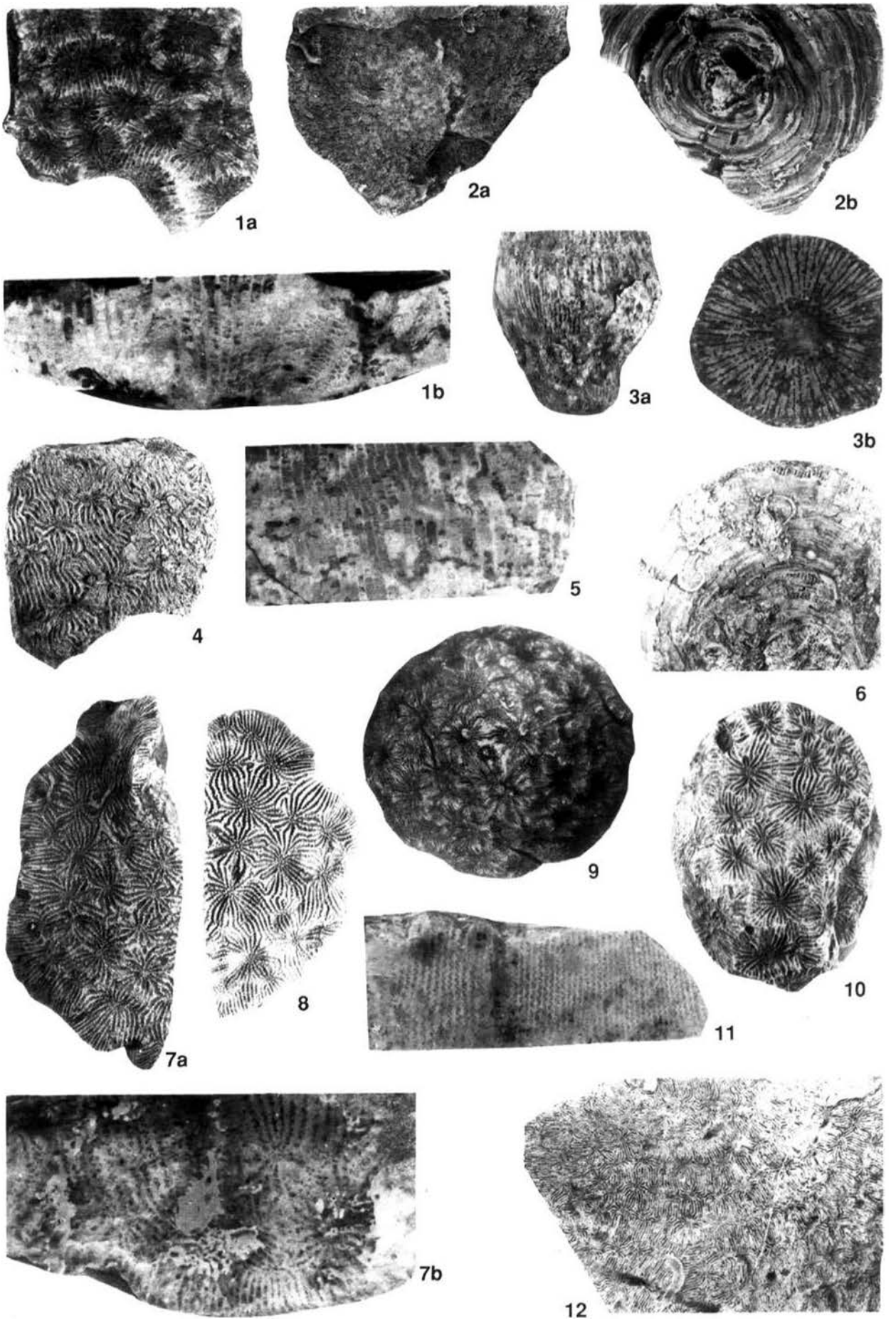
Patcham Formation of Jumara Dome.
RUC1992I 101, x 1. View of upper surface.

Fig. 17. *Collignonastraea* cf. *jumarensis* (GREGORY 1900)

Patcham Formation of Jumara Dome.
RUC1992I 396, x 1.3. Part of upper surface.



D. K. PANDEY & F. T. FÜRSICH: Jurassic corals of Kachchh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Appendix 1

Table 1. List of corals described in this paper and their occurrences in different localities (1-11) of Kachchh. 1. Khavda Formation, Kunwar Bet, Pachchham 'Island'; 2. Khavda Formation, 1.5 km north of Andhou, Gora Dongar, Pachchham Island; 3. Khavda Formation, 1.5 km north-east of Sadhara, Gora Dongar, Pachchham Island; 4. Patcham Formation near centre of Jara Dome; 5. Patcham Formation at centre of Jumara Dome; 6. Chari Formation of southern flank of Jumara Dome; 7. Chari Formation of Keera Dome; 8. Chari Formation of Jhura Dome; 9. Chari Formation on top and northern flank of Habo Dome; 10. Washtawa Formation, north of Washtawa, Wagad; 11. Chari Formation in the vicinity of Wanda, Jara Dome. See also Text-Fig. 1.

	1	2	3	4	5	6	7	8	9	10	11
Family **Actinastraeidae** ALLOITEAU											
Actinastrea bernensis (KOBY)	-	-	-	-	•	-	•	-	-	-	-
Family **Stylinidae** D'ORBIGNY											
Stylina kachensis GREGORY	-	-	-	•	•	-	-	-	-	-	-
Cryptocoenia wegeneri sp. nov.	-	-	-	-	•	-	-	-	-	-	-
Lochmaeosmilia trapeziformis (GREGORY)	-	-	-	-	•	-	-	-	-	-	-
cf. *Goniocora socialis* (ROEMER)	-	-	-	-	•	-	-	-	-	-	-
Family **Heliastraeidae** ALLOITEAU											
Rhabdocora sp.	-	-	-	-	•	-	-	-	-	-	-
Cladocora sp.	-	-	-	-	•	-	-	-	-	-	-
Family **Montlivaltiidae** DIETRICH											
Montlivaltia cornutiformis GREGORY	-	-	-	-	•	-	-	-	-	-	-
Montlivaltia frustriformis GREGORY	-	•	-	-	•	•	•	•	•	-	-
Montlivaltia chariensis GREGORY	-	-	-	-	-	-	-	•	-	-	•
Montlivaltia obconica (MÜNSTER)	-	-	-	-	•	-	-	-	-	-	-
Complexastraea kachensis GREGORY	-	-	-	-	•	-	-	-	•	-	-
Isastrea limitata (LAMOUROUX)	•	-	-	-	-	-	-	-	-	-	-
Isastrea propinqua THURMANN & ETALLON	-	-	-	-	•	-	•	-	-	-	-
Isastrea hemisphaerica GREGORY	-	-	-	-	•	-	-	-	-	-	-
Family **Dendrogyriidae** ALLOITEAU											
Melikerona parva (GREGORY)	•	-	•	-	-	-	-	-	-	•	-
Family **Amphiastraeidae** OGILVIE											
Amphiastraea piriformis GREGORY	•	-	-	-	-	-	-	-	•	-	-
Axosmilia kachensis (GREGORY)	-	•	-	-	-	-	-	-	-	-	-
Axosmilia aff. *sessilis* (MILASCHEWITSCH)	-	-	-	-	•	-	-	-	-	-	-
Family **Caryophylliidae** GRAY											
Coelosmilia indica GREGORY	-	-	-	-	•	-	-	-	-	-	-
Lophosmilia tenuicaulata GREGORY	-	-	-	-	•	-	-	-	-	-	-
Family **Astraraeidae** BEAUVAIS											
Kobya crassolamellosa GREGORY	-	-	-	-	•	-	•	-	-	-	-
Kobya lenticulata GREGORY	-	-	-	-	•	-	-	-	-	-	-
Kobya sp. A	-	-	-	-	•	-	-	-	-	-	-
Family **Andemantastraeidae** ALLOITEAU											
Ampakabastraea exserta (GREGORY)	-	-	-	-	-	-	•	-	-	-	-

	1	2	3	4	5	6	7	8	9	10	11
Vallimeandropsis davidsoni (MILNE-EDWARDS & HAIME)	-	-	-	-	-	-	•	-	-	-	-
Family **Thamnasteriidae** REUSS											
Thamnasteria nicoleti KOBY	-	-	-	-	•	-	-	-	-	-	-
Dimorphastrea sigillum GREGORY	-	-	-	-	•	-	-	-	-	-	-
Dimorphastrea paeninsulae (GREGORY)	-	-	-	-	•	-	-	-	-	-	-
Dimorphastrea sp. A	-	-	-	-	•	-	-	-	-	-	-
Family **Agaricidae** GRAY											
Craterastraea crateriformis (GREGORY)	-	-	-	-	•	-	-	-	-	-	-
Family **Fungiellidae** ALLOITEAU											
Gregorycoenia magna (GREGORY)	-	-	-	-	•	-	-	-	-	-	-
Family **Microsolenidae** KOBY											
Trochoplegma tenuilamellosa GREGORY	-	-	-	-	•	-	-	-	-	-	-
Trochoplegma aff. *fungiformis* GREGORY	-	-	-	-	•	-	-	-	-	-	-
Trocharea patelliformis GREGORY	-	-	-	-	•	-	-	-	-	-	-
'Anabacia' acaulis GREGORY	-	-	-	-	•	-	-	-	-	-	-
Microsolena subturbinata GREGORY	-	-	-	-	•	-	-	-	-	-	-
Microsolena amorpha (GREGORY)	-	-	-	-	•	•	-	-	-	-	-
Dimorpharaea stellans GREGORY	-	-	-	-	•	-	-	-	-	-	-
Dimorpharaea cf. *orbica* GREGORY	-	-	-	-	•	-	-	-	-	-	-
Family **Procyclolitidae** VAUGHAN											
Tricycloseris triangularis GREGORY	-	-	-	-	•	-	-	-	-	-	-
Family **Dermosmiliidae** KOBY											
Protethmos blanfordi (GREGORY)	-	-	-	-	•	-	-	-	-	-	-
Stibastraea structa GREGORY	-	-	-	-	•	-	-	-	-	-	-
Epistreptophyllum cornutiformis (GREGORY)	-	-	-	-	-	-	•	-	-	-	-
Family **Latomeandriidae** FROMENTEL											
Fungiastraea arachnoides (PARKINSON)	-	-	-	-	-	•	-	-	-	-	-
Periseris elegantula (D'ORBIGNY)	-	-	-	-	•	-	-	-	-	-	-
Periseris cf. *renevieri* (KOBY)	-	-	-	-	•	-	-	-	-	-	-
Periseris ? aff. *gillieroni* (KOBY)	-	-	-	-	•	-	-	-	-	-	-
Collignonastraea jumarensis (GREGORY)	-	-	-	-	•	-	-	-	-	-	-
Collignonastraea aff. *jumarensis* (GREGORY)	-	-	-	-	•	-	-	-	-	-	-
Collignonastraea microphyllioides (GREGORY)	-	-	-	-	•	-	-	-	-	-	-
Brachyseris ? cf. *discontinua* (GREGORY)	-	-	-	-	•	-	-	-	-	-	-

Appendix 2

Table 2. List of corals described by GREGORY (1900) and their present taxonomic status. Taxa not described in the present monograph are marked with an asterix.

Coral taxa of GREGORY (1900)	Present name	Reference
(1) *Lophosmilia tenuicaulata* GREGORY	*Lophosmilia tenuicaulata* GREGORY	
(2) *Lophosmilia magnocaulata* GREGORY	*Lophosmilia tenuicaulata* GREGORY	this paper
(3) *Coelosmilia indica* GREGORY	*Coelosmilia indica* GREGORY	
(4) *Goniocora turbinata* GREGORY*	*Cladophyllia turbinata* (GREGORY)	LATHUILIÈRE (1989)

(5) *Stylosmilia trapeziformis* GREGORY	*Lochmaeosmilia trapeziformis* (GREGORY)	ALLOITEAU (1958: 68)
(6) *Stylina kachensis* GREGORY	*Stylina kachensis* GREGORY	
(7) *Astrocoenia bernensis* KOBY var. *indica* GREGORY	*Actinastrea bernensis* (KOBY)	LATHUILIÈRE (1989); this paper
(8) *Stephanocoenia magna* GREGORY	*Gregorycoenia magna* (GREGORY)	BEAUVAIS (1978: 57)
(9) *Favia baryphyllioides* GREGORY*	*Gregorycoenia baryphyllioides* (GREGORY)	BEAUVAIS (1978: 58)
(10) *Amphiastraea piriformis* GREGORY	*Amphiastraea piriformis* GREGORY	
(11) *Placosmilia sessilis* (MILASCHEWITSCH)	*Axosmilia sessilis* (MILASCHEWITSCH)	LAUXMANN (1901: 158)
(12) *Placosmilia kachensis* GREGORY	*Axosmilia kachensis* (GREGORY)	this paper
(13) *Placosmilia scalpriformis* GREGORY*	*Placosmilia scalpriformis* GREGORY	
(14) *Placosmilia caeliformis* GREGORY*	*Axosmilia caeliformis* (GREGORY)	LAUXMANN (1901: 158)
(15) *Trochosmilia indica* GREGORY*	*Trochosmilia indica* GREGORY	
(16) *Montlivaltia paleta* GREGORY*	*Montlivaltia paleta* GREGORY	
(17) *Montlivaltia cornutiformis* GREGORY var. *typica* GREGORY	*Montlivaltia cornutiformis* GREGORY	BEAUVAIS (1972: 49)
(18) *Montlivaltia cornutiformis* GREGORY var. *crassa* GREGORY	*Montlivaltia cornutiformis* GREGORY	BEAUVAIS (1972: 49)
(19) *Montlivaltia cornutiformis* GREGORY var. *spissiradiata* GREGORY	*Montlivaltia cornutiformis* GREGORY	BEAUVAIS (1972: 49)
(20) *Montlivaltia cornutiformis* GREGORY var. *obliquata* GREGORY	*Montlivaltia cornutiformis* GREGORY	BEAUVAIS (1972: 49)
(21) *Montlivaltia cornutiformis* GREGORY var. *cordata* GREGORY	*Montlivaltia cornutiformis* GREGORY	BEAUVAIS (1972: 49)
(22) *Montlivaltia cornutiformis* GREGORY var. *elliptica* GREGORY	*Montlivaltia cornutiformis* GREGORY	BEAUVAIS (1972: 49)
(23) *Montlivaltia cornutiformis* GREGORY var. *vasiformis* GREGORY	*Montlivaltia cornutiformis* GREGORY	BEAUVAIS (1972: 49)
(24) *Montlivaltia chariensis* GREGORY	*Montlivaltia chariensis* GREGORY	
(25) *Montlivaltia frustriformis* GREGORY	*Montlivaltia frustriformis* GREGORY	
(26) *Montlivaltia kachensis* GREGORY	*Montlivaltia frustriformis* GREGORY	this paper
(27) *Montlivaltia cululus* GREGORY	*Montlivaltia frustriformis* GREGORY	this paper
(28) *Complexastraea kachensis* GREGORY	*Complexastraea kachensis* GREGORY	
(29) *Isastrea propinqua* THURMANN & ETALLON var. *kachensis* GREGORY	*Isastrea propinqua* THURMANN & ETALLON	this paper
(30) *Isastrea hemisphaerica* GREGORY	*Isastrea hemisphaerica* GREGORY	
(31) *Isastrea exserta* GREGORY	*Ampakabastraea exserta* (GREGORY)	this paper
(32) *Isastrea parva* GREGORY	*Melikerona parva* (GREGORY)	
(33) *Isastrocoenia kachensis* GREGORY*	*Isastrocoenia kachensis* GREGORY	
(34) *Thamnastraea crateriformis* GREGORY	*Craterastraea crateriformis* (GREGORY)	BEAUVAIS (1978: 56)
(35) *Thamnastraea mayeri* KOBY var. *indica* GREGORY	*Kobya* sp.	this paper
(36) *Thamnastraea valfinensis* KOBY* var. *kachensis* GREGORY	*Thamnastraea valfinensis* KOBY var. *kachensis* GREGORY	
(37) *Dimorphastraea sigillum* GREGORY	*Dimorphastrea sigillum* GREGORY	
(38) *Centrastraea kobyi* GREGORY*	?*Thamnasteria lyelli* (GREGORY)	BEAUVAIS (1978: 52)
(39) *Stibastraea structa* GREGORY	*Stibastraea structa* GREGORY	
(40) *Stibastraea paeninsula* GREGORY	*Dimorphastrea paeninsulae* (GREGORY)	BEAUVAIS (1978: 55)
(41) *Latomaeandra humilis* GREGORY*	*Latomaeandra humilis* GREGORY	
(42) *Archaeoseris thamnastraeoides* GREGORY*	*Comophyllia thamnastraeoides* GREGORY	LATHUILIÈRE (1989)
(43) *Comoseris jumarense* GREGORY var. *radiata* GREGORY	*Collignonastraea jumarensis* (GREGORY)	ALLOITEAU (1958: 99); BEAUVAIS (1978: 65)
(44) *Comoseris jumarense* GREGORY var. *irregularis* GREGORY	*Collignonastraea jumarensis* GREGORY	this paper
(45) *Comoseris discontinua* GREGORY	*Brachyseris* ? *discontinua* (GREGORY)	BEAUVAIS (1978: 66)
(46) *Comoseris plana* GREGORY	*Collignonastraea jumarensis* (GREGORY)	this paper
(47) *Comoseris microphyllioides* Gregory	*Collignonastraea microphyllioides* (GREGORY)	this paper
(48) *Protethmos Oldhami* GREGORY*	*Epistreptophyllum oldhami* (GREGORY)	VAUGHAN & WELLS (1943); FLÜGEL (1966: 59)
(49) *Protethmos Duncani* GREGORY*	*Epistreptophyllum duncani* (GREGORY)	LATHUILIÈRE (1989)
(50) *Metethmos Blanfordi* GREGORY	*Protethmos blanfordi* (GREGORY)	BEAUVAIS (1978: 60)
(51) *Metethmos Griesbachi* GREGORY	*Protethmos blanfordi* (GREGORY)	BEAUVAIS (1978: 60)
(52) *Frechia cornutiformis* GREGORY	*Epistreptophyllum cornutiformis* (GREGORY)	LATHUILIÈRE (1989)
(53) *Sematethmos sinuosa* GREGORY*	*Sematethmos sinuosa* GREGORY	
(54) *Kobya crassolamellosa* GREGORY	*Kobya crassolamellosa* GREGORY	
(55) *Kobya cancellata* GREGORY	*Kobya crassolamellosa* GREGORY	this paper
(56) *Kobya lenticulata* GREGORY	*Kobya lenticulata* GREGORY	
(57) *Anabacia acaulis* GREGORY	'*Anabacia*' *acaulis* GREGORY	this paper

(58) *Anabacia fungiformis* GREGORY	*Trochoplegma fungiformis* (GREGORY)	BEAUVAIS (1972: 70); this paper
(59) *Genabacia kachensis* GREGORY*	*Genabacia kachensis* GREGORY	
(60) *Trocharaea patelliformis* GREGORY	*Trocharea patelliformis* GREGORY	
(61) *Trochoplegma tenuilamellosa* GREGORY	*Trochoplegma tenuilamellosa* GREGORY	
(62) *Microsolena subturbinata* GREGORY	*Microsolena subturbinata* GREGORY	
(63) *Microsolena variolata* GREGORY	*Microsolena subturbinata* GREGORY	this paper
(64) *Tricycloseris triangularis* GREGORY	*Tricycloseris triangularis* GREGORY	
(65) *Tricycloseris patelliformis* GREGORY	*Dimorpharaea patelliformis* (GREGORY)	LATHUILIÈRE (1989)
(66) *Dimorpharaea stellans* GREGORY	*Dimorpharaea stellans* GREGORY	
(67) *Dimorpharaea distincta* GREGORY	*Dimorpharaea stellans* GREGORY	BEAUVAIS (1978: 63)
(68) *Dimorpharaea continua* GREGORY	*Dimorpharaea stellans* GREGORY	BEAUVAIS (1978: 63)
(69) *Dimorpharaea orbica* GREGORY	*Dimorpharaea orbica* GREGORY	
(70) *Thamnaraea amorpha* GREGORY	*Microsolena amorpha* (GREGORY)	this paper
(71) *Thamnaraea tuberosa* GREGORY	*Microsolena amorpha* (GREGORY)	this paper