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Middle to Upper Jurassic bivalves of the southwestern Morondava Basin (Madagascar)

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Abstract

Middle and Upper Jurassic bivalves from the southwestern Morondava Basin are described and figured. They belong to 74 species and 57 genera/subgenera. New taxa are *Eosphaera* gen. nov., *Neocrassina* (*Pruvostiella*) *madagascariensis* sp. nov., and *Quenstedtia* *madagascariensis* sp. nov. Most of the bivalves come from Callovian and Oxfordian strata. The fauna belongs to the Ethiopian faunal province and shows a great similarity to the bivalve fauna of the neighbouring Kachchh Basin in western India. The bivalves represent mainly shallow-marine environments, but some of them probably occupied brackish settings. Characteristic taxa of the faunal province are the genera *Seebachia* (with the subgenera *Seebachia* and *Eoseebachia*) and *Indogrammatodon*. Surprising is the relative scarcity of pectinid bivalves, which are represented only by three taxa.

Key words: Callovian, Oxfordian, Bivalves, Taxonomy, Ecology, Ethiopian faunal province, Malagasy Seaway.

Zusammenfassung

Mittel- und oberjurassische Bivalven des südwestlichen Morondava Beckens werden beschrieben und abgebildet. Neue Taxa sind *Eosphaera* gen. nov., *Neocrassina* (*Pruvostiella*) *madagascariensis* sp. nov. und *Quenstedtia* *madagascariensis* sp. nov. Der Großteil der Bivalven stammt aus Schichten des Callovium und Oxfordium. Die Fauna gehört zur Äthiopischen Faunenprovinz, und ähnelt stark der Bivalvenfauna des benachbarten Kachchh Beckens in Westindien. Die Fossilien deuten überwiegend auf flachmarine Habitate; einige Formen lebten vermutlich im Brackwasser. Charakteristische Taxa der Faunenprovinz sind die Gattungen *Seebachia* (mit den Untergattungen *Seebachia* und *Eoseebachia*) und *Indogrammatodon*. Überraschend ist die geringe Häufigkeit von Pectiniden, die lediglich mit drei Taxa vertreten sind.

Schlüsselwörter: Callovium, Oxfordium, Bivalven, Taxonomie, Äthiopische Faunenprovinz.

1. Introduction

The Mesozoic Malagasy Seaway was a southward-directed extension of the Neotethys between India, Madagascar and eastern Africa. Originating as a series of late Palaeozoic and Triassic pull-apart basins in context with the break-up of Gondwana (e.g., Montenat et al. 1996; Geiger et al. 2004; Schandlmeier et al. 2004), its Jurassic record consists of non-marine to shallow marine sediments and faunas that are locally preserved in rift basins at both margins of the seaway. Probably from the Callovian onwards, sea-floor spreading transformed the rift basin into the incipient Indian Ocean (Coffin & Rabinowitz 1992; Montenat et al. 1996).

Jurassic bivalves colonizing the margins of the seaway have received comparably little attention in

the last decades, except for those from the Kachchh rift basin of western India (Jaitly et al. 1995; Pandey et al. 1996; Fürsich & Heinze 1998; Fürsich et al. 2000) and a brief record of Upper Jurassic bivalves from Ethiopia (Kiessling et al. 2011). Older literature describing Jurassic bivalves mainly dealt with bivalves populating the African margin (e.g., Futterer 1897; Dacque 1905, 1910; Lange 1914; Hennig 1914, 1924; Dietrich 1925, 1933; Weir 1925, 1929, 1930, 1939; Stefanini 1925, 1939; Diaz-Romero 1931; Venzo 1949; Jaboli 1959; Cox 1965), whereas information from western Madagascar is fairly scant (Newton 1889, 1895; Barrabé 1929; Besairie 1932, 1936; Nicolai 1950, 1951).

The present description of Middle and Upper Jurassic (Bajocian to Kimmeridgian) bivalves is based on material from the Morondava Basin in southwe-

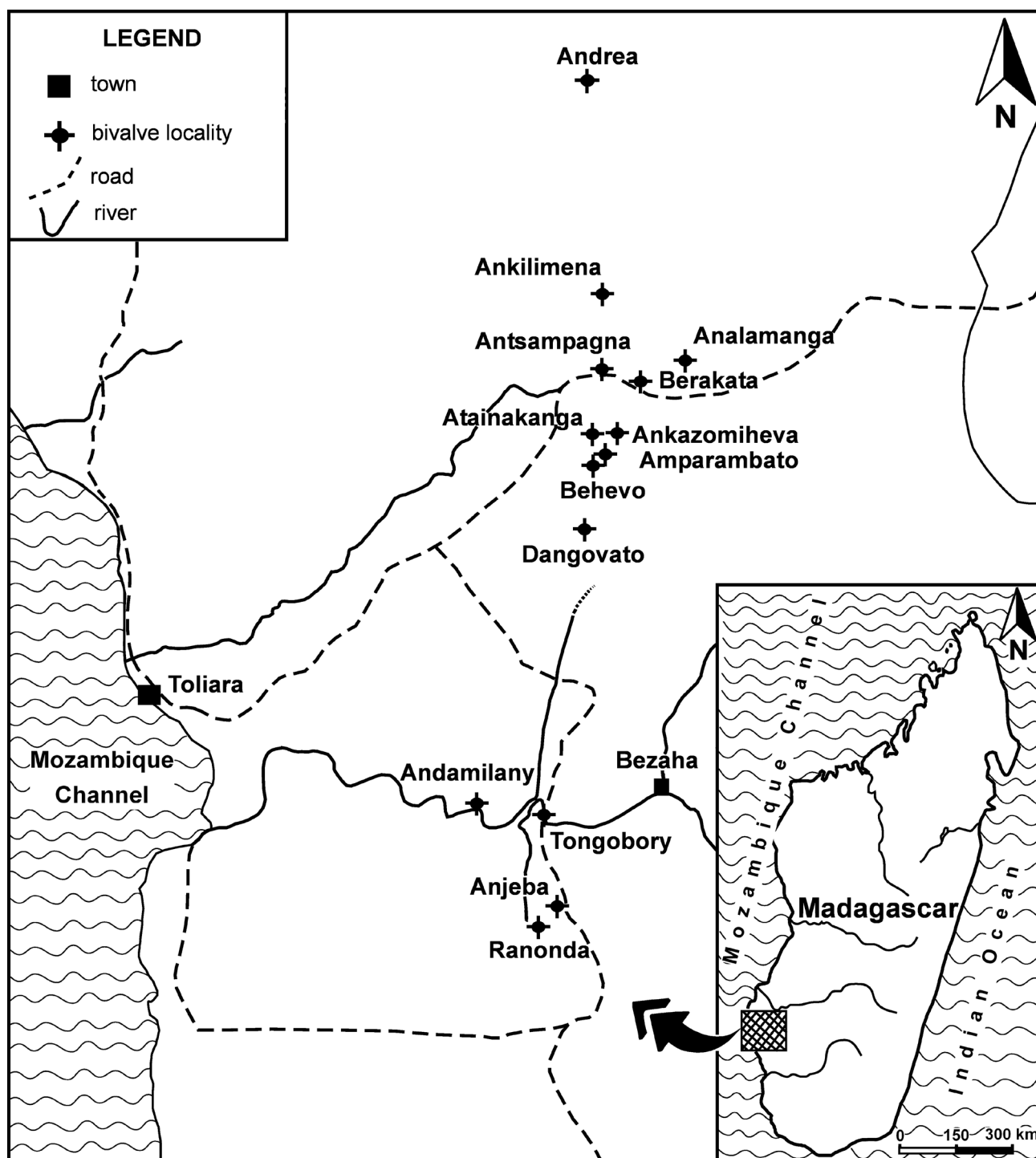
stern Madagascar (Text-fig. 1), which was collected by Markus Geiger in the context of a sedimentological-stratigraphic study (Geiger 2004). The stratigraphic distribution of the various taxa is found in Geiger & Schweigert (2006).

2. Material and localities

The material, altogether several hundred specimens, spans the time slice Bajocian to Kimmeridgi-

an (Text-fig. 2), whereby the bulk of the specimens are from the Callovian–Oxfordian strata. The bivalves have been sampled from 15 sections (Text-fig. 1; Roman numbers refer to the section numbering in Geiger & Schweigert 2006: fig. 2):

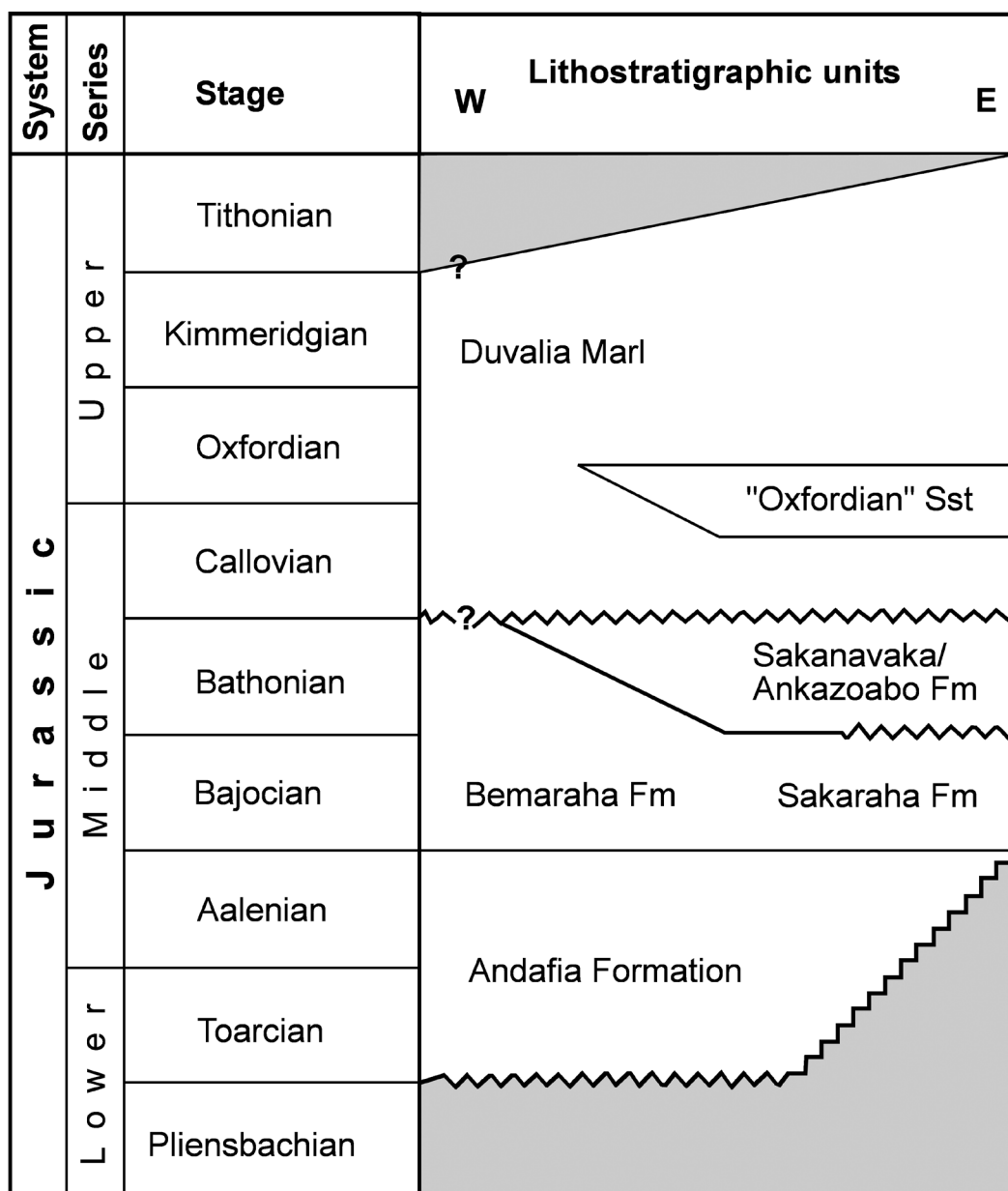
- (1) Anjeba (S23°42.090', E44°20.607'): Bathonian (= Ia);
- (2) Andamilany (S23°42.265', E44°20.395'): Bathonian (= Ib);
- (3) Ranonda (S23°43.438', E44°18.328'): ?Callovian (= IIb);



Text-figure 1: Position of the 15 sections in the Morondava Basin, from which the Jurassic bivalves have been collected. Detailed lithologies of the sections have been published by Mette & Geiger (2004a, b) and Geiger & Schweigert (2006).

- (4) Tongobory (S23°31.544', E44°19.070'): ?Lower – Middle Bathonian (= III);
- (5) Beraketa (S22°54.901', E44°28.618'): Middle – Upper Oxfordian (= IVb);
- (6) Dangovato (S23° 06.895', E44° 23.254'): ?Callovian – Lower Kimmeridgian (= IVa);
- (7) Ankazomiheva (S22° 58.078', E44° 26.941'): Bathonian – Lower Callovian (= V);
- (8) Amparambato (S23° 00.001', E44° 24.929'): upper Lower Callovian (=VIb);
- (9) Atainakanga (S22° 58.330' E 44°24.247'): Callovian (= VIa);
- (10) Antsampagna (S22° 52.470', E44° 24.950'): Upper Oxfordian – Lower Kimmeridgian (= VIb);
- (11) Analamanga (S22° 51.738', E44° 32.950'): Bajocian (= X);
- (12) Ankilimena (S22° 45.417', E44° 25.096'): Middle – Upper Oxfordian (= XI);
- (13) Andrea (S22° 25.695', E44° 23.459'): Middle Oxfordian (= XII);
- (14) Behevo (S23°01.105', E 44°24.940'): Callovian.
- (15) Beronono (S17° 16.225', E46° 22.225'): Bajocian.

Detailed logs of the sections from which the bivalves have been collected and information on their stratigraphic position can be found in Geiger (2004), Geiger & Schweigert (2006), Mette & Geiger (2004a; Beronono) and Mette & Geiger (2004b; Behevo). The Beronono section belongs to the neighbouring Majaungwa Basin, situated further north. The few bivalves in the present collection from this locality have also been included here.



Text-figure 2: Lithostratigraphy of the Jurassic rocks of the Morondava Basin (after Geiger 2004 and Geiger & Schweigert 2006).

3. Stratigraphy

The Middle and Upper Jurassic strata of the Morondava Basin still lack a coherent lithostratigraphic framework. Besairie & Collignon (1956, 1960, 1972) provided summaries of the Mesozoic rock succession, but did not create a lithostratigraphic framework for the Jurassic strata. Geiger (2004) briefly described the various lithostratigraphic units (Text-fig. 2) and correlated them across the southern Morondava Basin. In 2006, Geiger & Schweigert provided a chronostratigraphic framework for the various sections based on the distribution of ammonites. For this reason, chronostratigraphic terms rather than lithostratigraphic terms are given to describe the occurrence of the bivalve taxa.

4. Taxonomy

The classification scheme followed here is that of Bouchet et al. (2010) and Carter et al. (2011). The measurements were taken with a Vernier caliper. Abbreviations are as follows:

L = length

H = height

I = inflation

L_A = anterior length

n_{ribs} = number of ribs

AV: articulated specimen; RV: right valve; LV: left valve; SV: single valve.

The synonymy lists contain only the original reference and occurrences documented from the Ethiopian faunal province. The material has been deposited in the collections of the Bayerische Staatssammlung für Paläontologie und Geologie (prefix: BSPG 2015 XIII).

Class Bivalvia Linnaeus, 1758

Subclass Protobranchia Pelseneer, 1889

Order Nuculida Dall, 1889

Family Nuculidae J. Gray, 1824

Genus *Palaeonucula* Quenstedt, 1830

Type species. *Nucula hammeri* DeFrance, 1825.

Palaeonucula cuneiformis (J. de C. Sowerby, 1840)

Pl. 1, Figs. 1–3

- 1840 *Nucula?* *cuneiformis* sp. nov. – J. de C. Sowerby: pl. 22, fig. 4 and explanation.
 non 1939 *Nucula cuneiformis* Sow. – Stefanini: 219, pl. 24(25), fig. 3.
 1940 *Nucula* (*Palaeonucula*) *cuneiformis* J. de C. Sowerby – Cox: 13, pl. 1, figs. 5–10.
 1940 *Nucula* (*Palaeonucula*) *kaoraensis* sp. nov. – Cox: 15, pl. 1, figs. 11–14.
 1940 *Nucula* (*Palaeonucula*) *blanfordi* sp. nov. – Cox: 16, pl. 1, figs. 15–19.
 1956 *Nucula* (*Palaeonucula*) *kaoraensis* Cox – Agrawal: 51, pl. 7, fig. 3a.
 1959 *Nucula cuneiformis* Sowerby – Jaboli: 46, pl. 6, fig. 3.
 1980 *Palaeonucula kaoraensis* Cox – Kanjilal: 335, pl. 1, figs. 8–10.

1980 *Palaeonucula cuneiformis* (J. de C. Sowerby) – Kanjilal: 334, pl. 1, figs. 4–7.

v 1995 *Palaeonucula cuneiformis* (J. de C. Sowerby) – Jaitly et al.: 155, pl. 1, figs. 8–17, pl. 2, figs. 1–2, Textfigs. 6–9.

Material. Upper Bathonian of Tongobory S, Lower Callovian of Amparambato, Callovian of Behevo: 1 RV, 2 LV, 1 AV (BSPG 2015 XIII 188–191).

Description. Shell small (specimen BSPG 2015 XIII 190: L: 20.2 mm, H: 13.3 mm), elongate-ovate, moderately inflated, anterior part much longer than posterior one. Anterodorsal margin weakly convex, anterior end tapering, ventral margin strongly and asymmetrically convex. Posterior end subangular. Umbones slightly depressed, posteriorly directed. Lunule broad but poorly demarcated, escutcheon long and very narrow. Hinge taxodont with numerous subequal teeth. Shell surface covered with fine com-marginal growth lines. Anterior and posterior adductor muscle scars impressed, irregularly oval, pallial line entire.

Remarks. The specimens fall well within the range of variation of the species as documented by Jaitly et al. (1995).

Subclass Autobranchia Grobben, 1894

Order Mytilida Férussac, 1822

Family Mytilidae Rafinesque, 1815

Genus *Arcomytilus* Agassiz in J. Sowerby, 1842

Type species. *Mytilus pectinatus* J. Sowerby, 1821.

Arcomytilus laitmairensis (de Loriol, 1883)

Pl. 1, Figs. 4–7

- 1883 *Mytilus laitmairensis* sp. nov. – de Loriol: 57, pl. 8, figs. 6–12.
 1930 *Mytilus subpectinatus* d'Orbigny – Basse: 138, pl. 5, fig. 10.
 1931 *Mytilus laitmairensis* de Loriol – Diaz-Romero: 29, pl. 2, figs. 11, 12.
 1935 *Mytilus* (*Arcomytilus*) *laitmairensis* Loriol – Cox: 164, pl. 15, figs. 13, 14.
 1939 *Mytilus* (*Arcomytilus*) *cossmanni* Rollier – Stefanini: 215, pl. 23, fig. 22.
 1940 *Brachidontes* (*Arcomytilus*) *laitmairensis* (de Loriol) – Cox: 81, pl. 5, figs. 15–17.
 1959 *Mytilus* (*Arcomytilus*) *laitmairensis* de Loriol – Jaboli: 44, pl. 5, fig. 10.
 1965 *Mytilus* (*Arcomytilus*) *laitmairensis* (de Loriol) – Cox: 41, pl. 4, fig. 3.
 1968 *Brachidontes* (*Arcomytilus*) *laitmairensis* (de Loriol) – Ficcarelli: 33, pl. 3, fig. 5a, b.
 1971 *Mytilus* (*Arcomytilus*) *laitmairensis* de Loriol – Jordan: 152, pl. 20, fig. 8a, b.
 v 1995 *Arcomytilus laitmairensis* (de Loriol 1883) – Jaitly et al.: 201, pl. 21, figs. 1–3.
 2011 *Arcomytilus laitmairensis* (de Loriol 1883) – Kiessling et al.: 207, fig. 13A, B.

Material. Lower Callovian of Amparambato: 3 RV, 4 LV, 5 AV (BSPG 2015 XIII 145–152).

Measurements. Table 1.

Table 1. Measurements (in mm) of *Arcomytilus laitmairensis* (de Loriol, 1883).

specimen	diagonal length	inflation
BSPG 2015 XIII 145	33.3	23.8
BSPG 2015 XIII 149	58.7	37.6
BSPG 2015 XIII 150	56.8	-
BSPG 2015 XIII 151a	53.2	-
BSPG 2015 XIII 151b	58.3	-

Description. Shell medium-sized (Table 1), recurved, well-inflated. Umbones terminal, slightly incurved anteriorly. Posterodorsal margin long, weakly curved, forming a blunt angle with the evenly curved posterior margin, which grades smoothly into the anteroventral margin, the latter being concave. Posterior umbonal carina very broad, hardly noticeable, shell anterior of anterior umbonal carina slightly concave. Shell ornamented with distinct, spaced growth lines and growth restrictions in addition to numerous radial riblets, some of which bifurcate towards the shell margin. Anterior-most area ventrally of the beaks devoid of ornamentation.

Remarks. *Arcomytilus laitmairensis* is widespread within the Ethiopian faunal province, but so far had not been recorded from Madagascar, where it seems to be common only in Lower Callovian beds at Amparambato. An extensive synonymy list can be found in Kiessling et al. (2011).

Genus *Lycettia* Cox, 1937

Type species. *Mytilus lunularis* Lycett, 1857.

Lycettia indica Cox, 1940
Pl. 1, Fig. 8

1940 *Lycettia indica* sp. nov. – Cox: 85, pl. 5, figs. 19, 20.

Material. Lower Kimmeridgian of Antsampangna: 1 LV (BSPG 2015 XIII 153).

Description. Shell incomplete, posterior part missing. Umbones acute, terminal; dorsal margin straight, grading into the convex posterior margin. Sharp carina describing a faint curve from umbo towards posteroventral margin. Area anterior of the carina small, concave. Surface of shell smooth except for faint growth lines. Internal features not seen.

Remarks. The specimen from Madagascar closely resembles the figure of Cox (1940: fig. 19a, b) from Kachchh, a specimen of unknown locality and horizon. Cox mentions an obtuse angle of ~150° between the posterodorsal and posterior margin, a

feature not present in our specimen. However, judging from Cox' figure this angle might be an artefact as the posterodorsal margin appears to be slightly eroded.

Other Jurassic species of *Lycettia* are either much narrower (e.g., *Lycettia dalpriazi* Venzo, 1949: 127, pl. 14 fig. 6 from the Middle Jurassic of East Africa) or exhibit a distinct angulation between the posterior and posterodorsal margin.

Genus *Regulifer* Fürsich & Werner, 1988

Type species. *Mytilus beirensis* Sharpe, 1850.

Regulifer beirensis Fürsich & Werner, 1988
Pl. 1, Fig. 9

- v 1850 *Mytilus beirensis* sp. nov. – Sharpe: 187, pl. 26, fig. 1.
- v 1988 *Regulifer beirensis* (Sharpe, 1850) – Fürsich & Werner: 127, pl. 5, figs. 1–4, pl. 6 figs. 1–3, textfigs. 14, 15.

Material. Lower Callovian of Amparambato: 1 AV (BSPG 2015 XIII 155).

Description. Specimen thick-shelled, moderately large (L: 57.8 mm; H: 64.7 mm; I: 24.8 mm), modioliform, with broad, curved umbonal ridge, which fades towards the posteroventral margin. Umbones subterminal; ventral margin concave, posterodorsal margin faintly convex, forming an obtuse angle with the long, nearly straight posterior margin; posteroventral and ventral margins meeting in a well rounded curve. Internal ligament with at least two grooves running parallel to the posterodorsal margin. Shell surface covered with well developed commarginal growth lines.

Remarks. Diagnostic features of *Regulifer* are a thick shell and multiple ligament grooves running parallel to the posterodorsal margin (e.g., Fürsich & Werner 1988: text-fig. 15). Although the present specimen is articulated, part of the shell is broken off in the umbonal area revealing the typical ligament of *Regulifer*. Compared to the material from the Kimmeridgian of Portugal described by Fürsich & Werner (1988), the angulation between the posterodorsal and posterior margins is more strongly developed, a feature which we regard to fall within the variability of the species.

Within the Ethiopian faunal province *Regulifer* has been recorded also from Callovian rocks of Kachchh (Jaitly et al. 1995: 204, pl. 23, fig. 4, text-fig. 23), but that specimen is too fragmentary for identification at the species level.

Regulifer? sp.
Pl. 1, Fig. 12

Material. Bajocian of Analamanga: 1 AV (composite mould) (BSPG 2015 XIII 262).

Description and remarks. Posterior part of the articulated, obliquely elongated, slightly gaping composite mould missing. Umbones subterminal, anterior lobe rounded. Umbonal ridge broad, rounded, curved, extending to posteroventral margin. A shallow sulcus situated anterior of this ridge. Dorsal margin straight, forming obtuse angle with the posterior margin. Anteroventral margin straight to weakly concave. With at least two short sub-vertical teeth anterior of the umbones and two ligament grooves running parallel to the dorsal margin.

Due to its poor state of preservation, a precise identification of the specimen is impossible. Based on the presence of two ligament grooves, the specimen might well be a juvenile form of *Regulifer beirensis* Fürsich & Werner, 1988.

Genus *Lithophaga* Röding, 1798
Subgenus *Lithophaga* Röding, 1798

Type species. *Mytilus lithophagus* Linnaeus, 1780.

Lithophaga (Lithophaga) cf. alsus (d'Orbigny, 1850)
Pl. 1, Figs. 10, 11

- cf. 1850 *Lithodomus alsus* – d'Orbigny: 312, nr 293.
cf. 1913 *Lithodomus alsus* d'Orbigny – Thevenin: 157, pl. 27, figs. 37, 38.

Material. Lower Kimmeridgian of Antsampangna: 2 AV (internal moulds) (BSPG 2015 XIII 156a, b).

Description and remarks. The comparatively short internal moulds (specimen BSPG 2015 XIII 156a: L: 21.9 mm; H: 13.7 mm; I: 10.8 mm) are closest in outline and inflation to *Lithophaga alsus* (d'Orbigny, 1850), a species occurring in the Bathonian of Normandy (see also Cossmann 1906: 11, pl. 2, figs. 17–21), most other Jurassic species of *Lithophaga* being distinctly more elongated. The strongly prosogyrate umbones are subterminal. The anterior margin is small, the posterior margin well rounded; the dorsal and ventral margins are subparallel, the former being nearly straight, the latter describing a wide gentle curve. The posterior part of the specimens is distinctly expanded compared to the anterior part. As the two specimens are preserved as internal moulds, we only tentatively place them in *Lithophaga (L.) alsus*.

The taxa *Lithophaga* sp. indet. A, B, and C described by Cox (1940: 73–74, pl. 5 figs. 21–23) from Bathonian to Tithonian rocks of Kachchh constitute in fact borings and should be referred to the ichnogenus *Gastrochaenolites*.

Genus *Inoperna* Conrad in Kerr, 1875

Type species. *Modiolus (Inoperna) carolinensis* Conrad, 1875.

Inoperna khadirensis Fürsich & Jaitly, 1995
Pl. 1, Fig. 13

- 1910 *Modiola plicata* Sow. – Daque: 30, pl. 5, fig. 10 (non Sowerby).
1940 *Modiolus (Inoperna) plicatus* J. Sowerby – Cox: 71, pl. 5, fig. 13 only.
1974 *Inoperna sowerbyana* (d'Orbigny) – Singh & Kanjilal: 118, fig. 4.
v 1995 *Inoperna khadirensis* sp. nov. Jaitly et al.: 201, pl. 21, figs. 5–7.

Material. Upper Bathonian of Tongobory: 1 incomplete AV (BSPG 2015 XIII 154).

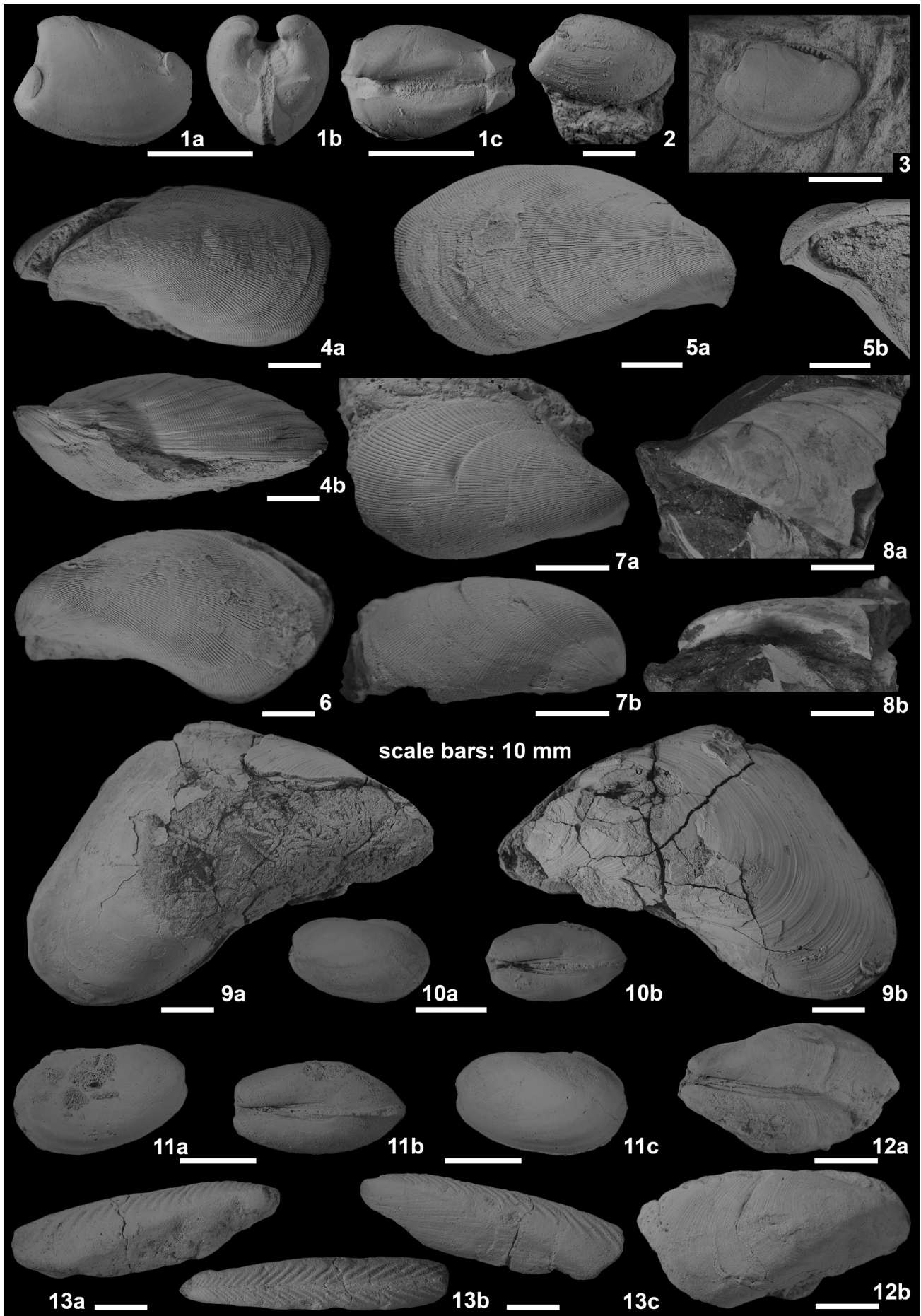
Description. Shell small for the genus (H: ~15 mm), narrow and strongly elongated. Umbones subterminal; dorsal and ventral margins nearly parallel, the dorsal margin slightly convex. Broad umbonal ridge extending to the posteroventral margin. Area anteroventral of the umbonal ridge smooth except for growth lines and nearly as large as area situated posterodorsally to the ridge. The latter area is covered with prominent, slightly curved, oblique and forward-directed primary ribs which fade towards the umbonal ridge. Secondary ribs absent.

Remarks. The specimen from Madagascar is very close in shape and ornamentation to the type material from the Bathonian-Callovian rocks of Kachchh.

Order Arcida J. Gray, 1854
Family Paralleodontidae Dall, 1898
Genus *Grammatodon* Meek & Hayden, 1861
Subgenus *Cosmetodon* Branson, 1942

Type species. *Arca keyserlingii* d'Orbigny, 1850.

Plate 1: (1–3) *Palaeonucula cuneiformis* (J. de C. Sowerby, 1840). 1. Articulated internal mould (BSPG 2015 XIII 191), Callovian strata, Behevo; a, right valve view; b, posterior view; c, dorsal view. 2. Right valve (BSPG 2015 XIII 188), Lower Callovian strata, Amparambato. 3. Internal mould of right valve (BSPG 2015 XIII 190), Upper Bathonian strata, Tongobory S. **(4–7)** *Arcomytilus laitmairensis* (de Loriol, 1883), Lower Callovian strata, Amparambato. 4. Articulated specimen (BSPG 2015 XIII 149); a, left valve view; b, ventral view. 5. Right valve (BSPG 2015 XIII 152); a, side view; b, view of hinge. 6. Articulated specimen (BSPG 2015 XIII 150), left valve view. 7. Right valve (BSPG 2015 XIII 145); a, side view; b, ventral view. **(8)** *Lycettia indica* Cox, 1940. Fragment of left valve, Lower Kimmeridgian strata, Antsampangna (BSPG 2015 XIII 153), a, side view; b, ventral view. **(9)** *Regulifer beirensis* Fürsich & Werner, 1988. Articulated specimen (BSPG 2015 XIII 155), Lower Callovian strata, Amparambato; a, right valve view; b, left valve view. **(10, 11)** *Lithophaga (Lithophaga) cf. alsus* (d'Orbigny, 1850), Lower Kimmeridgian strata, Antsampangna. 10. Articulated internal mould (BSPG 2015 XIII 156b); a, left valve view; b, dorsal view. 11. Articulated internal mould (BSPG 2015 XIII 156a); a, right valve view; b, dorsal view. **(12)** *Regulifer?* sp. Articulated internal mould (BSPG 2015 XIII 262), Bajocian strata, Analamanga; a, ventral view; b, right valve view. **(13)** *Inoperna khadirensis* Fürsich & Jaitly, 1995. Fragmented articulated composite mould (BSPG 2015 XIII 154), Upper Bathonian strata, Tongobory S; a, right valve view; b, dorsal view; c, left valve view.



Grammatodon (Cosmetodon) elongatum?
(J. de C. Sowerby, 1824)
Pl. 2, Fig. 1

- ? 1824 *Cucullaea elongata* sp. nov. – J. de C. Sowerby: 67, pl. 447, fig. 1.

Material. Lower Callovian of Amparambato: 1 RV, 1 AV (BSPG 2015 XIII 129, 130).

Description. Shell strongly elongated, rhomboidal. Umbones depressed, slightly prosogyrate, situated one-third to one-fourth of shell length from the anterior end. With well developed sulcus running from the umbo towards the ventral margin, increasing in strength ventrally. Ventral margin sinuous, with corresponding indentation. Posteroventral margin occupying the lowest position; anteroventral margin well rounded, anterodorsal margin forming an angle of ~80° with the straight dorsal margin. Posterior end of shell not preserved. Cardinal area well developed, anteriorly wider than posteriorly, with regularly arranged grooves forming a chevron pattern.

Hinge not seen. Surface ornamented with numerous fine, radial riblets, every third or fourth riblet slightly stronger; riblets crossed by delicate growth lines resulting in a reticulate pattern.

Remarks. *G. (Cosmetodon) elongatum* is a highly variable species with a wide geographic distribution in western Europe. As the hinge of our specimens is not seen, their placement in *Cosmetodon* is somewhat doubtful, some species of *Parallelodon* having a very similar external appearance (see also Fürsich & Werner 1988).

Subgenus *Indogrammatodon* Cox, 1937

Type species. *Cucullaea virgata* J. de C. Sowerby in Grant, 1840.

Grammatodon (Indogrammatodon) iddhurgurensis Cox, 1940
Pl. 2, Fig. 2

- v 1940 *Grammatodon (Indogrammatodon) iddhurgurensis* sp. nov. – Cox: 52, pl. 3, figs. 3–6, pl. 4, figs. 1, 2.
v 1995 *Grammatodon (Indogrammatodon) iddhurgurensis* Cox – Jaitly et al.: 166, pl. 4, fig. 1.

Material. Middle Oxfordian of Ankilimena: 1 LV (BSPG 2015 XIII 126).

Description and remarks. The poorly preserved, incomplete internal mould of a left valve closely corresponds to a specimen of the species figured by Jaitly et al. (1995: 166, pl. 4, fig. 1a–c) from the Lower Kimmeridgian Kantkote Sandstone of Kachchh. Despite the poor preservation, the species assign-

ment is therefore thought to be correct. Originally the shell was quite thick as seen from calcite-healed fractures on the mould. This is another diagnostic feature.

Grammatodon (Indogrammatodon) virgatus
(J. de C. Sowerby, 1840)
Pl. 2, Figs. 3–7

- 1840 *Cucullaea virgata* sp. nov. – J. de C. Sowerby: pl. 22, figs. 1, 2 and explanation.
1914 *Grammatodon (Indogrammatodon) virgatus* (J. de C. Sowerby) – Hennig: 175, pl. 14, fig. 6a–c.
1937 *Grammatodon (Indogrammatodon) virgatus* (J. de C. Sowerby) – Cox: 195: 195, pl. 15, figs. 8, 9.
1940 *Grammatodon (Indogrammatodon) virgatus* (J. de C. Sowerby) – Cox: 47, pl. 2, figs. 22–30.
1949 *Grammatodon (Indogrammatodon) virgatus* (Sow.) – Venzo: 130, pl. 14, figs. 17–20.
1950 *Myopholas acuticostata* Sow., var. *madagascariensis* nov. var. – Nicolai: pl. 4, fig. 9a, b.
1951 *Myopholas acuticostata* Sow., var. *madagascariensis* nov. var. – Nicolai: 39.
1956 *Grammatodon (Indogrammatodon) virgatus* (J. de C. Sowerby) – Agrawal: 57, pl. 7, figs. 1, 2.
1968 *Grammatodon (Indogrammatodon) virgatus* (J. de C. Sowerby) – Maithani: 499, pl. 30, fig. 1.
1968 *Grammatodon (Indogrammatodon) coxi* sp. nov. – Maithani: 500, pl. 30, fig. 3a, b.
1968 *Cucullaea kutchensis* sp. nov. – Maithani: 501, pl. 30, fig. 5.
v 1995 *Grammatodon (Indogrammatodon) virgatus* (J. de C. Sowerby) – Jaitly et al.: 165: pl. 3, figs. 12–15.

Material. Lower Oxfordian: Amparambato: 1 RV, 2 LV (BSPG 2015 XIII 136); Dongovato: 2 LV (BSPG 2015 XIII 134, 140); Middle Oxfordian: Andrea: 1 RV, 2 LV, 1 AV (BSPG 2015 XIII 131, 137); Ankilimena: 1 RV (BSPG 2015 XIII 138); Berateka: 1 LV (BSPG 2015 XIII 132); Dangovato: 1 RV, 1 LV (BSPG 2015 XIII 135, 139); Upper Oxfordian of Dongovato: 2 LV (BSPG 2015 XIII 133); Lower Kimmeridgian of Antsampagna: 1 RV (BSPG 2015 XIII 144).

Measurements. Table 2.

Table 2. Measurements (in mm) of *Grammatodon (Indogrammatodon) virgatus* (J. de C. Sowerby, 1840).

specimen	L	H	I
BSPG 2015 XIII 144	43.8	30.1	-
BSPG 2015 XIII 140	43.3	27.9	-
BSPG 2015 XIII 134	74.5	49.1	57.4
BSPG 2015 XIII 131b	50.6	32.1	-
BSPG 2015 XIII 132	-	27.2	32.2

Description. Shell elongate-trapezoidal (L/H-ratio: 1.4), well inflated. Umbones situated between one-third to one-fourth of shell length from the anterior end. Umbones strongly incurved, orthogyrate, overhanging the cardinal area. Cardinal area of moderate width, ornamented with numerous delicate grooves

forming a chevron-shaped pattern. Shell outline variable: anterior margin oblique, poorly rounded, forming a sharp angle with the straight hinge line to well curved, forming a blunt angle with the hinge line. Posterior margin oblique. Ventral margin faintly curved to nearly straight. Posterior umbonal ridge varying in strength but generally rounded and becoming less conspicuous towards the posteroventral corner. Area posterior of the umbonal carina concave. Ornamentation of left valve consisting of approximately 17 strong, sharp and well spaced radial ribs. Towards the posterior umbonal ridge a number of faint secondary radial riblets are seen in most specimens. In some specimens these faint secondary radial riblets occur throughout the shell surface. Hinge of left valve with three long, horizontal teeth, the anterior end of which curves downwards towards the centre of the shell. Posteriorly, below the umbonal region, several increasingly shorter and more vertically oriented teeth are present. Posterior teeth long, parallel to the hinge margin, but converging downwards at their anterior end. Length of the posterior and anterior elongated teeth increasing dorsally towards the hinge margin. All teeth finely crenulated.

Remarks. As all our well preserved shells are left valves nothing can be said about the ornamentation of the right valve, which in *Indogrammatodon* is supposed to consist of more numerous but less strongly developed radial ribs than those of the left valve. However, our material very closely resembles *G. (I.) virgatus* as figured by several authors. *Indogrammatodon* is a characteristic taxon of the Ethiopian faunal province. From Kachchh, Madagascar, and East-Africa a number of species have been described from Bajocian to Kimmeridgian strata (Gardner & Campbell 1997). Differences between the various species are not always clear, especially as several ones are based on single specimens (e.g. *G. (I.) kantkotensis* Cox, 1940: 51, pl. 3, fig. 1).

G. (I.) egertonianus (Stolizka, 1865: 89, pl. 8, fig. 7) appears to be distinctly more elongated. This species is also common in the Middle to Upper Jurassic strata of the Tethys-Himalaya (e.g., Spiti Shales). However, the specimens figured by Cox (1937: 196, pl. 15, figs. 10, 11) from the Kimmeridgian of Somaliland (the term is used here and in the following in a geographical sense only) are clearly less elongated than the material from the Himalayas (see also Holdhaus 1913: 431, pl. 45, figs. 1–10) and may more likely represent *I. virgatus*.

G. (I.) irritans (Hennig), which is common in Upper Jurassic strata in Eastern Africa, is, according to Cox (1965: 32), smaller, less elongated, more strongly inflated and has a sharper posterior umbonal carina. However, the holotype of Hennig (1914: 175, pl. 14, fig. 6a–c) falls well within the range of variation of *virgatus* and has therefore been included in this species.

Venzo (1949: 130, pl. 14, figs. 17–20) described *G. (I.) virgatus* from the Bathonian of Somaliland,

which is also distinctly shorter than typical *virgatus* and most likely represents a different species. This is also true of two varieties created by Venzo (1949: 131–132, pl. 14 figs. 21, 22), *G. (I.) virgatus* var. *lasti* (Müller) and *G. (I.)* var. *trigona* n. var., whose precise taxonomic positions are not clear.

Nicolai (1950: 156, pl. 2, fig. 1) described *Cucullaea (I.) alternicosta* from Upper Bathonian to Callovian rocks of Madagascar. The two right valves carry numerous radial ribs of various strength. This species is less elongated than *I. virgatus* and its anterior margin is regularly curved. In the same paper Nicolai (1951: 39, pl. 4, fig. 9a, b) described *Myopholas acuticostata* Sow., var. *madagascariensis* nov. var. from Upper Oxfordian strata north of Beroy. The figured specimen clearly shows that it is not a *Myopholas* but an *Indogrammatodon*, corresponding closely to *virgatus*. For this reason it has been included in the present species as a junior synonym.

What is clearly needed is a quantitative analysis of the various species of *Indogrammatodon* to elucidate their relationships.

Grammatodon (Indogrammatodon) blakei Cox, 1940
Pl. 2, Fig. 8

1940 *Grammatodon (Indogrammatodon) blakei* sp. nov. –
Cox: 50, pl. 3, fig. 2a–c.

Material. Lower Oxfordian of Dongovato: 2 RV, 1 AV (BSPG 2015 XIII 141, 142).

Description. Shell medium-sized (L: 37.8 mm; H: 25.2 mm), moderately inflated, umbones slightly depressed, situated around one-third of shell length from the anterior end, with a sharp posterior carina, followed posteriorly by a distinctly concave area. Ventral margin faintly arched, grading into the slightly sigmoidal anterior margin, which forms an acute angle with the straight hinge line. Posterior margin straight, oblique, forming a blunt angle with the hinge margin. Cardinal area comparatively narrow. Ornamentation consisting of sharp, spaced radial ribs on the left valve, whereas the right valve, in addition, carries around three faint radial riblets between each pair of coarser ribs. Number of primary ribs 15 in left valve and 17 in right valve. Faint, regularly spaced growth lines produce a reticulate pattern. Hinge not seen.

Remarks. The present species differs from the very similar *G. (I.) virgatus* by being slightly shorter and by having a much sharper posterior carina. *G. (I.) blakei* has been regarded as a synonym of *G. (I.) virgatus* by Jaitly et al. (1995: 165). Until a larger data base is available we cannot judge whether the differences between the two taxa merit separation. For this reason we follow the conservative approach and keep them separate.

Grammatodon (Indogrammatodon) kantkotensis
Cox, 1940

Pl. 2, Figs. 9, 10

1940 *Grammatodon (Indogrammatodon) kantkotensis* sp. nov. – Cox: 50, 51, pl. 3, fig. 1.

Material. Upper Oxfordian of Dongovato: 3 RV, 2 LV, 5 AV (BSPG 2015 XIII 143).

Measurements. Table 3.

Table 3. Measurements (in mm) of *Grammatodon (Indogrammatodon) kantkotensis* Cox, 1940.

specimen	L	H	I
BSPG 2015 XIII 143a	21.5	14.6	15.9
BSPG 2015 XIII 143b	24.5	17.2	18.2
BSPG 2015 XIII 143c	25.3	17.3	19.2
BSPG 2015 XIII 143d	30.1	17.4	19.8

Description. Specimens small for the genus (Table 3), highly inflated, preserved as internal moulds. Length exceeding height by approximately one-third. Outline trapezoidal with straight, oblique posterior margin that grades into the broadly arched ventral margin and forms a blunt angle with the hinge margin. Anterior margin forming an approximately right angle with the hinge margin and grading into the broadly arched ventral margin. Only traces of the ornamentation seen, which apparently consisted of spaced radial ribs.

Remarks. Despite their poor preservation the specimens closely resemble the species originally described from the Oxfordian of Kachchh. The most diagnostic feature is the great inflation.

Order Ostreida Férussac, 1822
Family Arctostreidae Vialov, 1983
Genus *Actinostreon* Bayle, 1878

Type species. *Ostrea solitaria* J. de C. Sowerby, 1824.

Actinostreon marshii (J. Sowerby, 1814)
Pl. 2, Fig. 11

- 1814 *Ostrea marshii* sp. nov. – J. Sowerby: 103, pl. 48.
1840 *Ostrea Marshii* – J. de C. Sowerby: pl. 22, fig. 9, and explanation.
? 1933 *Alectryonia hennigi* n. sp. – Dietrich: 70, pl. 10, figs. 144, 145.
1952 *Lopha marshii* (J. Sowerby) – Cox: 100, pl. 10, fig. 14 a, b, pl. 11, fig. 8.
1956 *Lopha marshii* (J. Sow.) – Agrawal: 88, pl. 9, fig. 14.
? 1965 *Lopha kindopeensis* sp. nov. – Cox: 70, pl. 10, figs. 3–5.
? 1965 *Lopha hennigi* (Dietrich) – Cox: 71.
v1995 *Actinostreon marshii* (J. Sowerby 1814) – Jaitly et al.: 186, pl. 14, figs. 6–8.

Material. Lower Kimmeridgian of Antsampangna: 1 AV (BSPG 2015 XIII 1).

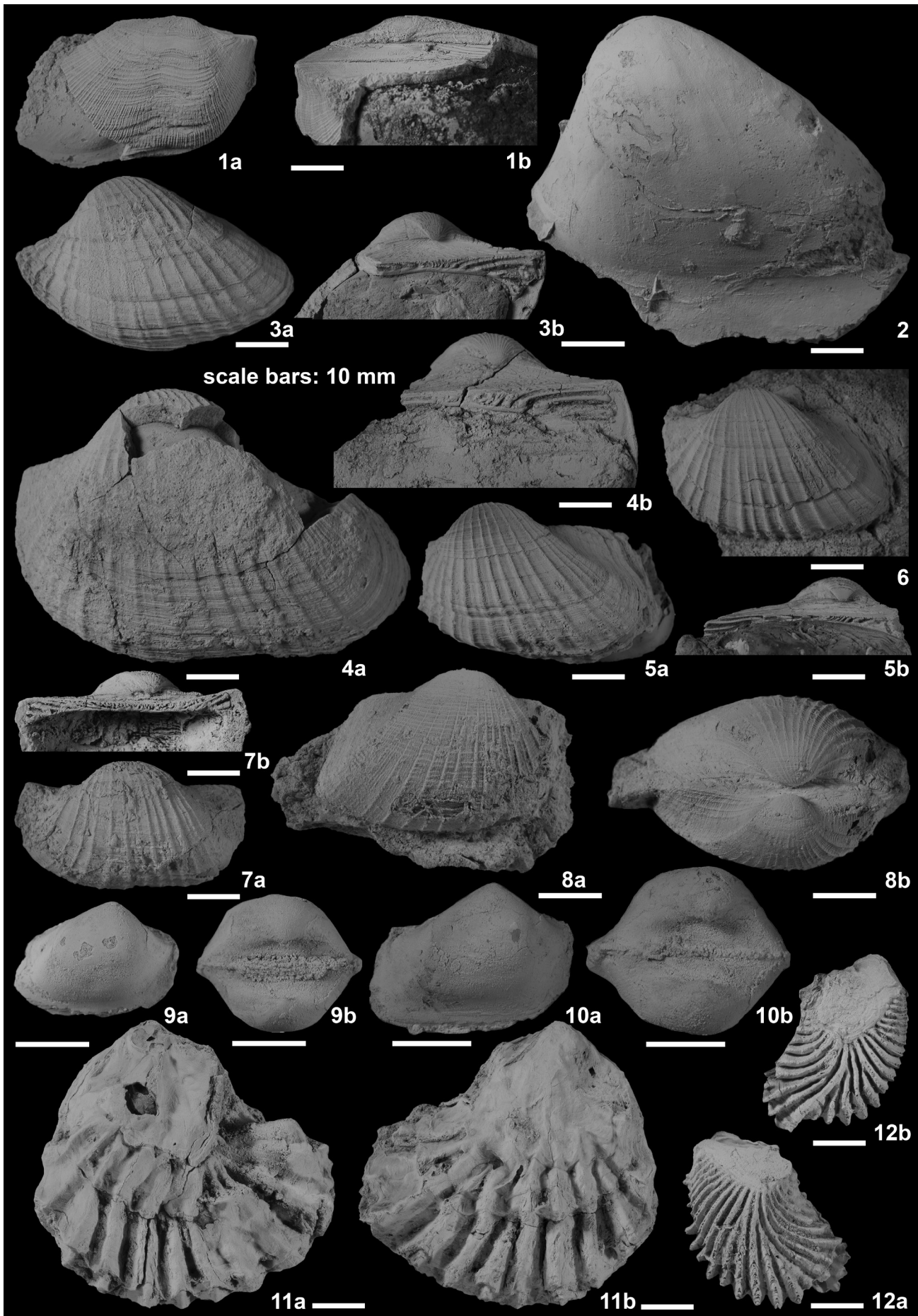
Description and remarks. Specimen 55.7 mm high and 58.2 mm long, rounded triangular in outline, moderately inflated. Attachment area of left valve large, highly irregular. Free part of left valve forming nearly a right angle with the attachment area. Right valve weakly inflated. Free part of valves with 15 strong, angular radial ribs, which vary in strength; those near the anterior and posterior ends being only weakly developed.

The specimen closely resembles the specimen figured by Cox (1952, pl. 10, fig. 14 a, b) from the Upper Bathonian of Kachchh. Jaitly et al. (1995) regarded *Lopha ? kindopeensis* Cox, 1965 from the Upper Kimmeridgian of East Africa as a synonym of *A. marshii*, interpreting the restriction of radial ribs to a relatively narrow area of the shell margin as an ecophenotypic feature, due to an unusually large attachment area. We regard this assignment here as tentative.

Dietrich (1933) erected the species *hennigi* based on large and thick-shelled specimens from the basal “Smeei-Stufe” of Tanzania. The diagnostic features of the species are, however, not clear. Cox (1952: 101) had regarded the species as a junior synonym of *Actinostreon marshii*, but later on he kept it as a separate species (Cox 1965: 71). As the features of *hennigi* fall within the morphological variability of *A. marshii*, we include it with doubt into the latter, although it expands the stratigraphic range of the species to the Upper Kimmeridgian.

Actinostreon gregareum (J. Sowerby, 1815)
Pl. 2, Fig. 12

Plate 2: (1) *Grammatodon (Cosmetodon) elongatum?* (J. de C. Sowerby, 1824). Fragmented articulated specimen (BSPG 2015 XIII 129), Lower Callovian strata, Amparambato; a, right valve view; b, view of ligament area. **(2)** *Grammatodon (Indogrammatodon) iddhurgurensis* Cox, 1940. Internal mould of left valve (BSPG 2015 XIII 126), Middle Oxfordian strata, Ankilimena. **(3–7)** *Grammatodon (Indogrammatodon) virgatus* (J. de C. Sowerby, 1840). 3. Left valve (BSPG 2015 XIII 131b), Middle Oxfordian strata, Andrea; a, side view; b, view of hinge area. 4. Fragmented left valve (BSPG 2015 XIII 134), Lower Oxfordian strata, Dangovato; a, side view; view of hinge area. 5. Fragmented left valve (BSPG 2015 XIII 131a), Middle Oxfordian strata, Andrea; a, left valve view; b, view of hinge area. 6. Left valve (BSPG 2015 XIII 140), Lower Oxfordian strata, Dangovato. 7. Left valve (BSPG 2015 XIII 132), Middle Oxfordian strata, Berateka; a, external view; b, view of hinge area. **(8)** *Grammatodon (Indogrammatodon) blakei* Cox, 1940. Articulated specimen (BSPG 2015 XIII 142a), Lower Oxfordian strata, Dangovato; a, right valve view; b, dorsal view. **(9, 10)** *Grammatodon (Indogrammatodon) kantkotensis* Cox, 1940., 9. Articulated internal mould (BSPG 2015 XIII 143a), Upper Oxfordian strata, Dangovato; a, right valve view; b, dorsal view. 10. Articulated internal mould (BSPG 2015 XIII 143c), Upper Oxfordian strata, Dangovato; a, right valve view; b, dorsal view. **(11)** *Actinostreon marshii* (J. Sowerby, 1814). Articulated specimen (BSPG 2015 XIII 1), Lower Kimmeridgian strata, Antsampangna; a, left valve view; b, right valve view. **(12)** *Actinostreon gregareum* (J. Sowerby, 1815). Articulated specimen (BSPG 2015 XIII 2), Callovian strata, Amparambato; a, left valve view; b, right valve view.



- 1815 *Ostrea gregarea* sp. nov. – J. Sowerby: 19, pl. 111, figs. 1, 4.
 1925 *Alectryonia rastellaris* (Münst.), 1834 – Weir: 86, pl. 12, fig. 16 (non figs. 15, 17).
 1929 *Alectryonia* cf. *asellus* (Greppin), 1900 – Weir: 21, pl. 1, figs. 19.
 1931 *Lopha pulligera* Goldf. – Diaz-Romero: 40, pl. 3, figs. 12, 13.
 1931 *Lopha Stefanini* n.f. – Diaz-Romero: 41, pl. 3, fig. 14 a–c.
 1936 *Alectryonia gregarea* Sow. – Besairie: pl. 7, fig. 17.
 1939 *Lopha Perdalianae* (Mgh.) – Stefanini: 195, pl. 22, figs. 4?, 5.
 1939 *Lopha solitaria* (Sow.) – Stefanini: 197, pl. 22, figs. 6, 7.
 1939 *Lopha* cf. *gregaria* (Sow.) – Stefanini: 198, pl. 22, fig. 8.
 1939 *Arctostrea rastellaris* (Münst.) – Stefanini: 200, pl. 22, figs. 13–16.
 1952 *Lopha gregarea* (J. Sowerby) – Cox: 96, pl. 4, fig. 2, pl. 10, figs. 7–13.
 1956 *Lopha gregarea* (J. Sow.) – Agrawal: 89, pl. 9, fig. 13.
 1960 *Lopha gregarea* (J. Sowerby) – Joubert: 30, pl. 9, fig. 1.
 1960 *Lopha solitaria* (J. Sowerby) – Joubert: 30, pl. 9, fig. 2 a–c.
 1965 *Lopha gregarea* (J. Sowerby) – Cox: 68: pl. 9, fig. 5.
 1965 *Lopha solitaria* (J. Sowerby) – Cox: 69: pl. 9, fig. 4.
 1968 *Lopha solitaria* (J. Sowerby) – Maithani: 510, pl. 31, fig. 2.
 1995 *Actinostreon gregareum* (J. Sowerby 1815) – Jaitly et al.: 186, pl. 13, fig. 13, pl. 14, figs. 1–5.
 2015 *Actinostreon gregareum* (J. Sowerby, 1815) – Koppka: 50, fig. 20, pls. 16–18, 19 figs. 1, 2, 22 (with exhaustive synonymy list).

Material. Callovian: Amparambato: 1 RV, 1 AV (BSPG 2015 XIII 2, 3); Ankazomikeva: 1 LV (BSPG 2015 XIII 4).

Description and remarks. Shells posteriorly elongated, moderately large (H: 22–29 mm, L: 31–34 mm) with an attachment area intermediate in size. Left valve strongly inflated due to the pronounced geniculation between the attached and the free part of the valve. In some specimens this geniculation occurs in the ribbed part, relatively close to the ventral margin. The

distinctly angular antimarginal ribs vary in number between 22 and 27. In order to maintain a constant distance between ribs additional ribs are intercalated towards the ventral margin. In some specimens ribs bifurcate or even trifurcate. Ligament area initially curved, prosodetic, turning anteroventrally during later growth stages. Other internal features not seen.

Family Eligmidae T. Gill, 1871

Genus *Eligmus* Eudes-Deslongchamps, 1856

Type species. *Eligmus polytypus* Eudes-Deslongchamps, 1856.

Eligmus rollandi (Douvillé, 1907)

Pl. 3, Figs. 1–6, Text-figs. 3, 4

- 1907 *Heligmus rollandi* sp. nov. – Douvillé: 105, pl. 15, figs. 1–3.
 1916 *Heligmus rollandi* Douvillé – Douvillé: 59, pl. 6, figs. 13–17.
 1929 *Heligmus Rollandi* H. Douvillé – Barrabé: 124, pl. 7, fig. 21.
 1929 *Heligmus rollandi* Douvillé – Weir: 23, pl. 1, figs. 24–28.
 1930 *Heligmus Rollandi* Douv. – Besairie: 200, pl. 10, figs. 4, 5.
 1935a *Eligmus rollandi* Douv. – Cox: 168, pl. 16, figs. 6–10.
 1940 *Eligmus rollandi* Douvillé – Cox: 128, pl. 10, figs. 1–8.
 1956 *Eligmus rollandi* Douvillé – Agrawal: 63.
 1959 *Eligmus Rollandi* Douvillé – Jaboli: 31, pl. 4, figs. 8, 9.
 1960 *Eligmus rollandi* Douvillé – Joubert: pl. 8, fig. 11a, b.
 1965 *Eligmus rollandi* Douvillé – Cox: 47: pl. 5, figs. 5, 6.
 1994 *Eligmus rollandi* Douvillé – Fürsich et al.: 282, fig. 9i.
 1995 *Eligmus rollandi* Douvillé – Jaitly et al.: 190, pl. 17, figs. 6–11, text-fig. 21.

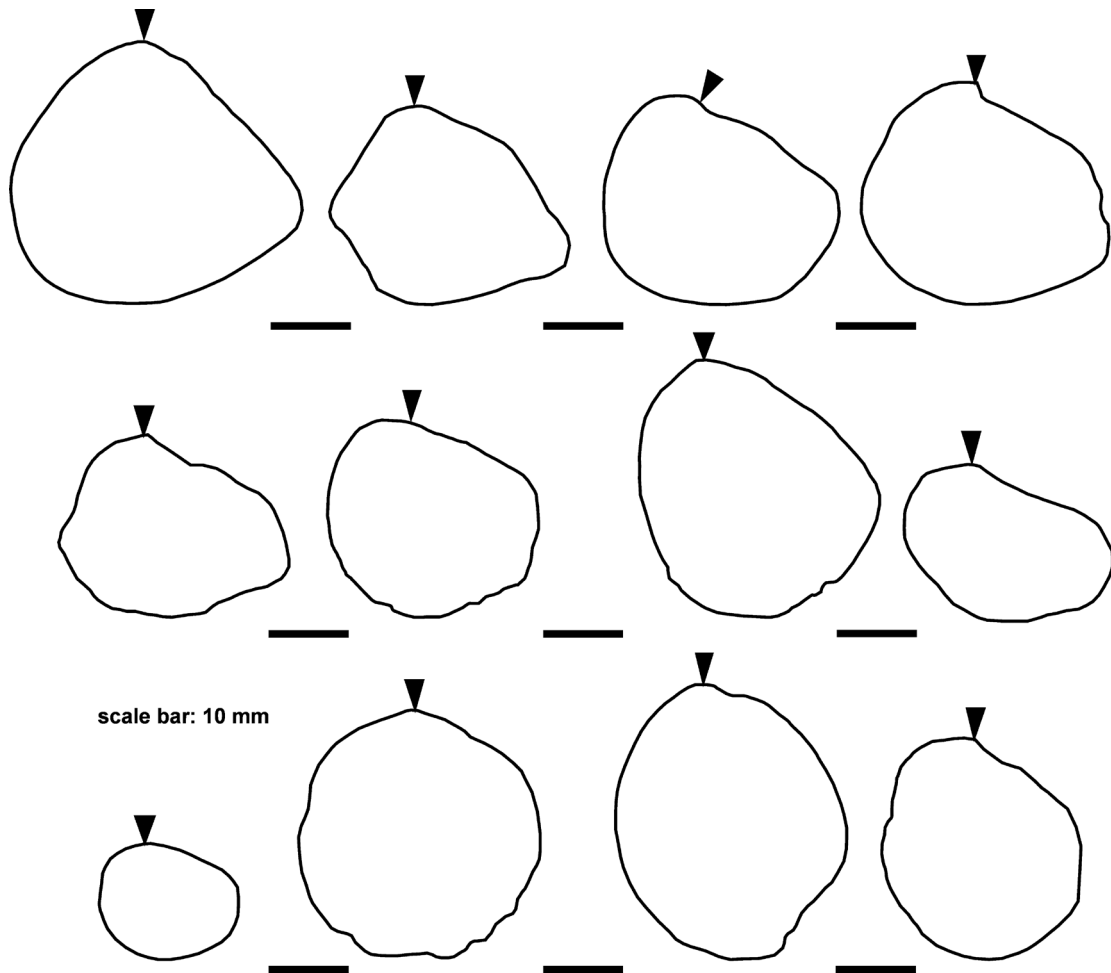
Material. Bathonian of Anjeba: 1 LV (BSPG 2015 XIII 38); Lower Callovian: Atainakanga: 1 AV (BSPG 2015 XIII 30); Ankazomiheva: 2 LV, 6 AV (BSPG 2015 XIII 37, 39); upper Lower Callovian of Amparambato: 4 LV, 10 AV (BSPG 2015 XIII 31–36).

Measurements. Table 4.

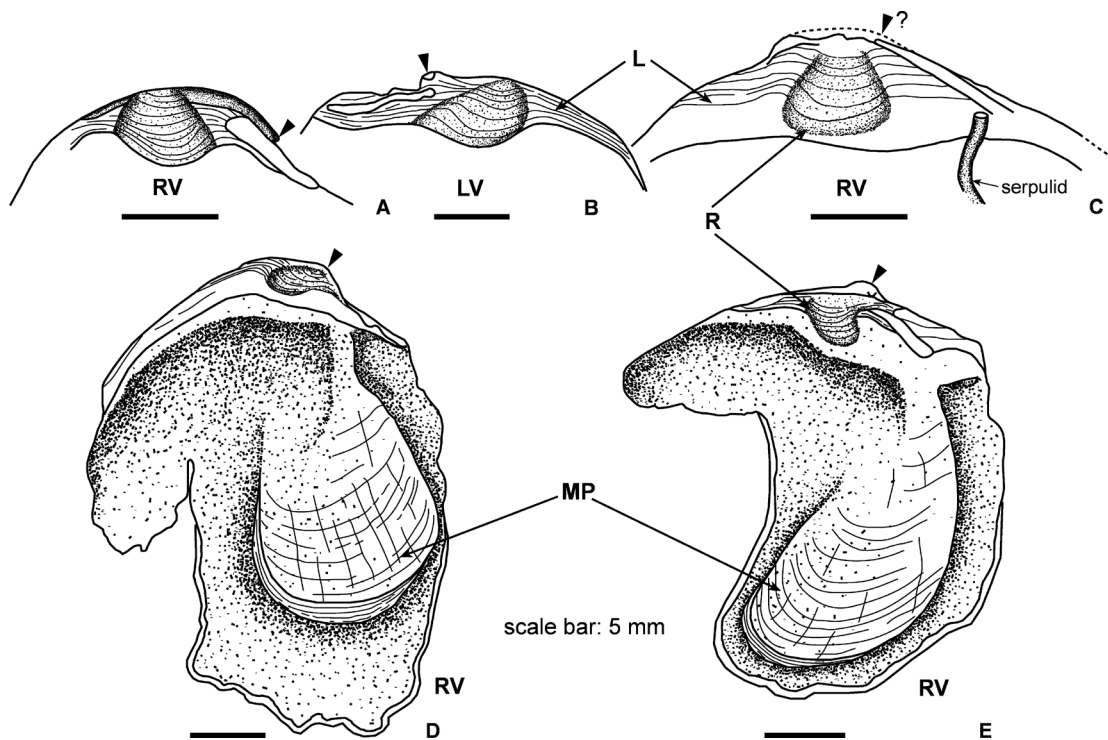
Table 4. Measurements (in mm) of *Eligmus rollandi* (Douvillé, 1907).

specimen	length (L)	height (H)	inflation (I)	n ribs*
BSPG 2015 XIII 39a	34	39	15.5	12
BSPG 2015 XIII 39b	~32	29.5	-	10
BSPG 2015 XIII 39c	21	17	7.5	~9
BSPG 2015 XIII 39d	32	22	-	~10
BSPG 2015 XIII 36a	41	38	15	16
BSPG 2015 XIII 36b	32	28	15	15
BSPG 2015 XIII 36c	34	32	13	13
BSPG 2015 XIII 32b	31	27.5	9	14
BSPG 2015 XIII 32a	37	34	14.5	15
BSPG 2015 XIII 31a	34	35	13.5	19
BSPG 2015 XIII 37b	25	27.5	10.5	14
BSPG 2015 XIII 37a	35.5	29.0	-	-
BSPG 2015 XIII 30	28	35	~10	11

*counted at or close to the ventral margin



Text-figure 3: Outline variations of left valves of *Eligmus rollandi* (Douville, 1907) from the Callovian strata at Atainakanga, Amparambato, Anjeba, and Ankazomiheva. The triangle denotes the position of the beak.



Text-figure 4: Interior of right (RV) and left (LV) valves of *Eligmus rollandi* (Douville, 1907) from the upper Lower Callovian strata at Amparambato showing the myophorous platform (MP) and the rounded-triangular to tear-shaped resilifer (R). A: Specimen BSPG 2015 XIII 32b, B: Specimen BSPG 2015 XIII 35, C: Specimen BSPG 2015 XIII 36d, D: Specimen BSPG 2015 XIII 32a, E: Specimen BSPG 2015 XIII 33. The triangle denotes the position of the beak.

Description. Shells up to 41 mm in length and 39 mm in height, moderately inflated, equivalved or right valve slightly more inflated than left valve. Inflation greatest at about one-third of height from umbo. Shape and outline highly variable, ranging from oval (higher than long or longer than high) to sub-trigonal, from sub-orbicular to strongly elongated (Text-fig. 3). Anterior margin generally weakly curved, posterior margin strongly curved, often with an obtuse posteroventral angulation; ventral margin strongly curved varying from regular to highly irregular (sinusoidal). Anterodorsal margin short and straight or sloping, posterodorsal margin sloping. Umbones inconspicuous, straight to commonly slightly to strongly (specimen BSPG 2015 XIII 32a; Pl. 3, Fig. 4) opisthogyrate. Position of umbones varying between mesial and about one-third of shell length from the anterior end. Shell surface covered with straight to slightly curved radial ribs except in umbonal, anterodorsal, and posterior areas. Posteriorly, the ribs disappear along a straight line, which is commonly posteroventrally directed. Posterior smooth area considerably larger than anterior one, both variable in size. The smooth areas are covered with growth lines and some commarginal folds. Rarely, specimens exhibit a small attachment area on either the right or left valve. This attachment area never starts right at the beak, but some distance away from it.

Ribs angular in cross-section, varying in number between nine and 19 and increasing in strength towards the ventral margin and towards the mid-flank. In some specimens (e.g., BSPG20 15 XIII 34; Pl. 3, Fig. 5) the radial ribs fade on the last 8 mm before reaching the ventral margin. Towards the latter additional ribs are intercalated. In some specimens ribs bifurcate.

Hinge area flat, broad, with shallow, rounded-triangular to tear-shaped resilifer with narrow postero-dorsal extension. Interior of right and left valve with well-developed, posteroventrally elongated, raised myophorous platform, situated posterodorsally and sloping towards the central area of the shell, to accommodate the adductor scar (Text-fig. 4). Close to the ventral margin the shell interior is radially corrugated, mirroring the external ribs.

Remarks. *Eligmus rollandi* is a highly variable species with respect to both outline and number of radial ribs. Crowding of the epibyssate bivalve may be

partly responsible for the variability. The species is widely distributed in Bathonian–Callovian strata of the Morondava Basin, and occurs also in East Africa (Cox 1935a, 1965), Kachchh (Cox 1940; Jaitly et al. 1995), Saudi Arabia (Zakhera et al. 2017), Jordan (Ahmad 1999), Sinai (Douville 1916), Ethiopia (Jaboli 1959), Iran (Fürsich & Pan 2014), northern Tibet (Yin & Fürsich 1991), and in western Europe (e.g., Douville 1907; Cossmann 1924).

Some *Eligmus rollandi* appear to have been facultative encrusters for part of their life. This feature has also been observed in specimens from the Bathonian of Kachchh (Jaitly et al. 1995). The more usual mode of life, however, was epibyssate, the byssus probably emerging anterodorsally.

Family Gryphaeidae Vialov, 1936

Genus *Gryphaea* Lamarck, 1801

Subgenus *Bilobissa* Stenzel, 1971

Type species. *Gryphaea bilobata* J. de C. Sowerby, 1835.

Gryphaea (Bilobissa) cf. hennigi Dietrich, 1925

Pl. 3, Figs. 7, 8

cf. 1925 *Gryphaea hennigi* sp. nov. – Dietrich: 6, pl. 2, fig. 4.

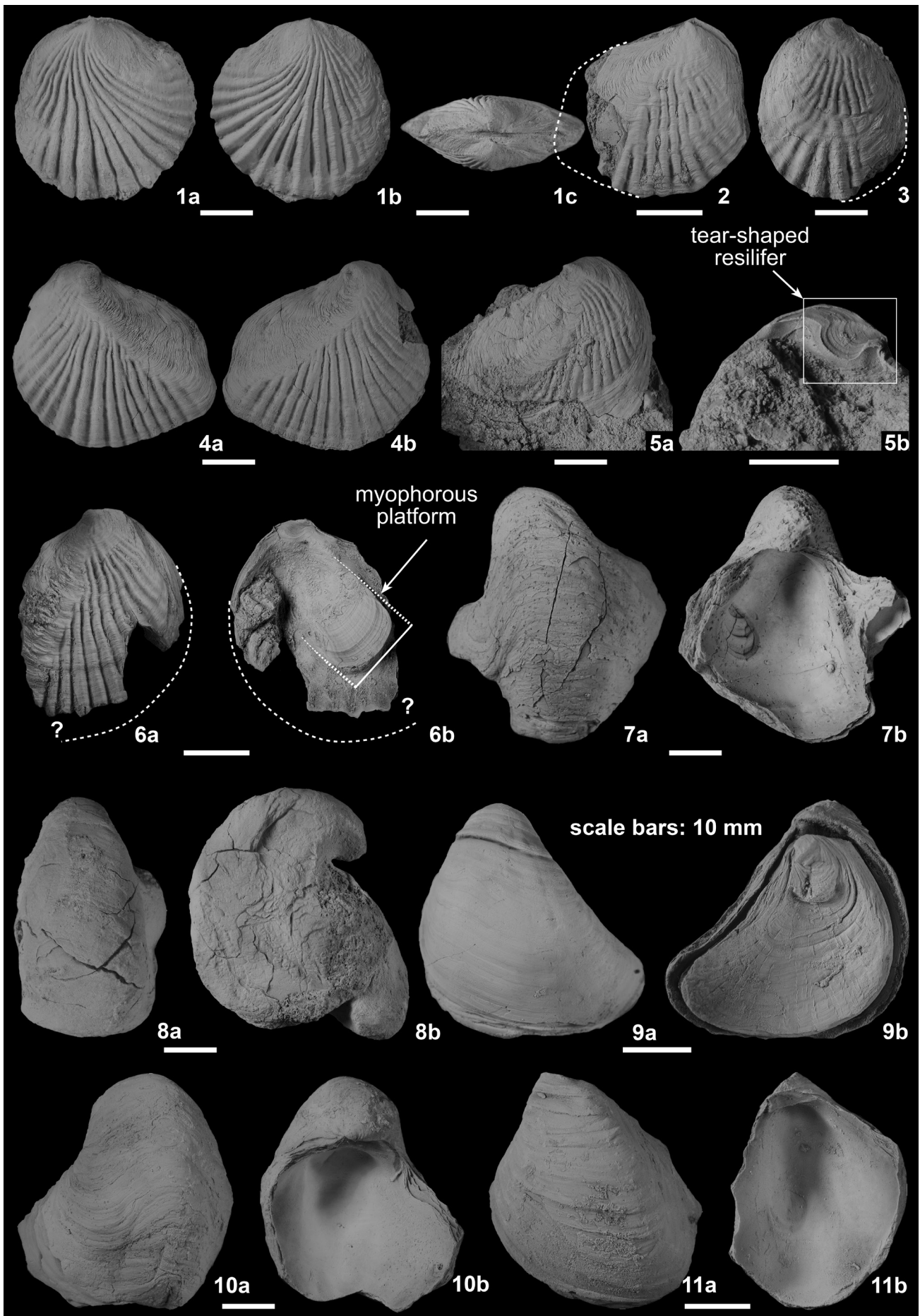
cf. 1952 *Gryphaea hennigi* Dietrich – Cox: 83, pl. 8, figs. 7–9.

cf. 1965 *Gryphaea hennigi* Dietrich – Cox: 73, pl. 11, fig. 1a, b.

Material. Upper Middle Oxfordian: Antsampagna: 2 LV (BSPG 2015 XII 20); Ankilimena: 3 LV (BSPG 2015 XII 21).

Description and remarks. None of the specimens is complete. Left valve thick-shelled, umbo coiled to a variable degree, slightly opisthogyrate, attachment area tiny. With a distinct posterior lobe, separated from the comparatively narrow umbonal area by a sulcus; anteriorly also a lobe is developed, but due to the poor preservation of the specimens its size cannot be ascertained. Interior of left valve with distinct umbonal cavity in specimens where the umbo is strongly coiled, but lacking in specimens where the degree of coiling is low. Adductor scar sub-circular, slightly elongated in an anterior-posterior direction. Shell surface covered with growth rugae. Right valve not known.

Plate 3: (1–6) *Eligmus rollandi* (Douville, 1907). 1. Articulated specimen (BSPG 2015 XIII 31), Lower Callovian strata, Amparabato; a, left valve view; b, right valve view; c, dorsal view. 2. Fragmented articulated specimen (BSPG 2015 XIII 32c), Lower Callovian strata, Amparabato; right valve view. 3. Articulated specimen (BSPG 2015 XIII 30), Lower Callovian strata, Atainakanga; left valve view. 4. Articulated specimen (BSPG 2015 XIII 32a), Lower Callovian strata, Amparabato; a, left valve view; b, right valve view. 5. Right valve (BSPG 2015 XIII 34), Lower Callovian strata, Amparabato; a, external view; b, ligamental area. 6. Fragmented right valve (BSPG 2015 XIII 32b), Lower Callovian strata, Amparabato; a, external view; b, interior of valve with myophorous platform. **(7, 8)** *Gryphaea (Bilobissa) cf. hennigi* Dietrich, 1925. 7. Left valve (BSPG 2015 XIII 21a), Middle Oxfordian strata, Ankilimena; a, external view; b, internal view. 8. Left valve (BSPG 2015 XIII 20), Upper Oxfordian strata, Antsampagna. a, exterior view; b, posterior view. **(9–11)** *Gryphaea (Bilobissa) balli* (Stefanini, 1925). 9. Articulated specimen (BSPG 2015 XIII 9), Lower Oxfordian strata, Dangovato; a, left valve view; b, right valve view. 10. Left valve (BSPG 2015 XIII 8), Lower Kimmeridgian strata, Dangovato; a, exterior view; b, interior view. 11. Left valve (BSPG 2015 XIII 5a), Upper Oxfordian – Lower Kimmeridgian strata, Antsampagna; a, exterior view; b, interior view.



The incomplete preservation makes it difficult to place our specimens in any of the known species, especially as these are also in many cases based on fragmentary material. For this reason, we tentatively refer our specimens to *Gryphaea (Bilobissa) hennigi* described by Dietrich (1925) from the Kimmeridgian of East Africa, by Cox (1965) from the Oxfordian of East Africa, and by Cox (1952) from the Oxfordian of Kachchh. The figured specimens of *G. hennigi* usually have a broader umbo than our specimens, except the specimen figured by Cox (1952, pl. 8, fig. 8), which fits our specimens reasonably well. The poor preservation of our material precludes any discussion of its relationship with well-known, to some extent similar species, such as *Gryphaea (Bilobissa) dilobotes* Duff (1978: 77, pl. 6, figs. 16–20, pl. 7, figs. 1–9, pl. 8, figs. 1, 4).

Gryphaea (Bilobissa) balli (Stefanini, 1925)
Pl. 3, Figs. 9–11, Pl. 4, Fig. 1

- 1925 *Liogryphaea Balli* sp. nov. – Stefanini: 164, pl. 29, fig. 2.
1925 *Exogyra Fourtaui* sp. nov. – Stefanini: 168, pl. 29, fig. 4, non fig. 3.
1929 *Liogryphaea balli* Stefanini – Weir: 19, pl. 1, figs. 2–4.
1931 *Exogyra fourtaui* (non Stefanini) – Diaz-Romero: 38, pl. 3, figs. 9, 10, non figs. 6–8.
1935a *Gryphaea balli* (Stefanini) – Cox: 173: pl. 18, figs. 1–7.
1935b *Gryphaea balli* (Stefanini) – Cox: 12, pl. 2, figs. 1–3, 4?
2011 *Gryphaea (Bilobissa) balli* (Stefanini) – Kiessling et al.: 209, fig. 13H.

Material. Upper Oxfordian - Lower Kimmeridgian of Antsampangna: 1 LV (BSPG 2015 XIII 5); Lower Kimmeridgian: Antsampangna: 1 RV, 25 LV, commonly abraded (BSPG 2015 XIII 6, 7); Dangovato: 1 LV, 1 AV (BSPG 2015 XIII 8, 9).

Description and remarks. Medium-sized *Gryphaea* (L= 34.2 mm, H= 31.7 mm). Left valve strongly curved with small attachment area, right valve flat to concave. Shape variable; left valve usually, but not invariably, with an anterior flange. Posteriorly a shallow, commonly inconspicuous sulcus extends from the umbonal area some distance towards the posteroventral margin. Ventral margin in most specimens strongly indented. Umbones opisthogyrate, but not coiled. Shells covered with irregular, commarginal growth folds. Ligament area triangular, of variable width, with well-developed bourrelets. Adductor muscle scar of left valve reniform, elongated in an anterior-posterior direction.

The species has been originally described from Somaliland by Stefanini (1925) as *Liogryphaea balli*. It differs from *Gryphaea coxi* Nicolai, 1950, which has been recorded from Middle Oxfordian strata in Madagascar, mainly by the lack of a coiled umbo and the possession of an anterior flange. Although the posterior sulcus is only weakly developed in our specimens, we refer them to *Bilobissa* as the most fitting subgenus.

Subgenus *Catinula* Rollier, 1911

Type species. *Ostrea knorri* Voltz, 1828.

Gryphaea (Catinula?) stoliczkai Cox, 1952
Pl. 4, Fig. 2

- 1952 *Liostrea (Catinula) stoliczkai* sp. nov. – Cox: 75, pl. 6, figs. 5, 6.
1995 *Gryphaea (?Catinula) stoliczkai* Cox – Jaitly et al.: 189, pl. 16, figs. 16, 17.

Material. Upper Lower Callovian of Amparambato: 2 LV (BSPG 2015 XIII 28–29).

Description and remarks. Medium-sized oyster (L: 47.2 mm, specimen BSPG 2015 XIII 28), rounded-subtriangular to subquadrangular in outline. Left valve with a moderately sized attachment area; ventral part of valve with strong geniculation up to 90 degrees. Surface covered with growth rugae. Adductor muscle scar sub-central. Right valve not known.

The poorly preserved specimens closely resemble *Liostrea (Catinula) stoliczkai* of Cox (1952) from the Middle Jurassic of Kachchh. As has been already stated by Jaitly et al. (1995: 189), the generic assignment of the species is somewhat doubtful.

Genus *Exogyra* Say, 1820
Subgenus *Exogyra* Say, 1820

Type species. *Exogyra costata* Say, 1820.

“*Exogyra*” *fourtaui* Stefanini, 1925
Pl. 4, Figs. 3–8

- 1925 *Exogyra Fourtaui* n. sp. – Stefanini: 168, pl. 29, fig. 3 (non fig. 4).
1929 *Exogyra fourtaui* Stefanini – Weir: 20, pl. 1, figs. 6–10.
? 1935b *Exogyra fourtaui* Stefanini – Cox: 13, pl. 2, fig. 5a, b.
1950 *Gryphaea Coxi* nov. sp. – Nicolai: 166, pl. 3, figs. 6–9.
2015 *Nanogyra (Palaeogyra?) fourtaui* (Stefanini, 1925) – Koppka: 29, fig. 12.

Material. Middle Oxfordian: Antsampangna: 1 LV (BSPG 2015 XIII 23); Dangovato: 5 RV, 9 LV, 2 AV (BSPG 2015 XIII 10, 13–19); Upper Oxfordian of Dangovato: 1 RV, 3 LV (BSPG 2015 XIII 12); Lower Kimmeridgian of Dangovato: 1AV (BSPG 2015 XIII 11).

Measurements. Table 5.

Description. Commonly arcoid, medium-sized (L: 19.5–42.2 mm, H: 31.6–56.8 mm), relatively narrow “*Exogyra*” with a strongly convex left valve, often much higher than long. Attachment area small to medium-sized, umbones opisthogyrate, incurved. Shell covered with distinct commarginal growth folds. Ligament area triangular, composed of resilium and anterior and posterior bourrelet, which are of equal size. Initial part of ligament spirally incurved

Table 5. Measurements (in mm) of “*Exogyra*” *fourtaui* Stefanini, 1925.

specimen	right/left valve	L	H
BSPG 2015XIII 10a	r-v	29.4	39.9
BSPG 2015XIII 10b	l-v	38.1	49.5
BSPG 2015XIII 12	r-v	19.5	31.6
BSPG 2015XIII 13a	r-v	32.4	38.5
BSPG 2015XIII 13b	r-v	33.3	37.5
BSPG 2015XIII 15a	r-v	36.2	35.9
BSPG 2015XIII 16	r-v	36.5	36.8
BSPG 2015XIII 17a	r-v	35.0	45.6
BSPG 2015XIII 17b	r-v	36.6	44.7
BSPG 2015XIII 18a	r-v	37.8	57.0
BSPG 2015XIII 18b	r-v	36.1	56.8
BSPG 2015XIII 19a	l-v	42.2	49.0
BSPG 2015XIII 19b	l-v	42.0	49.4

in a posterior direction. Chomata not developed. Adductor muscle scar irregularly ovoid, situated close to the posterior margin. Interior of left valve with narrow, grooved shelf running along the posterodorsal margin, starting close to the umbo. Right valve flat to slightly concave or convex.

Remarks. Within the Ethiopian faunal province there are a number of oyster species which, based on their partly coiled umbo, are difficult to place. As these species have often only insufficiently been illustrated and appear to be morphologically highly variable, it is very difficult to differentiate between them without having seen the type material. For this reason we are only in a position to comment on the validity of some of these taxa.

The specimens from Madagascar are best placed in *Exogyra fourtaui* Stefanini, 1925 from Somaliland. Koppka (2015: 29) placed *fourtaui* in *Nanogyra* and tentatively in the subgenus *Palaeogyra* Mirkamalov,

1963. We do not accept Koppkas assignment for the following reasons: The lack of chomata precludes its assignment to *Palaeogyra*. Moreover, the comparatively large size (Table 5) speaks against its placement in *Nanogyra*. Koppka (2015) included several large oysters in *Nanogyra*, a view that is not followed here. The classification of these oysters clearly requires a comprehensive revision, which is beyond the scope of this paper.

Plate 29, fig. 4 of Stefanini (1925) displays a distinct posteroventral lobe and therefore has been placed in *Gryphaea balli* (see above).

Exogyra fourtaui of Cox (1935b) from the Attock District of Pakistan can only be placed with doubts in the synonymy of this species, as the large attachment area does not reveal the characteristic shape of *Exogyra fourtaui*.

The specimens of *E. fourtaui* of Diaz-Romero (1931: 38, pl. 3, figs. 6–10) from a stratigraphically older horizon (Bathonian-Callovian) of Eritrea are distinctly smaller and most likely do not belong to the species. The material of Weir (1929) from Somaliland, although from a similar stratigraphic horizon, resembles more closely the typical shape of *E. fourtaui* and therefore is regarded to belong to this species.

Gryphaea coxi Nicolai, 1950 clearly falls into the range of variation of *E. fourtaui* and is regarded as a junior synonym of the latter, even though his specimens are stratigraphically younger (Kimmeridgian-Tithonian) than the present specimens.

“*Exogyra*” *tramausensis* Cox, 1952
Pl. 4, Fig. 9, Pl. 5, Fig. 1

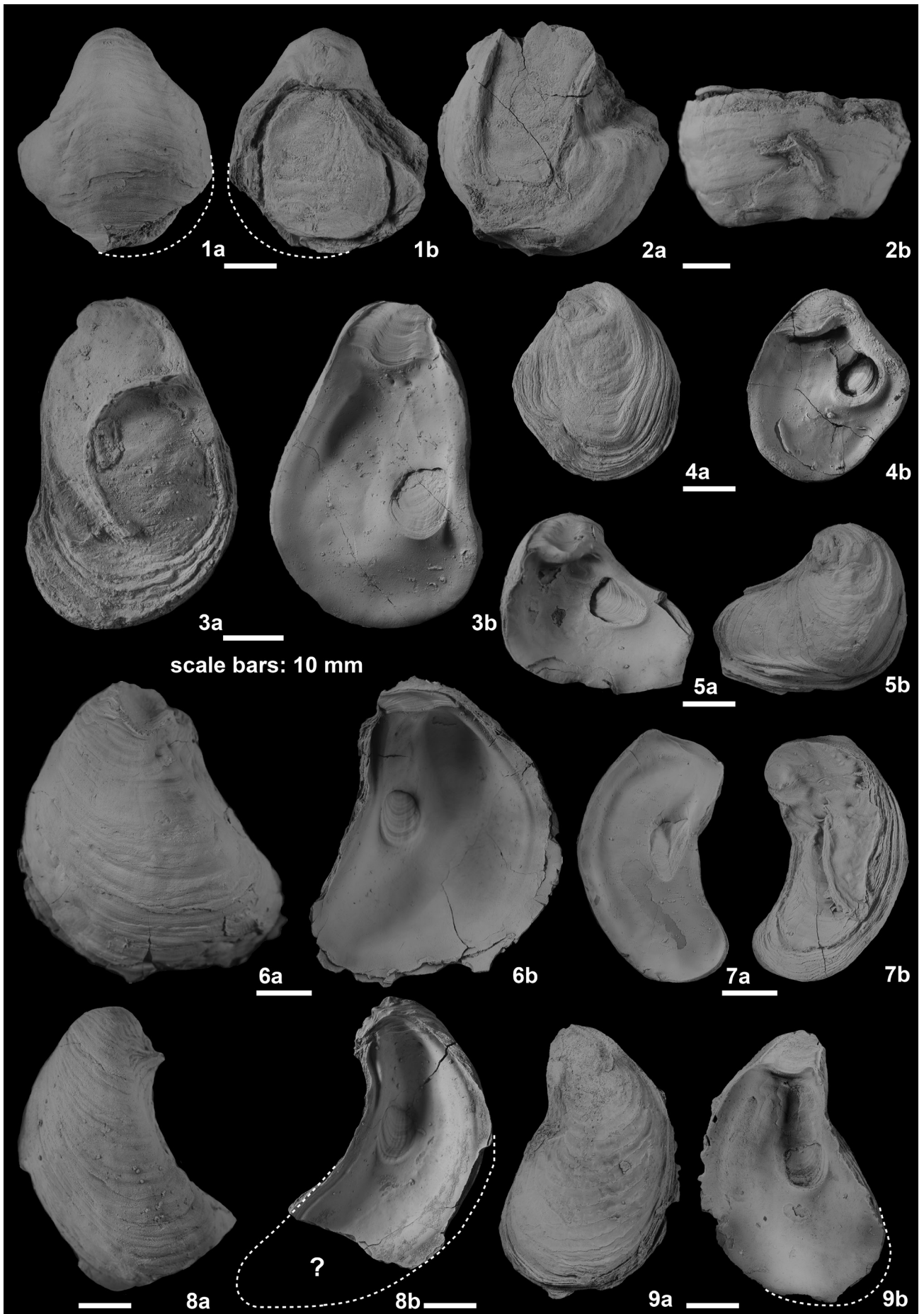
1952 *Exogyra tramausensis* sp. nov. – Cox: 94, pl. 10, figs. 5, 6.

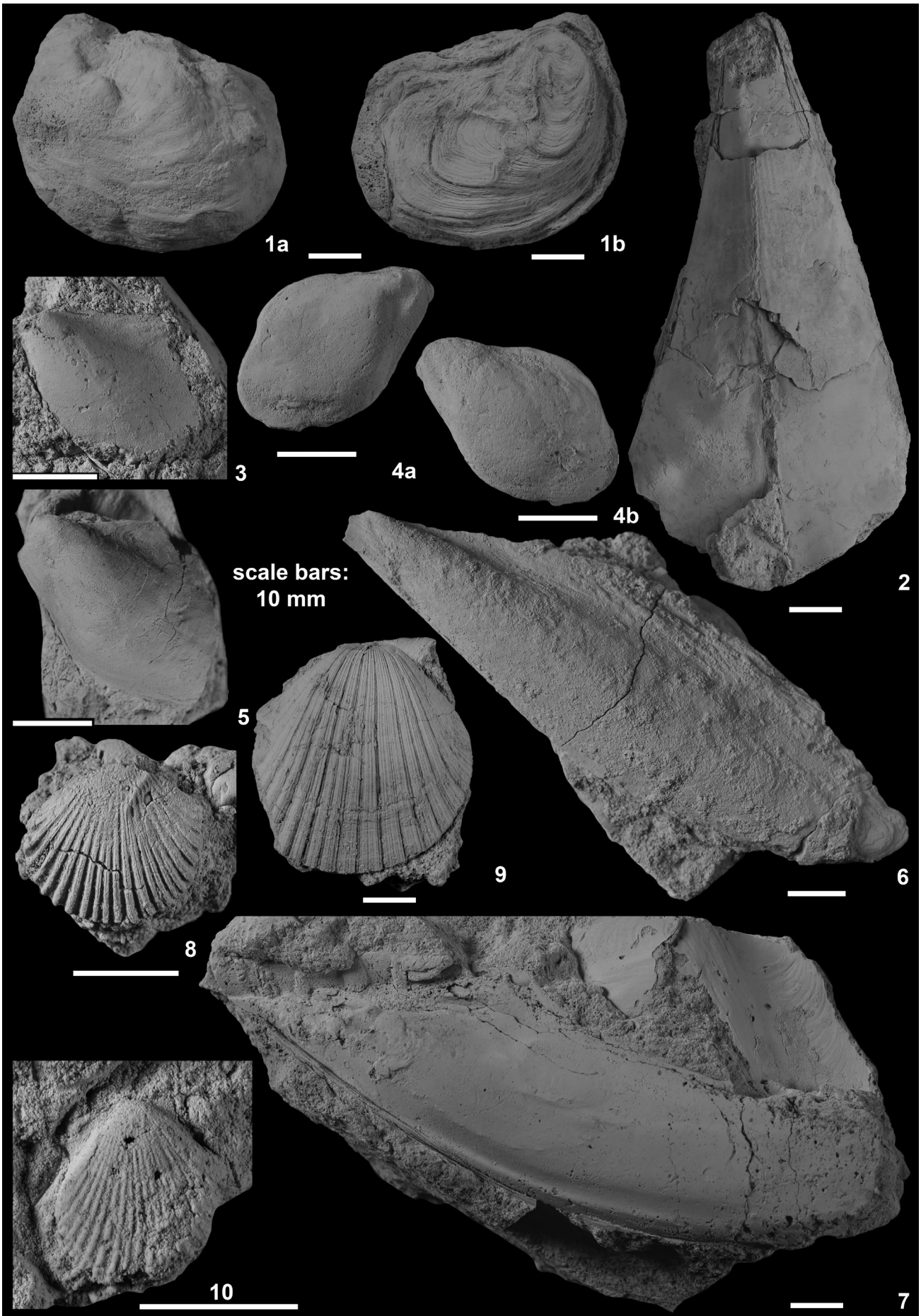
Material. Lower Oxfordian of Dangovato: 3 AV (BSPG 2015 XIII 24); Lower Kimmeridgian of Dangovato: 1 RV (BSPG 2015 XIII 26).

Description. Medium-sized *Exogyra*, distinctly higher than long (H: 47–57 mm, L: 35–42.5 mm),

(Page 160) Plate 4: (1) *Gryphaea (Bilobissa) balli* (Stefanini, 1925). Articulated specimen (BSPG 2015 XIII 6), Lower Kimmeridgian strata, Antsampangna; a, left valve view; b, right valve view. (2) *Gryphaea (?Catinula) stoliczkai* Cox, 1952. Left valve (BSPG 2015 XIII 28), Lower Callovian strata, Amparambato; a, exterior view showing large attachment area; b, ventral view showing distinctly raised ventral margin. (3–8) “*Exogyra*” *fourtaui* Stefanini, 1925, Middle Oxfordian strata, Dangovato. 3. Right valve (BSPG 2015 XIII 18a); a, exterior view; b, interior view. 4. Right valve (BSPG 2015 XIII 13); a, exterior view; b, interior view. 5. Right valve (BSPG 2015 XIII 16); a, internal view; b, external view. 6. Left valve (BSPG 2015 XIII 9b); a, exterior view; b, interior view. 7. Right valve (BSPG 2015 XIII 17); a, interior view; b, exterior view. 8. Left valve (BSPG 2015 XIII 14); a, exterior view; b, interior view. (9) “*Exogyra*” *tramausensis* Cox, 1952. Right valve (BSPG 2015 XIII 26), Lower Kimmeridgian strata, Dangovato; a, exterior view; b, interior view.

(Page 161) Plate 5: (1) “*Exogyra*” *tramausensis* Cox, 1952. Articulated specimen (BSPG 2015 XIII 24a), Kimmeridgian strata, Dangovato; a, left valve view; b, right valve view. (2) *Pinna (Pinna) cf. mitis* Phillips, 1829. Articulated specimen with remains of shell (BSPG 2015 XIII 159), Lower Callovian strata, Amparambato; left valve view. (3) *Pteria* sp. Internal mould of left valve (BSPG 2015 XIII 259), Lower Callovian strata, Amparambato. (4, 5) *Bakevellia waltoni* (Lycett, 1863), Bajocian strata, Analamanga. 4. Internal mould of articulated specimen (BSPG 2015 XIII 261a); a, right valve view; b, left valve view. 5. Internal mould of left valve (BSPG 2015 XIII 261b). (6, 7) *Gervillella aviculoides* (J. Sowerby, 1814), Lower Callovian strata, Amparambato. 6. Left valve (BSPG 2015 XIII 250). 7. Internal mould of left valve (BSPG 2015 XIII 256). (8) *Chlamys curviviarians* Dietrich, 1933. Single valve (BSPG 2015 XIII 192), Lower Callovian strata, Ankazomiheva. (9) *Indoweyla coxi* Fürsich & Heinze, 1995. Right valve (BSPG 2015 XIII 176), Lower Callovian strata, Atainakanga. (10) *Spondylopecten (Spondylopecten) palinurus* (d’Orbigny, 1850). Internal mould of right valve (BSPG 2015 XIII 177), Upper Bathonian strata, Tongobory.





reniform to irregular in shape. Umbones posteriorly directed, with distinctly coiled beaks, attachment area small to very large. In specimens with a large attachment area free part of the left valve forming a 90° angle with the attached part, and the right valve being moderately to strongly convex. Specimens with a small attachment area gryphaeid in shape during early growth stages. The initially strongly convex left valve becoming widely arched during later growth stages. Right valve flat to faintly concave. Specimens with a large attachment area usually with xenomorphic ornamentation on the right valve. Subcircular adductor scar of right valve situated close to the posterior margin; ligament of right valve curved, triangular with poorly developed bourrelets.

Remarks. Our material closely resembles *Exogyra tramaensis* Cox, 1952 from the Oxfordian of Kachchh. The shape of the oysters is strongly influenced by the size of the attachment area. Cox (1952: 95) discussed the relationship of *E. tramaensis* with similar forms such as *Ostrea (Exogyra) rivelensis* de Loriol (1904: 256, pl. 25, figs. 11–13). According to Cox (1952) the right valve of that species is not coiled, but de Loriol (1904: 256) states that “... crochets large, très contourné du côté interne”. De Loriol’s figures are, unfortunately, not clear enough to resolve this matter. As it is not clear whether *O. (E.) rivelensis* belongs to *Exogyra*, we prefer to accommodate the specimens from Madagascar in “*E. tramaensis*”.

Koppka (2015) placed *tramaensis* in *Nanogyra (Nanogyra)*. As in the case of “*Exogyra*” *fourtaui* we do not accept Koppka’s definition of the genus *Nanogyra* and prefer to keep large taxa such as *tramaensis* provisionally in the genus *Exogyra*.

Family Pinnidae Leach, 1819
Genus *Pinna* Linnaeus, 1758
Subgenus *Pinna* Linnaeus, 1758

Type species. *Pinna rudis* Linnaeus, 1758.

Pinna (Pinna) cf. *mitis* Phillips, 1829
Pl. 5, Fig. 2

- cf. 1829 *Pinna mitis* sp. nov. – Phillips: 137, pl. 5, fig. 7.
cf. 1940 *Pinna mitis* Phillips – Cox: 132, pl. 10, fig. 11.
cf. 1914 *Pinna mitis* Ziet. – Hennig: 71, pl. 2, fig. 7.
v cf. 1995 *Pinna mitis* Phillips – Jaitly et al.: 175, pl. 8, figs. 10–12.

Material. Lower Callovian of Amparambato: 1 AV (BSPG 2015 XIII 159).

Description: Greatest length of wedge-shaped specimen 118 mm, but anterior-most part and posterior part missing. Specimen moderately inflated, dorsal margin straight, ventral margin describing a wide concave curve. Secondary ligament well-seen, dividing the valves into a dorsal and ventral half of

equal size. Dorsal half with around 12 to 14 poorly preserved radial riblets and wide, but not very conspicuous growth rugae. Ventral half with nine faint radial riblets. Shell only partially preserved.

Remarks. Identification of Jurassic species of *Pinna* is often difficult due to compaction, breakage and loss of shell material. Only two species have been described from the Ethiopian faunal province, i.e. *Pinna mitis* (see synonymy list) and *Pinna* cf. *constantini* de Loriol (Dietrich 1933: 60, pl. 8, figs. 131–134). A precise identification of the present specimen is not possible due to its poor preservation, but the ribbing pattern and outline of the shell agrees well with that of *P. mitis*. Therefore it is tentatively placed in this species.

Family Pteriidae J. Gray, 1847
Genus *Pteria* Scopoli, 1777

Type species. *Mytilus hirundo* Linnaeus, 1758.

Pteria sp.
Pl. 5, Fig. 3

Material. Lower Callovian of Amparambato: 1 LV (internal mould) (BSPG 2015 XIII 259).

Description and remarks. The small rhomboidal specimen (H: 18.3 mm) lacks the umbo. Posterior wing set off from the main body and forming a blunt angle with the posterior margin. The nearly straight anterior margin grades into the asymmetrically curved ventral margin. Posterior margin nearly straight and slightly oblique. Impressions of an elongated, posterior directed tooth seen at hinge line. Ligament plate not preserved.

The specimen is too poorly preserved for identification at the species level. It differs clearly from *Bakevella* in the curvature of the flank.

Family Bakevelliidae W. King, 1850
Genus *Bakevella* King, 1848
Subgenus *Bakevella* King, 1848

Type species. *Avicula antiqua* Münster in Goldfuss, 1836.

Bakevella waltoni (Lycett, 1863)
Pl. 5, Figs. 4, 5

- 1863 *Gervillia waltoni* sp. nov. – Lycett: 110, pl. 32, figs. 4, 4a, b.
1940 *Bakevella (Bakevella) waltoni* (Lycett) – Cox: 108, pl. 7 figs. 1–7.
1994 *Bakevella waltoni* (Lycett) – Fürsich et al.: 118, pl. 2, fig. 9.
1995 *Bakevella (Bakevella) waltoni* (Lycett 1863) – Jaitly et al.: 170, pl. 6, figs. 1–9.

Material. Bajocian of Analamanga: 2 LV, 2 AV (in-

ternal moulds) (BSPG 2015 XIII 260–261).

Description. Specimens medium-sized (L: 30.4 mm, H: 22.3 mm in specimen BSPG XIII 260a), oblique-rhomboidal, moderately inflated, left valve slightly more convex than right valve. Umbones slightly salient to hinge line. Anterior auricle small, posterior one large, flat, acute in juvenile stages, blunt in adults. Anisomyarian; posterior adductor muscle scar large, orbicular, anterior one distinctly smaller. Ligament area with several pits; teeth not seen.

Remarks. Even though no teeth could be observed due to the poor preservation of the specimens, there is little doubt that they belong to *B. waltoni*, as their shape falls within the range of variation of the species.

Genus *Gervillella* Waagen, 1907

Type species. *Perna aviculooides* J. Sowerby, 1814.

Gervillella aviculooides (J. Sowerby, 1814) Pl. 5, Figs. 6, 7

- 1814 *Perna aviculooides* sp. nov. – J. Sowerby: 147, pl. 66, figs. 1–4.
1940 *Gervillella anceps* (Deshayes in Leymerie) – Cox: 117, pl. 9, figs. 1–5.
1940 *Gervillella kantkotensis* sp. nov. – Cox: 115, pl. 8, figs. 1–5.
1995 *Gervillella aviculooides* (J. Sowerby) – Muster: 63, pl. 11, figs. 1–7, pl. 12, figs. 1, 2; text-fig. 47 (see for extensive synonymy list).
v 1995 *Gervillella aviculooides* (J. Sowerby) – Jaitly et al.: 172, pl. 7, fig. 1.

Material. Lower Callovian of Amparambato: 4 RV, 17 LV, 3 AV, most of them fragments, (BSPG 2015 XIII 250, 252–254, 256–258); Middle Callovian of Ankillimena (BSPG 2015 XIII 251) and Andrea (BSPG 2015 XIII 255).

Measurements. Table 6.

Table 6. Measurements (in mm) of *Gervillella aviculooides* (J. Sowerby, 1814).

specimen	L	H	L _{diagonal}	L _{posterior wing}	W
BSPG 2015 XIII 250	95.5	33.6	97.5	54.5	30.6
BSPG 2013 XIII 256	118.5	56.0	121	52.8	32

Description. Most of the shells are fragments of the anterior-most part of the valve. Shell oblique-lanceolate, slightly curved. Anterior auricle short, pointed, posterior auricle forming an obtuse angle with the main body of the shell, both separated from the main body by a groove. Umbones small, pointed. Ligament area rectangular, with numerous pits equal in width or slightly narrower than the intervening elevated parts. With 2–3 obliquely backward directed

elongated teeth situated below the ligament plate in the anterior part of the hinge (posterior part not visible).

Remarks. According to Muster (1995) the dimensions of the specimens place them in *Gervillella aviculooides* (J. Sowerby, 1814). In the similar *Gervillella lanceolata* (Münster, 1826) the diagonal length is five to six times the maximum width and about twice the length of the posterior wing.

Order Pectinida J. Gray, 1854
Family Pectinidae Rafinesque, 1815
Genus *Chlamys* Roeding, 1798
Subgenus *Chlamys* Roeding, 1798

Type species. *Pecten islandicus* Müller, 1776.

Chlamys curviviarians Dietrich, 1933 Pl. 5, Fig. 8

- 1929 *Chlamys* aff. *palmyrensis* (Krumbeck) – Weir: 24, pl. 1, fig. 34 only.
1929 *Chlamys* sp. – Weir: 25, pl. 1, fig. 38.
1933 *Pecten (Chlamys) curviviarians* sp. nov. – Dietrich: 63, pl. 8, figs. 122–123.
1935a *Chlamys curviviarians* Dietrich – Cox: 176, pl. 18, figs. 14, 15.
? 1939 *Chlamys* aff. *curviviarians* Dietrich – Weir: 48, pl. 3, fig. 11.
1939 *Chlamys curviviarians* Dietr. – Stefanini: 183, pl. 20, fig. 9.
1950 *Chlamys Piveteaui* nov. sp. – Nicolai: pl. 4, figs. 2–5.
1951 *Chlamys Piveteaui* nov. sp. – Nicolai: 31.
1952 *Chlamys (Chlamys) curviviarians* Dietrich – Cox: 8, pl. 2, figs. 5–8.
? 1960 *Chlamys curviviarians* (Dietrich) – Joubert: 29, pl. 7, fig. 5.
1968 *Chlamys curviviarians* Dietrich – Maithani: 504, pl. 31, fig. 4.
1981 *Chlamys (Chlamys) curviviarians* Dietrich – Kanjilal: 270, pl. 1, fig. 8.
v 1995 *Chlamys (Chlamys) curviviarians* Dietrich – Jaitly et al. 198: pl. 20, figs. 8–11.

Material. Lower Callovian of Ankazomiheva: 1 SV (BSPG 2015 XIII 192).

Description and remarks. In the weakly inflated shell the umbonal area is missing, so that it is not clear, whether the specimen is a right or a left valve. The disc is ornamented with 27 radial ribs, rounded in cross-section and separated by flat interstices that are slightly wider than the ribs. Towards the ventral margin some of the ribs split into two. The ribs curve outwards near the anterior and posterior ends. This is the diagnostic feature of the species, which Dietrich (1933) recorded from the Upper Jurassic strata of East Africa. The species also occurs in the Middle Jurassic Chari Formation of the Kachchh Basin (Cox 1952; Jaitly et al. 1995) and appears to be a characteristic taxon of the Ethiopian faunal province. Related and possibly a junior synonym is *Chlamy matapwaensis* Cox (1965: 56, pl. 7, figs. 1, 2).

In contrast to Johnson (1984: 125), who regarded *curviviarians* as a synonym of *Camptonectes* (*C.*) *laminatus* (J. Sowerby, 1818), we followed Jaitly et al. (1995: 198) and recognize it as a valid species. The photograph of the species published by Joubert (1960: pl. 7, fig. 5) is too poor to evaluate its features with certainty. *Chlamys* aff. *palmyrensis* (Krumbeck) of Weir (1929: 24, pl. 1, fig. 34) clearly differs from Krumbeck's species, which appears to lack the outward-curved anterior and posterior ribs and corresponds more likely to *curviviarians*. The same feature is shown by *Chlamys* sp. of Weir (1929: 25, pl. 1, fig. 38), which has therefore been taken in synonymy.

Nicolai (1950) figured and described *Chlamys piveteaui* from Upper Bathonian and Callovian rocks of south-western Madagascar. As the species displays the characteristic outward-curved radial ribs, we place it in synonymy with *curviviarians*.

The number of ribs quoted for the various described specimens varies considerably (from 18 to >30). As the ribs tend to bifurcate during ontogeny, smaller, juvenile individuals tend to have fewer ribs than larger, adult ones. With the available information it is not possible to decide whether we are dealing with a single, highly variable species or with two or even more species.

Genus *Indoweyla* Fürsich & Heinze, 1995

Type species. *Indoweyla coxi* Fürsich & Heinze, 1995.

Remarks. As *Indoweyla* is confined to the Ethiopian faunal province, we raise it from subgeneric to generic rank.

Indoweyla coxi Fürsich & Heinze, 1995 Pl. 5, Fig. 9

v 1995 *Weyla* (*Indoweyla*) *coxi* sp. nov. – Fürsich & Heinze in Jaitly et al.: 199, pl. 20, figs. 13–15.

Material. Lower Callovian of Atainakanga: 1 RV (BSPG 2015 XIII 176).

Description. Shell suborbicular, well inflated, but umbonal area depressed; anterior auricle triangular, with byssal notch, posterior auricle broken off. Ornamentation consisting of approximately 20 broadly arched radial ribs, separated by much narrower interstices. Both ribs and interstices are covered with 4 to 6 and 1 to 2 secondary radial riblets, respectively.

Anterior auricle with well developed growth lines and radial riblets, creating a reticulate pattern.

Remarks. *Indoweyla* is a rare faunal element within the Ethiopian faunal province. Apart from *Indoweyla coxi* individuals occurring in this province have been accommodated in two more species, *Pecten rochi* Agrawal (1956: 75, pl. 9, figs. 1, 2) and *Pecten kachhensis* Cox (1952: 21, pl. 2, fig. 4a, b). These species come from the Callovian of Kachchh (*rochi* and *kachhensis*) and Madagascar (*rochi*), and differ only in small details. In *Pecten rochi* radial ribs are commonly paired and secondary radial riblets are present, albeit in lower numbers. *Pecten kachhensis* appears to lack secondary radial riblets. Whether these differences deserve separation at the species level is, at present, not clear. We cannot exclude that *Indoweyla coxi* and *Pecten rochi* are in fact junior synonyms of *Pecten kachhensis*. However, without the knowledge of left valves, no final conclusion can be reached at present.

Genus *Spondylopecten* Roeder, 1882 Subgenus *Spondylopecten* Roeder, 1882

Type species. *Pecten* cf. *erinaceus* Buvignier, 1882.

Spondylopecten (*Spondylopecten*) *palinurus* (d'Orbigny, 1850) Pl. 5, Fig. 10

1850 *Pecten palinurus* sp. nov. – d'Orbigny: 342.

1952 *Chlamys* (*Spondylopecten*) *badiensis* sp. nov. – Cox: 16, pl. 1, fig. 14a, b.

1956 *Spondylopecten rogeri* sp. nov. – Agrawal: 73, pl. 8, figs. 4a–b, 5–7.

1965 *Chlamys* (*Spondylopecten*) *badiensis* Cox – Cox: 58, pl. 7, figs. 3, 4.

1968 *Chlamys* (*Spondylopecten*) *kotalensis* sp. nov. – Maithani: 505, pl. 31, fig. 5.

1968 *Chlamys curviviarians* Dietrich – Maithani: 504: pl. 31, fig. 4 (non Dietrich).

1981 *Spondylopecten rogeri* [sic] Agrawal – Kanjilal: 272, pl. 2, figs. 1, 4.

1981 *Spondylopecten chipionkari* sp. nov. – Kanjilal: 273, pl. 2, figs. 2, 5–7.

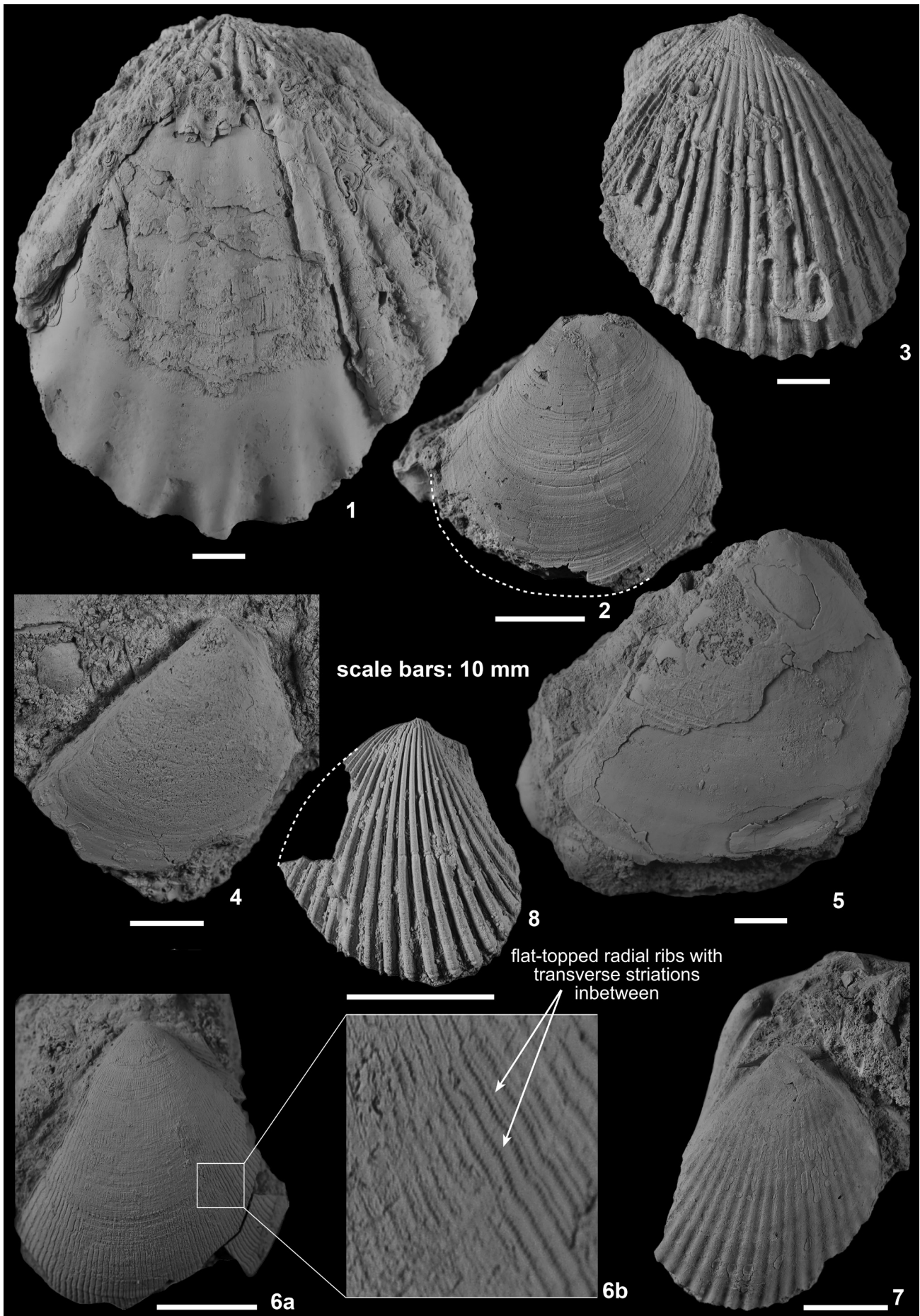
1981 *Spondylopecten* sp. indet. – Kanjilal: 274, pl. 2, fig. 3.

v 1995 *Spondylopecten* (*Spondylopecten*) *palinurus* (d'Orbigny 1850) – Jaitly et al.: 194, pl. 18, figs. 16–18.

2011 *Spondylopecten* (*Spondylopecten*) *palinurus* (d'Orbigny) – Kiessling et al.: 211, fig. 13N, O.

Material. Upper Bathonian of Tongobory: 1 LV (internal mould) (BSPG 2015 XIII 177).

Plate 6: (1) *Ctenostreon rugosum* (Smith, 1817). Articulated specimen (BSPG 2015 XIII 160), Lower Callovian strata, Amparambato; left valve view. (2) *Plagiostoma rodburgense* (Widborne, 1883). Left valve (BSPG 2015 XIII 166), Middle Oxfordian strata, Antsampangna. (3) *Plagiostoma* sp. A. Right valve (BSPG 2015 XIII 164), Lower Callovian strata, Atainakanga. (4, 5) *Plagiostoma* sp. B. 4. Left valve (BSPG 2015 XIII 171), Callovian strata, Ranonda. 5. Left valve (BSPG 2015 XIII 170), Lower Callovian strata, Atainakanga. (6) *Plagiostoma* sp. C. Left valve (BSPG 2015 XIII 167), Lower Callovian strata, Ankazomiheva; a, side view; b, detail of ornamentation. (7, 8) *Peudolimea duplicata* (J. de C. Sowerby, 1827). 7. Left valve (BSPG 2015 XIII 175), Lower Kimmeridgian strata, Antsampangna. 8. Right valve (BSPG 2015 XIII 173), Lower Callovian strata, Amparambato.



Description and remarks. Specimen small (H: 10.9 mm; L: 10.8 mm), suborbicular, inequilateral, moderately inflated. Auricles well developed, distinctly set off from disc, anterior auricle with byssal notch. Disc covered with around 20 radial ribs, separated by interstices that are wider than the ribs.

Despite its poor preservation, the specimen can be firmly placed in *Spondylopecten* (*S.*) *palinurus* according to the diagnosis of the species given by Johnson (1984).

Family Limidae Rafinesque, 1815
Genus *Ctenostreon* Eichwald, 1862

Type species. *Ostracites pectiniformis* Schlotheim, 1820.

Ctenostreon rugosum (Smith, 1817)
Pl. 6, Fig. 1

- 1817 *Ostrea rugosa* sp. nov. – Smith: 92, 106.
1935b *Ctenostreon proboscideum* (J. Sowerby) – Cox: 14, pl. 1, fig. 16.
1939 *Ctenostreon rugosum* (W. Smith) – Stefanini: 168, pl. 19, fig. 10.
1952 *Ctenostreon proboscideum* (J. Sowerby) – Cox: 64, pl. 5, figs. 13, 14.
1960 *Ctenostreon proboscideum* (J. de C. Sowerby) – Joubert: 29, pl. 8, fig. 7.
1968 *Ctenostreon proboscideum* (J. Sowerby) – Maithani: 507, pl. 30, fig. 7, pl. 31, fig. 3.
1968 *Ctenostreon proboscideum* (J. Sowerby) – Jaitly: 42.
v 1995 *Ctenostreon proboscideum* (J. Sowerby) – Jaitly et al.: 178, pl. 10, figs. 2, 3, pl. 11, figs. 2, 5.

Material. Lower Callovian of Amparambato: 1 AV (BSPG 2015 XIII 160); Lower Kimmeridgian of Antsampangna: 1 RV, 2 LV (BSPG 2015 XIII 161, 162).

Description. Shell thick, moderate to large in size (maximum length: 87 mm; height: 97 mm, inflation: 58.6 mm), rounded triangular in outline. With distinct posterior auricle and deep anterior lunule. Surface covered with 8 to 12 strong, rounded radial ribs, interstices between ribs of equal width or wider than ribs.

Remarks. Aberhan (1994: 23) discussed the problem how to distinguish the various Jurassic species of *Ctenostreon*, a bivalve genus, in which the number of radial ribs varies widely. Aberhan (1994) tentatively included the common species *C. proboscideum* (J. Sowerby, 1820) and *C. pectiniforme* (Schlotheim, 1820) in *C. rugosum* (Smith, 1817), as there are no clear differences between the three taxa. The range of variation of individuals of *Ctenostreon*, documented from the Ethiopian faunal province, supports Aberhan's view. Based on our experience with Jurassic *Ctenostreon*, also from other regions, we regard the three taxa as conspecific.

Genus *Plagiostoma* J. Sowerby, 1814

Type species. *Plagiostoma giganteum* J. Sowerby, 1814.

Remarks. There are numerous species of Mesozoic *Plagiostoma*, and the genus is in urgent need of a thorough revision. As this is beyond the scope of the present study, several species occurring in the Morondava Basin are kept in open nomenclature.

Plagiostoma rodburgense (Widborne, 1883)
Pl. 6, Fig. 2

- 1883 *Lima rodburgensis* Lycett MS – Widborne: 511, pl. 17, fig. 10.
v 1995 *Plagiostoma* cf. *rodburgense* Widborne – Jaitly et al.: 181, pl. 12, figs. 10, 11.

Material. Lower Callovian of Amparambato: 1 RV (BSPG 2015 XIII 165); Middle Oxfordian of Antsampangna: 1 LV (BSPG 2015 XIII 166).

Description. Small *Plagiostoma*, obliquely ovate in outline, with large, elongated lunule bordered by a faintly concave ridge. Umbonal area well inflated, but damaged in both specimens. Shell surface nearly completely smooth, except for faint, punctate radial striae at the anterior and posterior ends.

Remarks. The two specimens closely correspond to the small specimens of the species figured by Cox (1943: 172, pl. 22, figs. 61, 62).

Plagiostoma sp. A
Pl. 6, Fig. 3

Material. Lower Callovian of Atainakanga: 1 RV (BSPG 2015 XIII 164).

Description. Shell medium-sized (L: 59.8 mm; H: 67.1 mm), obliquely ovate, moderately inflated. Posterior auricle larger than anterior one, lunule well developed, depressed, extending for half the shell height and bordered by distinct ridge. Shell ornamented with 28 narrowly rounded radial ribs, separated by intervals, which are distinctively wider, especially towards the ventral margin. Intervals crossed by delicate transverse striations. Ribs with occasional transverse nodes. Triangular hinge area high, with an oblique, triangular resilifer.

Remarks. *Plagiostoma* sp. A belongs to the strongly ribbed taxa of the genus, several of which have been described from Jurassic strata of the Ethiopian faunal province, such as *Plagiostoma* sp. B from the Callovian of southern Tunisia (Holzapfel 1998: 104, pl. 5, fig. 10a, b), *Lima* (*Plagiostoma*) sp. indet. (Cox 1952: 53, pl. 5, figs. 9, 10) from the Bathonian of Kachchh and *Lima* (*Plagiostoma*) *callovica* Cossmann (Cox 1952: 55, pl. 5, fig. 8) from the Callovian of Kachchh, *Lima* sp. (Weir 1925: 88, pl. 12, fig. 4)

from the Jurassic? of Somaliland, and *Lima (Plagiostoma) muddoensis* Cox (1965: 60, pl. 8, fig. 2) from the Callovian strata of Kenya. All of these taxa as well as some species from northwestern Europe (e.g., *Lima (Plagiostoma) bradfordensis* Cox, 1943: 159, pl. 9, fig. 10a, b) share well-rounded radial ribs and interstices that are of equal width or only slightly wider than the ribs.

Plagiostoma sp. A may well represent a new species, but considering that there is only a single specimen available for study we prefer to keep it in open nomenclature.

Plagiostoma sp. B
Pl. 6, Figs. 4, 5

Material. Lower Callovian of Atainakanga: 1 LV (BSPG 2015 XIII 170); Callovian of Ranonda: 1 LV (BSPG 2015 XIII 171).

Description. Medium-sized, rounded-triangular, poorly inflated *Plagiostoma* (L: 59.6 mm; H: 55.5 mm in specimen BSPG 2015 XIII 170). Anterior margin long, straight; ventral margin widely arched and grading smoothly into the convex posteroventral margin; posterodorsal margin straight. A distinct ridge, running from the umbo to the anteroventral margin, separates the concave, narrow anterior-most part of the shell from the flank. Posterior auricle well developed, anterior auricle not seen. As only relicts of the shell are preserved, only limited information concerning the ornamentation is available. The anterior part of the shell appears to be covered with delicate radial grooves, but it is not clear whether this ornamentation extends across the whole shell.

Remarks. Due to the poor preservation of the two specimens a specific identification is not possible. Comparable in shape and inflation is *Lima schimperi* Branco (1879: 111, pl. 6, fig. 4a-c) from the lower Middle Jurassic strata of Lorraine (eastern France), a species that is covered with numerous flat-topped ribs, separated by narrow interstices. *Plagiostoma championi* Skwarko (1974: 86, pl. 24, figs. 11–13) from the Bajocian of western Australia is also similar in shape, but more inflated. Its ornamentation consists of fine radial grooves and ridges, which appear to be more prominent in the anterior and posterior parts of the shell.

Plagiostoma sp. C
Pl. 6, Fig. 6

Material. Lower Callovian of Ankazomiheva: 1 LV (BSPG 2015 XIII 167); Lower Kimmeridgian of Antsampagna: 1 RV (BSPG 2015 XIII 168).

Description. Small *Plagiostoma*, higher than long (L: 23.2 mm, H: 26.0 mm), obliquely ovate; anterior margin long, straight, posterior margin convex and

grading smoothly into the strongly convex ventral margin. Lunule bordered by a ridge, posterior auricle small, anterior one not seen. Shell surface covered with approximately 60 flat-topped radial riblets, separated by generally narrower interspaces. These interspaces exhibit faint transverse striations.

Remarks. Based on size and ornamentation the two specimens resemble, but do not closely fit, several species described in the literature, in particular *Lima (Plagiostoma) strigillata* Laube of Stefanini (1939: 162, pl. 19, fig. 5a, b) from the Bajocian-Oxfordian strata of Somalia. As Laube's (1867: 15, pl. 1, fig. 9) specimen is distinctly longer, we refrain from accommodating our material in *strigillata* but prefer to keep it in open nomenclature.

Genus *Pseudolimea* Arkell in Douglas & Arkell, 1932

Type species. *Plagiostoma duplicata* (J. de C. Sowerby, 1827).

Pseudolimea duplicata (J. de C. Sowerby, 1827)
Pl. 6, Figs. 7, 8

- 1827 *Plagiostoma duplicata* sp. nov. – J. de C. Sowerby: 114, pl. 559, fig. 3.
- 1929 *Lima (Mantellum) cf. duplicata* (J. de C. Sow.) –Weir: 28, pl. 1, fig. 45.
- 1952 *Pseudolimea duplicata* (J. de C. Sowerby) – Cox: 60, pl. 5, figs. 11, 12.
- v 1956 *Limatula rathodi* sp. nov. – Agrawal: 86, pl. 9, fig. 4.
- v? 1956 *Limatula mithali* sp. nov. – Agrawal: 86, pl. 10, fig. 14.
- 1965 *Pseudolimea duplicata* (J. de C. Sowerby) – Cox: 64, pl. 8, fig. 8a, b.
- v 1995 *Pseudolimea duplicata* (J. de C. Sowerby) – Jaitly et al.: 183, pl. 13, figs. 3–5.

Material. Lower Callovian of Amparambato: 2 RV (BSPG 2015 XIII 173, 174); Lower Kimmeridgian of Antsampagna: 1 LV (BSPG 2015 XIII 175).

Description. Shell obliquely drop-shaped with well rounded, convex anteroventral, ventral and posteroventral margins; height up to 30.0 mm (specimen BSPG 2015 XIII 175). Anterodorsal and posterodorsal margins straight. Umbonal area narrow, inflation moderate, anterior and posterior auricles well developed, subequal. Anterior umbonal ridge poorly developed. Ornamentation consisting of 19 to 20 angular radial ribs, separated by furrows, which exhibit acute, delicate secondary radial riblets at their centre.

Remarks. The specimens closely correspond to *Pseudolimea duplicata* (J. de C. Sowerby 1827).

Order Trigoniida Dall, 1889
Family Trigoniidae Lamarck, 1819
Genus *Trigonia* Bruguière, 1789
Subgenus *Trigonia* Bruguière, 1789

Type species. *Venus sulcata* Hermann, 1781.

Trigonia (Trigonia) elongata J. de C. Sowerby, 1823
Pl. 7, Fig. 1

- 1823 *Trigonia elongata* sp. nov. – J. de C. Sowerby: 39, pl. 431.
1840 *Trigonia costata* var. - J. de C. Sowerby: 328, pl. 21, fig. 16.
1903 *Trigonia chariensis* sp. nov. – Kitchin: 18, pl. 1, fig. 4, pl. 2, fig. 1.
1952 *Trigonia (Trigonia) elongata* (J. de C. Sowerby) – Cox: 109, pl. 12, figs. 3-4, 7.
1956 *Trigonia (Trigonia) elongata* J. de C. Sowerby – Agrawal: 96, pl. 10, fig. 1.
? 1956 *Trigonia (Trigonia) elongata* J. de C. Sowerby var. *haboensis* var. nov. – Agrawal: 97, pl. 10, figs. 4, 9a, b.
non 1956 *Trigonia (Trigonia) elongata* J. de C. Sowerby var. *mebhaensis* var. nov. – Agrawal: 97, pl. 10, fig. 2a, b.
1965 *Trigonia elongata* J. de C. Sowerby – Cox: 76, pl. 2, fig. 8.
v 1998 *Trigonia (Trigonia) elongata* J. de C. Sowerby – Fürsich & Heinze: 124, pl. 1, figs. 8-10, pl. 2, fig. 1.

Material. Lower Callovian of Amparambato: 1 AV (BSPG 2015 XIII 186).

Description. Outline rounded triangular, slightly longer than high (L: ~54 mm; H: 53.3 mm), well inflated. Umbones narrow, opisthogyrate. Flank covered with 25 commarginal ribs, which tend to undulate near the anterior end. Marginal carina faintly concave, strong, and ornamented with blade-like spaced protuberances. Area broad, covered with radial riblets that are crossed by transverse lamellae which produce a knob-like reticulate pattern. Area consisting of two parts, the inner one slightly depressed. Escutcheon carina faintly curved, ornamented with distinct tubercles. Escutcheon comparatively short and wide, depressed and ornamented with closely spaced oblique lamellae.

Remarks. The present specimen is very similar to the specimens of *T. elongata*, described and figured by Kitchin (1903) and Fürsich & Heinze (1998) from the Middle Jurassic of the Kachchh Basin.

Trigonia sp. A
Pl. 7, Fig. 2

Material. Bajocian of Analamanga: 3 RV (internal moulds) (BSPG 2015 XIII 184); Upper Bathonian of Tongobory S: 1 LV (BSPG 2015 XIII 185).

Description and remarks. The present specimens belong to a large group of small *Trigonia* species that are common in the Ethiopian faunal province. As the area of our material displays radial ornamentation and the flank is ornamented with strong commarginal ribs the specimens can be referred without doubt to *Trigonia*. The poor preservation (all specimens are composite moulds), however, precludes identification at the species level. Based on the presence of 9 to 10 commarginal flank ribs and of a well developed antecarinal groove, comparable species are *T. (T.) brevicosta* Kitchin (1903: 23, pl. 2, figs. 4, 5), *T. (T.) distincta* Kitchin (1903: 25, pl. 2, figs. 6, 7) and *T. (T.) patchamensis* Fürsich & Heinze (1998: 155, pl. 2, figs. 6–10). Considering that the two former species are known from the Callovian Chari Formation and the latter from the Bajocian-Lower Bathonian Jhurio Formation of Kachchh our specimens more likely belong to *T. (T.) patchamensis*.

Genus *Indotrigonia* Dietrich, 1933

Type species. *Trigonia smeei* J. de C. Sowerby, 1840.

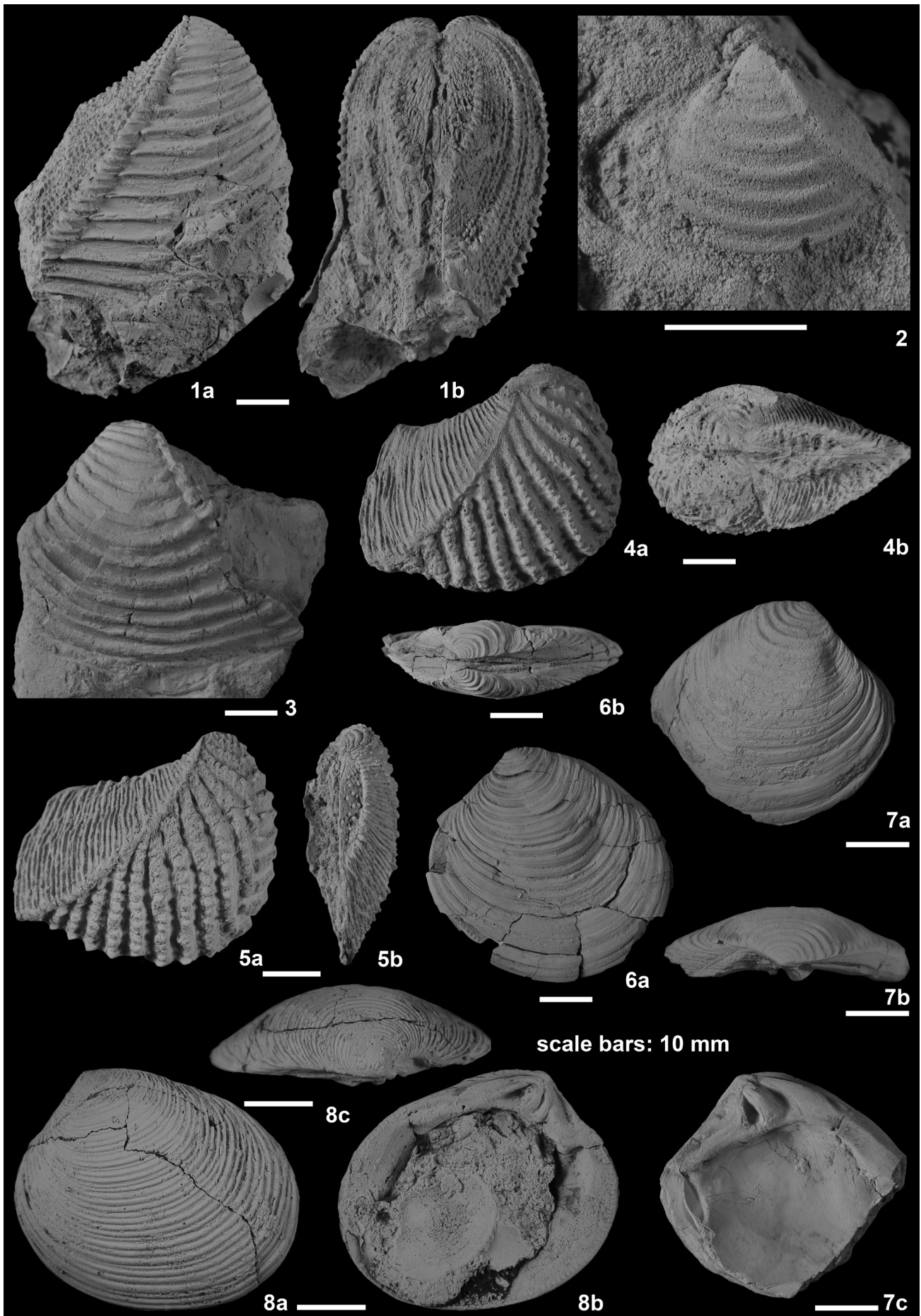
Indotrigonia sp.
Pl. 7, Fig. 3

Material. Lower Kimmeridgian of Antsampangna: 1 LV (BSPG 2015 XIII 187).

Description and remarks. The poorly preserved specimen (the anteriormost part of the shell and the area are missing) is ornamented with approximately 17 strong, broad commarginal ribs, separated by wider grooves. Remnants of the marginal carina in the umbonal area carry strong tubercles, elongated in the direction of the flank ribs.

Most likely the specimen belongs to *Indotrigonia smeei* J. de C. Sowerby (1840: 715, pl. 61, fig. 5) common in the Upper Jurassic strata of the Kachchh Basin. As several closely related species of *Indotrigonia* have been described from Upper Jurassic and Lower Cretaceous rocks of East Africa and Kachchh, such as *Trigonia crassa* Kitchin (1903: 44, pl. 4, figs. 4–6, pl. 5, figs. 1–3) and species figured in Lange (1914), an identification at the species level is not possible. Most of these species are Tithonian or Early Cretaceous in age; therefore, the Kimmeridgian specimen more likely belongs to *smeei*.

Plate 7: (1) *Trigonia (Trigonia) elongata* J. de C. Sowerby, 1823. Articulated specimen (BSPG 2015 XIII 186), Lower Callovian strata, Amparambato; a, right valve view; b, posterior view. (2) *Trigonia* sp. A. Composite mould of left valve (BSPG 2015 XIII 185), Upper Bathonian strata, Tongobory S. (3) *Indotrigonia* sp. Fragmented left valve (BSPG 2015 XIII 187), Lower Kimmeridgian strata, Antsampangna. (4, 5) *Vaugonia (Orthotrigonia) hispida* (Kitchin, 1903). 4. Articulated specimen (BSPG 2015 XIII 179), Lower Callovian strata, Ankazomiheva; a, right valve view; b, dorsal view. 5. Right valve (BSPG 2015 XIII 182), Lower Callovian strata, Amparambato; a, side view; b, posterior view. (6, 7) *Neocrassina (Pruvostiella) madagascariensis* sp. nov. 6. Articulated specimen (holotype) (BSPG 2015 XIII 210), Middle Oxfordian strata, Andrea; a, left valve view; b, dorsal view. 7. Right valve (paratype) (BSPG 2015 XIII 211), Middle Oxfordian strata, Andrea; a, side view; b, dorsal view; c, interior view. (8) *Neocrassina (Neocrassina) rajnathi* Agrawal, 1956. 8. Left valve (BSPG 2015 XIII 214), Lower Oxfordian strata, Dongovato; a, exterior view; b, interior view; c, dorsal view.



Family Myophorellidae T. Kobayashi, 1854
 Genus *Vaugonia* Crickmay, 1930
 Subgenus *Orthotrigonia* Cox, 1952

Type species. *Trigonia duplicata* J. Sowerby, 1819.

Vaugonia (*Orthotrigonia*) *hispida* (Kitchin, 1903)
 Pl. 7, Figs. 4, 5

1903 *Trigonia hispida* sp. nov. – Kitchin: 93, pl. 9, fig. 6.

1952 *Trigonia* (*Scaphotrigonia*) *hispida* Kitchin – Cox: 117.

v 1998 *Vaugonia* (*Orthotrigonia*) *hispida* (Kitchin) – Fürsich & Heinze: 166, pl. 4, fig. 6.

Material. Upper Bathonian of Tongoboro N: 1 LV (BSPG 2015 XIII 178); Lower Callovian: Ankazomiheva: 2 AV (BSPG 2015 XIII 179, 180); Amparambato: 2 RV (BSPG 2015 XIII 181, 182).

Description. Shell ovate with truncated posterior end, moderately inflated, distinctly inequilateral. Umbo pointed, posteriorly directed. Flank rounded-triangular in outline, separated from the wide area by a distinct, slightly concave ridge. Posterior end subvertical, posterodorsal margin faintly concave. Ornamentation of flank complex: first five to six ribs arcuate with numerous radially arranged riblets that extend from the crest of the arcuate ribs, where they form short spines, to the ventrally adjacent rib. The following rib is V-shaped, the remaining 10–12 ribs are subvertical. Near the anterior end the V-shaped rib is followed by short subhorizontal ribs. All these ribs carry numerous small tubercles. Likewise, the marginal carina carries small tubercles. Area with numerous sharp lamellar ribs. Escutcheon carina distinct, slightly curved and covered with blade-like extensions of the lamellae. Escutcheon excavated, moderately wide, ornamented with small rounded tubercles, which form irregular rows.

Remarks. The material from Madagascar closely fits the description of Kitchin (1903: 90, pl. 9, figs. 4, 5). In the Jurassic rocks of Kachchh several closely related species of *Vaugonia* (*Orthotrigonia*) occur. According to Fürsich & Heinze (1998: 166) *V. (O.) hispida* differs from *V. (O.) exortiva* (Kitchin) by its greater inflation, shorter escutcheon and lower number of subvertical radial ribs on the flank. *V. (O.) kutchensis* (Kitchin) differs by its sparser ribbing. *V. (O.) gracilis* (Kitchin) is much smaller and its inflation is very low.

Order Cardidita Dall, 1889
 Family Astartidae d'Orbigny, 1844
 Genus *Neocrassina* Fischer, 1886
 Subgenus *Neocrassina* P. Fischer, 1887

Type species. *Cypricardia obliqua* Lamarck, 1819.

Neocrassina (*Neocrassina*) *rajnathi* Agrawal, 1956
 Pl. 7, Fig. 8

1956a *Astarte* (*Neocrassina*?) cf. *subdepressa* Blake & Hudleston – Agrawal: 106, pl. 10, fig. 12.

1956b *Astarte* (*Neocrassina*) *rajnathi* n. sp. – Agrawal: 433, pl. 21, figs. 1–4.

non 1968 *Astarte* (*Neocrassina*) *rajnathi* Agrawal – Maithani: 511, pl. 32, figs. 3, 4.

1982 *Neocrassina* (*Neocrassina*) *rajnathi* Agrawal – Singh & Kanjilal: 50, pl. 1, figs. 4, 5(?).

Material. Lower Oxfordian of Dongovato: 1 LV (BSPG 2015 XIII 214).

Description. Shell medium-sized for the genus, elongated oval (H: 33.6 mm; L: 40.4 mm), moderately inflated. Anterior and posterior margins evenly rounded, grading smoothly into broadly rounded ventral margin. Anterodorsal margin short, concave, posterodorsal margin nearly straight. Lunule and escutcheon well developed, sharply demarcated, umbones prosogyrate. Shell ornamented with numerous regular commarginal ribs. Internal margin denticulated. Hinge of left valve with two cardinal teeth, the posterior one longer but more feebly developed than the stout anterior one, and one posterior lateral tooth.

Remarks. *Neocrassina* (*N.*) *rajnathi* was created by Agrawal (1956b) for slightly elongated forms that otherwise are very close to *N. (N.) subdepressa* (Blake & Hudleston, 1877) as figured, for example, by Fürsich et al. (2000: 74, pl. 2, figs. 8–14, text-figs. 7–9). Similarly to the Kachchh Basin, the species occurs in the Oxfordian.

A number of species of the genus *Neocrassina* described from Kachch and East Africa are poorly documented and therefore difficult to evaluate (Maithani 1968; Singh & Kanjilal 1982; Jaitly 1992).

Neocrassina (*Neocrassina*) sp. A
 Pl. 8, Fig. 1

Material. Lower Callovian of Amparambato: 1 RV (BSPG 2015 XIII 217); Lower Kimmeridgian of Antsampangna: 2 RV, 1 LV (BSPG 2015 XIII 216).

Description and remarks. Shell large for the genus (maximum height: 54.7 mm), thick-shelled, weakly inflated. Umbones small, prosogyrate. Lunule deeply excavated, comparatively narrow and well-demarcated, escutcheon long, narrow and deep. Shell outline oblique-oval. Anterior margin well rounded, grading smoothly into the widely arched ventral margin. Posterodorsal margin faintly convex, posterior margin well-rounded. Interior shell margin crenulated. Ornamentation consisting of numerous commarginal ribs, closely spaced near the umbo, becoming more widely spaced ventrally and disappearing near the ventral margin. Hinge of right valve with two cardinal teeth, the posterior one long, triangular, the anterior one short and knob-shaped, and one posterior lateral tooth.

The present specimens do not resemble any of the Jurassic species of *Neocrassina*. As the material is fragmentary and not well preserved, we keep it in open nomenclature.

Subgenus *Pruvostiella* Agrawal, 1956

Type species. *Astarte (Pruvostiella) freneixae* Agrawal, 1956 [= *Neocrassina (Pruvostiella) unilateralis* (J. de C. Sowerby, 1840)].

Remarks. The subgenus *Pruvostiella* was erected by Agrawal (1956) for neocrassinids that are characterised by moderately to well inflated shell and a nearly flat umbonal area with distinct, widely spaced commarginal ribs. In *Neocrassina (Neocrassina)* the umbonal area is regularly curved and the ribbing in that area does not differ from that on the flank. Species that belong to *Pruvostiella* include, apart from *Astarte unilateralis* J. de C. Sowerby, 1840, *Astarte (Pruvostiella) freneixae* Agrawal, 1956 of Singh & Kanjilal (1982) and *Astarte spitiensis* Stoliczka, 1865.

The type species *Neocrassina (Pruvostiella) freneixae* is a junior synonym of *Astarte unilateralis* J. de C. Sowerby (1840: 327, pl. 21, fig. 14). Fürsich et al. (2000: 74) argued that the flat umbonal area does not justify a subgeneric distinction, a view no longer upheld.

Neocrassina (Pruvostiella) madagascariensis sp.
nov.
Pl. 7, Figs. 6, 7

- ? 1950 *Astarte* sp. B – Nicolai: pl. 19, fig. 1a, b.
? 1951 *Astarte* sp. B – Nicolai: 45.
non 1956b *Astarte (Pruvostiella) freneixae* nov. subgen., nov. sp. –
Agrawal: 436, pl. 21, figs. 5, 6.
1982 *Neocrassina (Pruvostiella) freneixae* Agrawal – Singh &
Kanjilal: 54, pl. 1, fig. 14 (only), non Agrawal 1956b.

Derivation of name. After Madagascar.

Material. Middle Oxfordian of Andrea: Holotype: AV (BSPG 2015 XIII 210); paratypes: 1 AV, 1 fragmented RV, 2 fragmented LV (BSPG 2015 XIII 211–213).

Diagnosis. Suborbicular, poorly inflated *Pruvostiella* with two striated cardinal teeth and one anterior and one posterior lateral tooth in each valve. Interior shell margin denticulated.

Description. Shell medium in size (H: 42 mm, L: 48 mm), weakly inflated, suborbicular, with well rounded anterior, ventral, and posterior margins which smoothly grade into each other; anterodorsal margin short, slightly concave, posterodorsal margin long, weakly arcuate; umbones prosogyrate, flat. Lunule and escutcheon sharply demarcated. Shell ornamented with broad, distinct commarginal ribs, asymmetric in cross-section with the steeper side facing the umbo. Delicate growth lines occasionally

superimposed on the ribs. Ornamentation of the flat umbonal area more distinct. Internal margin denticulated. Hinge of right valve with two cardinals, the posterior one much stronger than the anterior one, one faint anterior lateral and one distinct posterior lateral. Left valve also with two cardinals and one anterior and one posterior lateral tooth. Cardinal teeth laterally striated.

Remarks. As discussed above, we regard the flat umbonal area with more widely spaced commarginal ribs as characteristic of the subgenus *Pruvostiella*. The present species differs from other species of the subgenus such as *N. (P.) unilateralis* (J. de C. Sowerby) by the suborbicular shape and comparatively weak inflation. *Neocrassina (Pruvostiella) madagascariensis* shares with *Seebachia (Eoseebachia)* the flat umbonal area, differing in ornamentation from the remaining valve, and the distinctly striated cardinal teeth. Species of *Seebachia (Eoseebachia)* are, however, much larger and differ in outline.

Genus *Coelastarte* Boehm, 1893

Type species. *Astarte excavata* J. Sowerby, 1819.

“*Coelastarte*” sp.
Pl. 8, Fig. 2

Material. Lower Callovian of Amparambato: 1 LV (BSPG 2015 XIII 194).

Description. Shell (L: 46.9 mm; H: 30.2 mm) distinctly elongated (L/H: 1.55), strongly inequilateral and compressed. Umbo situated about one-fourth of total shell length from the anterior end. Umbo depressed, prosogyrate. Ventral margin straight, dorsal margin faintly convex, but sloping towards the posterior end, which is slightly truncated; anterior margin well-rounded. Without lunule; escutcheon not seen. Shell surface covered with delicate growth rugae, which are more strongly developed in the posterodorsal umbonal area than in the rest of the shell. Internal features not seen.

Remarks. In outline, the specimen looks like members of the genus *Coelastarte* Boehm, 1893. The present specimen somewhat resembles *Astarte rzehaki* (Boehm 1883: 558, pl. 62, fig. 33), but differs in the curvature of the dorsal margin, which is subparallel to the ventral margin in the latter. Both taxa share other features of the shell, such as the absence of a lunule. According to the Treatise (Chavan 1969: N567) an excavated lunule is a diagnostic feature of *Coelastarte*. Therefore, these taxa should be accommodated in a new genus, with the present specimen representing a new species. We refrain, however, from this step as it requires a more thorough study of such forms., based on more material.

Astarte cotteai d’Orbigny, 1850 as described and

figured by Lorient & Pellat (1875: 256, pl. 15, fig. 42) is also similar and lacks a lunule, but is less elongated (L/H: 1.43) and dorsal and ventral margins are parallel.

Genus *Nicaniella* Chavan, 1945

Type species: *Astarte communis* Zittel & Goubert, 1861.

Nicaniella cf. *phillis* (d'Orbigny, 1850)
Pl. 8, Fig. 3

cf. 1850 *Astarte phillis* sp. nov. – d'Orbigny: 363 no. 253.
cf. 1927 *Astarte phillis* d'Orbigny – Cottreau: 49, pl. 46, figs. 6, 7.

Material. Lower Callovian of Amparabato: 7 RV, 12 LV, 33 AV (BSPG 2015 XIII 238–240).

Measurements. Table 7.

Table 7. Measurements (in mm) of *Nicaniella* cf. *phillis* (d'Orbigny, 1850).

specimen	L	H	I	I/H	preservation
BSPG 2015 XIII 238a	9.2	9.2	8.3	0.90	steinkern
BSPG 2015 XIII 238b	10.1	9.3	8.4	0.90	steinkern
BSPG 2015 XIII 238c	9.6	8.9	8.0	0.90	shell
BSPG 2015 XIII 238d	8.3	7.2	6.5	0.90	shell
BSPG 2015 XIII 238e	9.7	8.6	7.8	0.91	steinkern
BSPG 2015 XIII 238f	10.8	10.2	8.9	0.87	steinkern
BSPG 2015 XIII 238g	9.3	8.7	7.9	0.91	steinkern
BSPG 2015 XIII 238h	8.2	8.0	7.3	0.91	steinkern
BSPG 2015 XIII 238i	9.3	8.6	8.1	0.94	steinkern
BSPG 2015 XIII 239a	9.4	9.0	9.6	1.06	shell
BSPG 2015 XIII 239b	8.8	7.3	6.4	0.88	shell
BSPG 2015 XIII 240a	9.0	9.3	8.3	0.89	steinkern
BSPG 2015 XIII 240b	9.3	9.7	9.2	0.95	steinkern
BSPG 2015 XIII 240c	7.1	6.5	5.0	0.77	shell

Description. Shells generally poorly preserved, small, suborbicular to subquadrate, mostly slightly longer than high, strongly inflated. Inflation variable (I/H ranging from 0.77 to 1.06 but mainly around 0.9; Table 7). Umbones prosogyrate, situated at about mid-length. Both cordiform lunule and lanceolate escutcheon deeply impressed and well demarcated.

Anterodorsal margin slightly concave, anteroventral margin well rounded, grading into the widely arched ventral margin. Posterodorsal margin weakly convex, forming an obtuse angle with the subvertical posterior margin. Posterior end of shell around or slightly above mid-height. Interior shell margin crenulated; outer surface covered with regularly spaced, narrow, acute commarginal ribs, numbering around 15.

Hinge of right valve with a trace of 3a and well developed 3b and 5b, hinge of left valve with 2 and 4b; both valves with an anterior and a posterior lateral tooth.

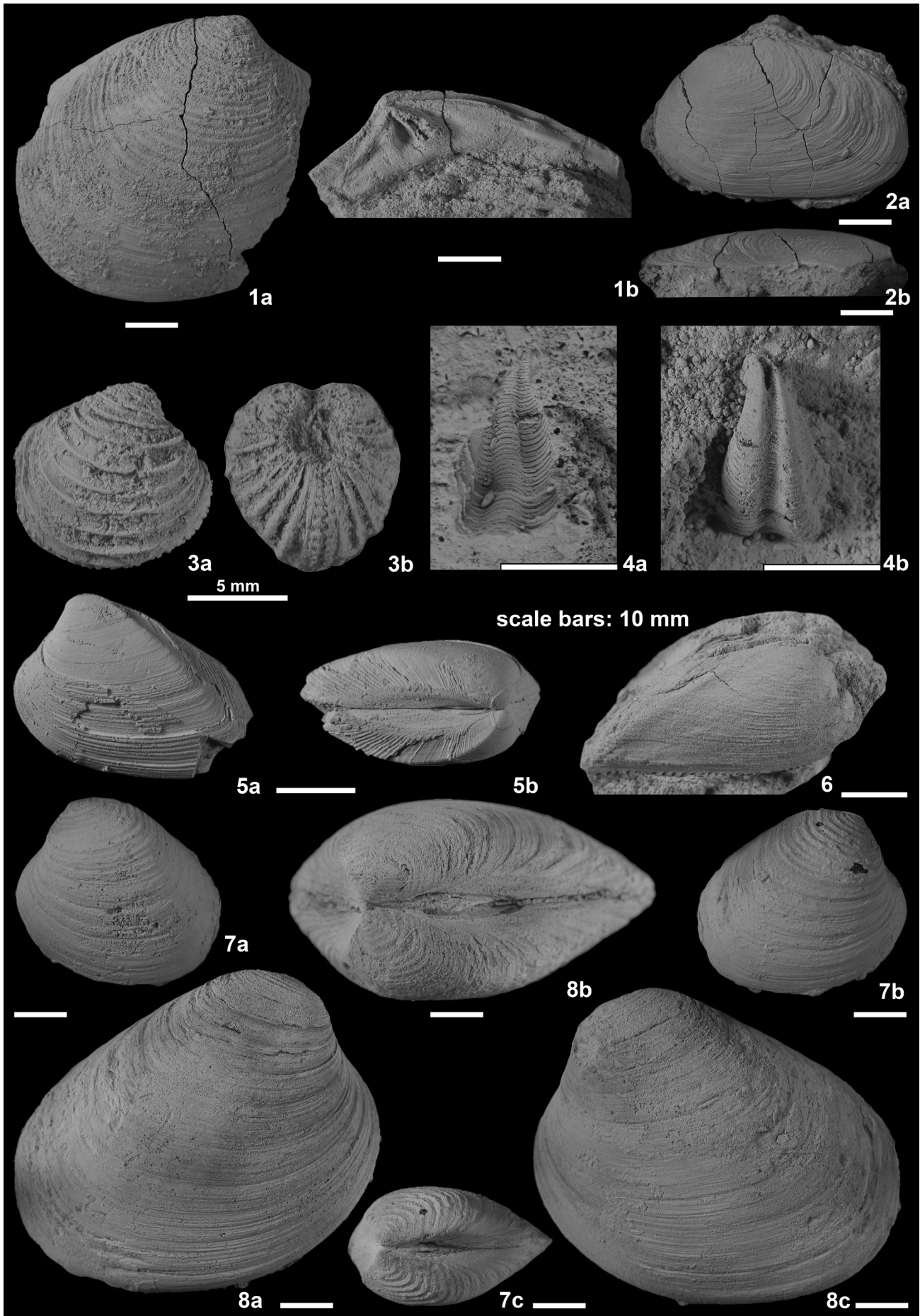
Remarks. Most of the specimens are poorly preserved articulated internal moulds, commonly with some remains of shell. Their most characteristic feature is their great inflation, which distinguishes them from the otherwise similar *Nicaniella extensa* (Phillips, 1829). In the past, strongly inflated *Nicaniella* have commonly been accommodated in the subgenus *Trautscholdia* Cox & Arkell, 1948 (e.g., *N. (T.) cordata* (Trautschold, 1860), a species with restricted and strongly inflated umbones; see also Kelly 1992). Kelly (1992: 118) re-defined the two subgenera based on their outline (e.g., the presence of a concave posterodorsal margin in *Trautscholdia*) and hinge features. Accordingly, our specimens occupy an intermediate position between the two subgenera. Gardner & Campbell (2002: 34) regarded *Trautscholdia* as a junior synonym of *Nicaniella*, arguing that numerous transitional forms exist between the two taxa. This view is followed here.

The present specimens are placed, with reservation, in *Astarte phillis* d'Orbigny, 1850, a species with similar outline and great inflation. Other comparable species are *Astarte sauvagei* de Lorient (in Lorient & Pellat 1875: 52, pl. 15, figs. 33–34) from the Kimmeridgian of the Boulonnais, northern France [see also *Astarte sauvagei* Lorient of Boden (1911: 186, pl. 25, figs. 18, 19), and *Astarte carinata* Phillips of Mantell (1850: 317, pl. 30, fig. 2) from the Callovian of southern England].

Genus *Coelopsis* Munier-Chalmas in P. Fischer, 1887
Subgenus *Coelopsis* Munier-Chalmas in P. Fischer, 1887

Type species. *Cardita lunulata* J. Sowerby, 1819 (erroneously cited as “*Opis lunulata* Miller” by Munier-Chalmas in Fischer 1887).

Plate 8: (1) *Neocrassina* (*Neocrassina*) sp. A. Right valve (BSPG 2015 XIII 217), Lower Callovian strata, Amparabato; a, side view; b, hinge area. (2) “*Coelastarte*” sp. Left valve (BSPG 2015 XIII 194), Lower Callovian strata, Amparabato. (3) *Nicaniella* cf. *phillis* (d'Orbigny, 1850). Articulated specimen (BSPG 2015 XIII 240a), Lower Callovian strata, Amparabato; a, eight valve view; b, anterior view. (4) *Coelopsis* (*Coelopsis*) *deshayesii* (Morris & Lycett, 1853). Left valve (BSPG 2015 XIII 234), Lower Callovian strata, Amparabato; a external mould; b, rubber cast. (5, 6) *Seebachia* (*Seebachia*) aff. *bronnii* (Krauss, 1850). 5. Articulated specimen (BSPG 2015 XIII 221), Middle Oxfordian strata, Ankilimena; a, left valve view; b, dorsal view. 6. Composite mould of articulated specimen (BSPG 2015 XIII 220), Upper Oxfordian strata, Dangovato; right valve view. (7, 8) *Seebachia* (*Eoseebachia*) *sowerbyana* (Holdhaus, 1913), Lower Oxfordian strata, Dongovato. 7. Articulated specimen (BSPG 2015 XIII 207), a, left valve view; b, right valve view; c, dorsal view. 8. Articulated specimen (BSPG 2015 XIII 199), a, right valve view; b, dorsal view; c, left valve view.



Coelopsis (Coelopsis) deshayesii (Morris & Lycett, 1853)
Pl. 8, Fig. 4

1853 *Opis Deshayesii* sp. nov. – Morris & Lycett: 81, pl. 6, fig. 5, 5a.

Material. Lower Callovian of Amparabato: 1 LV (external mould) (BSPG 2015 XIII 234).

Description. Specimen much higher than long, narrow triangular, flank with two rounded ridges running from the umbo to the ventral margin, separated by a narrow, concave groove that gradually widens ventrally. Ventral margin indented. Area behind the posterior ridge concave, delimited posteriorly by straight and strongly sloping carina. Posteroventral margin subvertical. Shell surface covered with faint growth lines. No other features seen.

Remarks. The single specimen closely resembles *Coelopsis (C.) deshayesii* as figured by Bigot (1895: 100, pl. 11, fig. 21) from the Bathonian of Normandy. Also closely comparable are *Opis buvignieri* d'Orbigny (Cottreau 1927. 115, pl. 15, figs. 19–21) from the Oxfordian rocks of northeastern France and *Opis divisus* Rigaux & Sauvage (1869: 78, pl. 6, figs. 17, 18) from the Bathonian of northern France. In both species the groove on the flank is distinctly wider than in the present specimen.

Genus *Seebachia* Holub & Neumayr, 1881
Subgenus *Seebachia* Holub & Neumayr, 1881

Type species: *Astarte bronni* Krauss, 1850.

Seebachia (Seebachia) aff. bronni (Krauss, 1850)
Pl. 8, Figs. 5, 6

aff. 1850 *Astarte bronni* sp. nov. – Krauss: 449: pl. 49, fig. 1a–e.
aff. 2000 *Seebachia (Seebachia) bronni* (Krauss, 1850) – Fürsich et al.: 92, pl. 9, fig. 1a–d.

Material. Middle Oxfordian of Ankilimena: 1 AV (BSPG 2015 XIII 221); Upper Oxfordian of Dangovato: 1 RV, 6 LV, 1 AV (internal moulds) (BSPG 2015 XIII 2018–220).

Description: Shell small for genus (L: ~32 mm; H: 21.8 mm in specimen BSPG 2015 XIII 221), elongated-trigonal, moderately inflated. Umbones elevated, beaks incurved, prosogyrate, situated around one-fourth of shell length from the anterior end. Anterior margin well rounded, grading smoothly into the gently rounded ventral margin; posterior margin straight, obliquely truncated, forming an obtuse angle with the straight posterodorsal margin; anterodorsal margin concave. Lunule large, bordered by rounded ridge; escutcheon long, bordered by ridge; posterior ligamental grooves well visible. A distinct posterodorsal ridge running from the umbo to the posterior end. Ornamentation consisting of

numerous fine commarginal riblets. Interior of shell margin crenulated. Anterior adductor muscle scar orbicular, posterior adductor muscle scar oval. No other internal features seen.

Remarks. The internal moulds are incomplete and distorted by compaction. The specimen from Ankilimena is comparatively well preserved and exhibits characteristic features of the subgenus *Seebachia*. It is, however, distinctly smaller and less elongated than the two previously described species of the subgenus, *S. (S.) bronni* Krauss, 1850 and *S. (S.) janenschi* Dietrich, 1933 from South Africa and Tanzania, respectively. These two species come from higher horizons than the Middle and Upper Oxfordian specimens from Madagascar. The latter most likely represent a new species, but considering that the hinge is not known and most specimens are poorly preserved, we prefer to keep them in open nomenclature. Possibly, the taxon from Madagascar is an ancestor of the much larger latest Jurassic-earliest Cretaceous species *S. bronni* and *S. janenschi*.

Subgenus *Eoseebachia* subgen. nov.

Type species. *Astarte major* J. de C. Sowerby, 1840 by original designation herein.

Diagnosis (modified from Fürsich et al. 2000). Obliquely oval *Seebachia* without prominent umbonal ridge. Shell not gaping posteriorly. Right valve with three striated cardinals, and one faint posterior or lateral tooth. Left valve with two cardinals and a well-developed remote posterior lateral tooth. Both valves with a short, poorly developed anterior lateral tooth.

Remarks. When erecting the new subgenus *Eoseebachia* Fürsich, Heinze & Jaitly (2000: 92) did not designate a type species, and the subgenus name is thus not available from that publication. In order to rectify this mistake *Astarte major* J. de C. Sowerby, 1840 [= *Seebachia (Eoseebachia) sowerbyana* (Holdhaus, 1913)] is herewith designated as type species of *Eoseebachia*, which is therefore treated as a new subgenus herein.

Seebachia (Eoseebachia) sowerbyana (Holdhaus, 1913)

Pl. 8, Figs. 7, 8, Pl. 9, Figs. 1–3

- 1840 *Astarte major* n. sp. – J. de C. Sowerby: pl. 61, fig. 1.
1913 *Astarte sowerbyana* n. sp. – Holdhaus: 443, pl. 94, figs. 12, 13, 15, pl. 100, fig. 1.
1933 *Astarte Krenkeli* n. sp. – Dietrich: 40, pl. 4, figs. 62, 64, 66.
1965 *Astarte sowerbyana* Holdhaus – Cox: 88, pl. 13, fig. 6a, b.
1966 *Astarte krenkeli* Dietrich – Henriques da Silva: 63, pl. 2, fig. 1, pl. 4, fig. 1.
v 2000 *Seebachia (Eoseebachia) sowerbyana* (Holdhaus

1913) – Fürsich et al.: 92, pl. 6, fig. 24, pl. 7, figs. 1–5, pl. 8, fig. 1, pl. 10, fig. 5, text-figs. 14–16.

Material. Lower Oxfordian of Dongovato: 5 RV, 3 LV 8 AV (BSPG 2015 XIII 196–199, 206, 207); Middle Oxfordian: Ankilimena: 3 AV (internal moulds) (BSPG 2015 XIII 202); Andrea: 2 RV, 2 LV 3 AV (internal moulds) (BSPG 2015 XIII 203, 204, 204); Lower Kimmeridgian of Antsampangna: 3 AV (BSPG 2015 XIII 200, 201).

Measurements. Table 8.

Table 8. Measurements (in mm) of *Seebachia* (*Eoseebachia*) *soerbyana* (Holdhaus, 1913).

specimen	L	H	I
BSPG 2015 XIII 196a	62.6	54.0	-
BSPG 2015 XIII 196b	66.0	55.3	-
BSPG 2015 XIII 196c	68.9	56.6	35.9
BSPG 2015 XIII 196d	69.7	56.8	-
BSPG 2015 XIII 196e	60.7	50.3	31.8
BSPG 2015 XIII 196f	65.5	60.2	36.3
BSPG 2015 XIII 196g	63.6	52.5	32.1
BSPG 2015 XIII 197	62.9	50.1	38.7
BSPG 2015 XIII 198	71.3	59.0	38.3
BSPG 2015 XIII 199	70.1	57.6	34.9
BSPG 2015 XIII 207	39.0	33.9	21.7

Description. Specimens large, thick-shelled, elongated-oval with prominent umbones, well inflated. With large, deeply set lunule and elongated, lanceolate escutcheon, the latter demarcated by distinct ridge. Umbones initially fairly flat, prosogyrate, after approximately 12 mm with a change in growth trajectory (producing an obscure geniculation in side view). Anterior and posterior margins well rounded, grading smoothly into the ventral margin. Postero-dorsal margin straight. Ornamentation of shell in the flat area of the umbo with around 12 broad, commarginal ribs. At the point of geniculation these ribs fade to be replaced by distinct growth lines. Interior shell margin crenulated.

Hinge of right valve with two cardinal teeth, the anterior of which is smaller and knob-like, and an indistinct, short anterior lateral tooth. Hinge of partially preserved left valves with two cardinal teeth, subequal in size. In both valves the lateral surfaces of the cardinal teeth are transversely striated.

Internal moulds, which generally have a distinctly greater length-height ratio because of absence of the thick-shelled umbonal area, exhibit a complete pallial line and two subequal adductor muscle scars, the anterior of which is more deeply impressed than the posterior one. In the lower anterior part of the hinge line there is a small suborbicular, deeply im-

pressed retractor muscle scar.

Remarks. The species has been described and discussed in detail by Fürsich et al. (2000). It appears to be a characteristic species of the Ethiopian faunal province occurring, apart from Madagascar, in East-Africa, Mozambique, Kachchh and the southern Himalayas. In Madagascar the species occurs from the Early Oxfordian to the Early Kimmeridgian, whereas in Kachchh the earliest occurrence is from the Late Oxfordian. The species has been recorded from Upper Oxfordian rocks in Madagascar as *Astarte* sp. B by Nicolai (1951).

Order Megalodontida Starobogatov, 1992
Family Ceratomyopsidae Cox, 1964
Family Ceratomyopsidae Cox, 1964
Genus *Ceratomyopsis* Cossmann, 1915

Type species. *Ceromyopsis Helvetica* de Loriol, 1897.

Ceratomyopsis striata (d'Orbigny, 1822)
Pl. 9, Fig. 4

1822 *Isocardia striata* sp. nov. – d'Orbigny: 104, pl. 7, figs. 7–9.

1897 *Isocardia striata* d'Orb. – Futterer: 602, pl. 21, fig. 3, 3a.

1956 *Ceromyopsis* aff. *striata* (d'Orb.) – Agrawal: 122, pl. 11, fig. 8.

1979 *Ceratomyopsis striata* (d'Orbigny) – Kanjilal: 26, pl. 1, fig. 4.

Material. Lower Callovian: Amparambato: 4 RV, 1 LV, 2 AV (BSPG 2015 XIII 101–105); Atainakanga: 1 RV, 1 LV, 1 AV (BSPG 2015 XIII 107); Callovian of Behevo: 1 RV, 1 LV (BSPG 2015 XIII 106); Middle Oxfordian: Ankilimena: 1 LV (BSPG 2015 XIII 108); Andrea: 1 LV (BSPG 2015 XIII 109).

Description. Most of the specimens are composite moulds with their posterior-most part missing. Specimens distinctly higher than long and well-inflated. Umbones salient, spirally coiled anteriorly. With distinct, moderately developed posterior lobe, which in contrast to the remainder of the flank is barely inflated. Shell ornamented with numerous, regular, commarginal ribs. Ligament external, posterior, situated in a groove.

Remarks. The species is highly variable in shape (see also Arkell 1934: 318). Commonly the posterior lobe is totally or partially broken off, due to the strong curvature of the flank. The high morphological variability of the species makes it difficult to evaluate the validity of similar species. *Ceratomyopsis basochiana* (Defrance, 1822) and its synonyms that occur in the Ethiopian faunal province such as *Ceromyopsis kiliani* Rollier of Joubert (1960: pl. 11, fig. 2a, b) and *Ceromyopsis helvetica* de Loriol of Weir (1929: 32, pl. 3, fig. 7) appear to be much more

inflated than the present species. Cox (1965: 107) differentiated *C. striata* and *C. basochiana* mainly based on their stratigraphic occurrence, the former typically occurring in the Kimmeridgian, the latter in the Callovian. The presence of our specimens in the Callovian and Oxfordian of Madagascar questions the validity of this assumption.

Order Lucinida J. Gray, 1854
Family Lucinidae J. Fleming, 1828

Remarks. Taylor et al. (2011) classified the Family Lucinidae based on a molecular phylogeny. They accommodated the Fimbriidae Nicol, 1950 as a subfamily, Fimbriinae, within the Lucinidae, a view followed here. Earlier on Monari (2003) had attempted a phylogeny of Jurassic members of the Fimbriinae and documented *Sphaera* J. Sowerby, 1822 as clearly belonging to the subfamily. For this reason, the new genus *Eosphaera* (see below) is also placed in the subfamily Fimbriinae. Taylor et al. (2011), in contrast, doubted the lucinid status of some Mesozoic genera such as *Sphaera* and *Sphaeriola*.

Genus *Mesomiltha* Chavan, 1938

Type species. *Lucina pulchra* Zittel & Goubert, 1861.

Mesomiltha bellona (d'Orbigny, 1850)
Pl. 9, Figs. 5–7, Pl. 10, Fig. 1

1850 *Lucina Bellona* sp. nov. – d'Orbigny: 309, no. 234.

Material. Bathonian: Anjeba: 1 AV (internal mould with traces of shell) (BSPG 2015 XIII 265); Andamilany: 1 RV, 3 LV, 23 AV (internal moulds with traces of shell) (BSPG 2015 XIII 264, 266).

Measurements. Table 9.

Table 9. Measurements (in mm) of *Mesomiltha bellona* (d'Orbigny, 1850).

specimen	L	H	I
BSPG 2015 XIII 263a	52.8	44.0	18.5
BSPG 2015 XIII 263b	36.9	31.0	~15.5
BSPG 2015 XIII 266a	37.2	32.4	17.2
BSPG 2015 XIII 266b	22.6	18.3	10.8

Description. Specimens suborbicular, poorly inflated. Umbones small, forward-directed. Shell margins regularly rounded except for anterodorsal margin, which is slightly concave. Ornamentation consisting of thin, regularly spaced commarginal ribs; flat intervals between ribs with 2–3 even more delicate commarginal ribs. Hinge not seen.

Remarks. Without knowledge of the hinge features the generic identification of lucinids is often impossible. However, the characteristic ornamentation places the present specimens firmly into *Mesomiltha bellona* as figured, for example, by Fischer (1969: 107, fig. 20, pl. 12, fig. 15a, b) from the Bathonian of France.

Genus *Fimbria* Megerle von Mühlfeld, 1811

Type species. *Fimbria magna* Megerle von Mühlfeld, 1811 (replacement name for *Venus fimbriata* Linnaeus, 1758).

Fimbria sp.
Pl. 10, Figs. 2–4

Material. ?Bathonian of Andamilany: 1 RV (internal mould), 2 LV (composite moulds with remains of shell) (BSPG 2015 XIII 246–248).

Description and remarks. Despite their fragmentary and partially abraded nature the specimens can be placed with confidence in the genus *Fimbria* based on their shape (elongated-oval), thick shell, and ornamentation (coarse commarginal ribs). Anterior and posterior margins well rounded, dorsal margins straight, sloping, ventral margin broadly curved. Interior shell margin crenulated. Umbones mesial, straight. Lunule narrow, lanceolate. Hinge not seen.

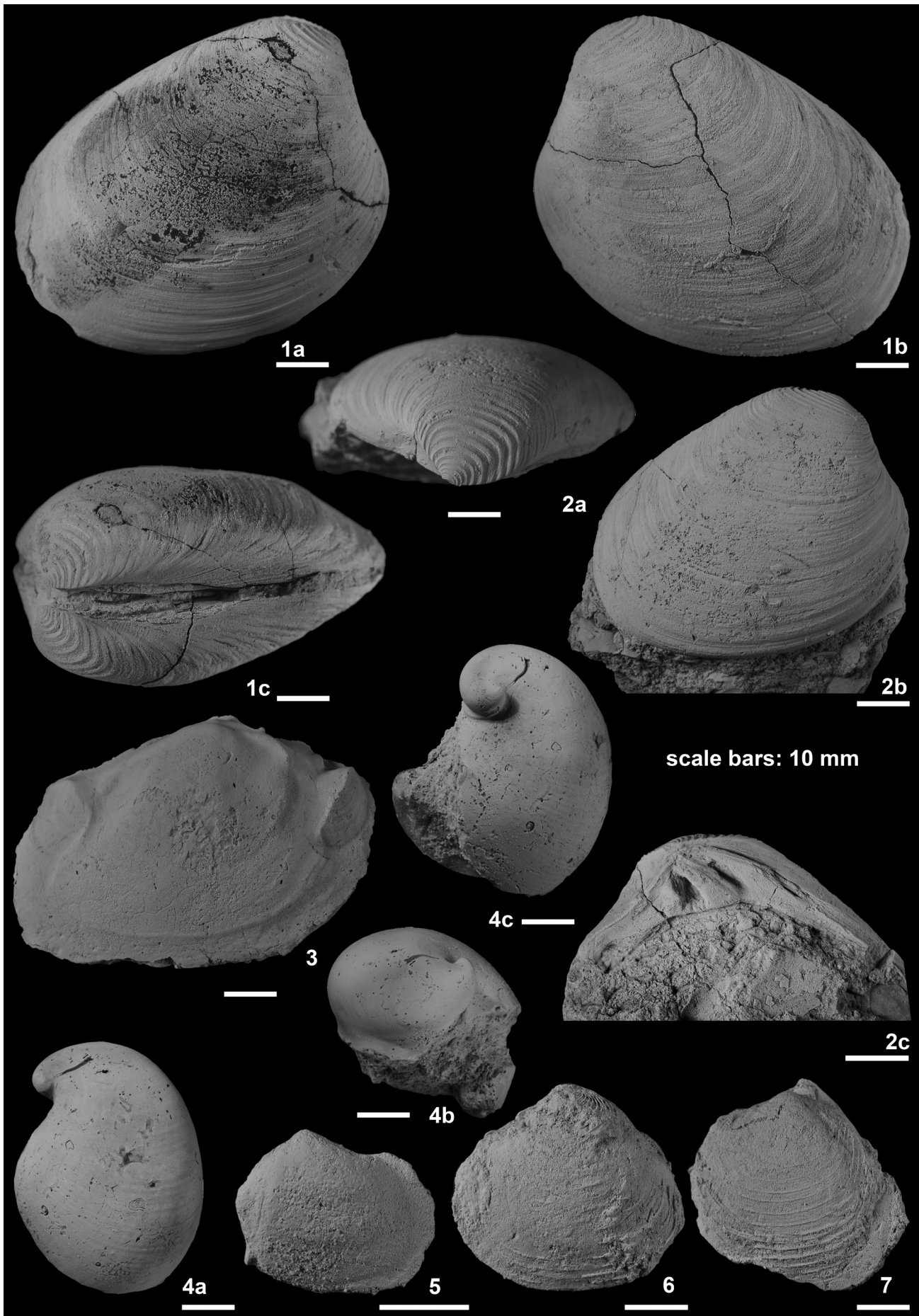
The specimens co-occur with a lucinid bivalve of comparable size, which is equally poorly preserved. The two taxa differ, however, in their length-height ratio and ornamentation.

Genus *Eosphaera* gen. nov.

Type species. *Sphaera madagascariensis* Newton, 1889.

Derivation of name. After Eos, Goddess of dawn, as the genus precedes the closely related Early Cretaceous genus *Sphaera*.

Plate 9: (1–3) *Seebachia (Eoseebachia) sowerbyana* (Holdhaus, 1913). 1. Articulated specimen (BSPG 2015 XIII 198), Lower Oxfordian strata, Dongovato; a, right valve view; b, left valve view; c, dorsal view. 2. Right valve (BSPG 2015 XIII 197), Lower Oxfordian strata, Dongovato; a, oblique dorsal view; b, side view. 3. Internal mould of articulated specimen (BSPG 2015 XIII 208), Middle Oxfordian strata, Ankilimena; right valve view. **(4)** *Ceratomyopsis striata* (d'Orbigny, 1822). Composite mould of right valve (BSPG 2015 XIII 109), Middle Oxfordian strata, Andrea; a, side view; b, dorsal view; c, posterior view. **(5–7)** *Mesomiltha bellona* (d'Orbigny, 1850); Bathonian strata, Andamilany. 5. Articulated composite mould (BSPG 2015 XIII 266c), right valve view. 6. Articulated composite mould (BSPG 2015 XIII 266a). 7. Articulated composite mould (BSPG 2015 XIII 266b).



Diagnosis. Thick-shelled, suborbicular, with thick hinge plate. RV with one knob-like cardinal tooth (1), and a subhorizontal cardinal tooth anterior of it (3a), and one long, narrow, inconspicuous posterior lateral tooth. LV with knob-like anterior cardinal (2a), followed dorsally by a shallow groove for 3a. With two anterior lateral teeth, which are terminally connected, and a narrow posterior lateral tooth, situated close to the dorsal margin. Both valves with suborbicular to elongated area ventrally of the posterior lateral tooth with loop-like, rounded ridges.

Remarks. The specimens included in the new genus *Eosphaera* have been originally placed in *Sphaera*, according to the Treatise an Early Cretaceous genus (Cox et al. 1969: N514). The hinge of *Sphaera corrugata* J. Sowerby, 1822, the type species of the genus as figured by Woods (1904: pl. 25, fig. 2), differs, however, in several details from *Eosphaera*: The shape and orientation of the cardinal and lateral teeth is different and instead of the loop-like ridges ventrally of the posterior lateral there is a distinct pit followed ventrally by a bulge. The new genus is placed here in the subfamily Fimbriinae, because its type species, *Eosphaera madagascariensis* is part of the cladogram of the subfamily (Monari 2003).

Eosphaera occurs in the Middle Jurassic of Kachchh, Sinai, and Madagascar and in the Kimmeridgian of the Lusitanian Basin (Portugal; pers. obs.).

Eosphaera madagascariensis (Newton, 1889)
Pl. 10, Figs. 7–11

- 1889 *Sphaera madagascariensis* n. sp. – Newton: 336, pl. 14, figs. 6–8.
1916 *Sphaera madagascariensis* Newton – Douvillé: 52, pl. 4, fig. 13a, b.
1956 *Sphaera rogeri* sp. nov. – Agrawal: 111, pl. 11, figs. 3–5.
2000 *Sphaera madagascariensis* Newton 1889 – Fürsich et al. 72, pl. 2, figs. 1–3, text-fig. 4.

Material. Lower Callovian: Amparabato: 6 RV, 10 LV, 5 AV (BSPG 2015 XIII 117–124); Atainakanga: 1 AV (BSPG 2015 XIII 125).

Measurements. Table 10.

Description. Shells thick, moderately inflated, suborbicular, slightly inequilateral, slightly longer

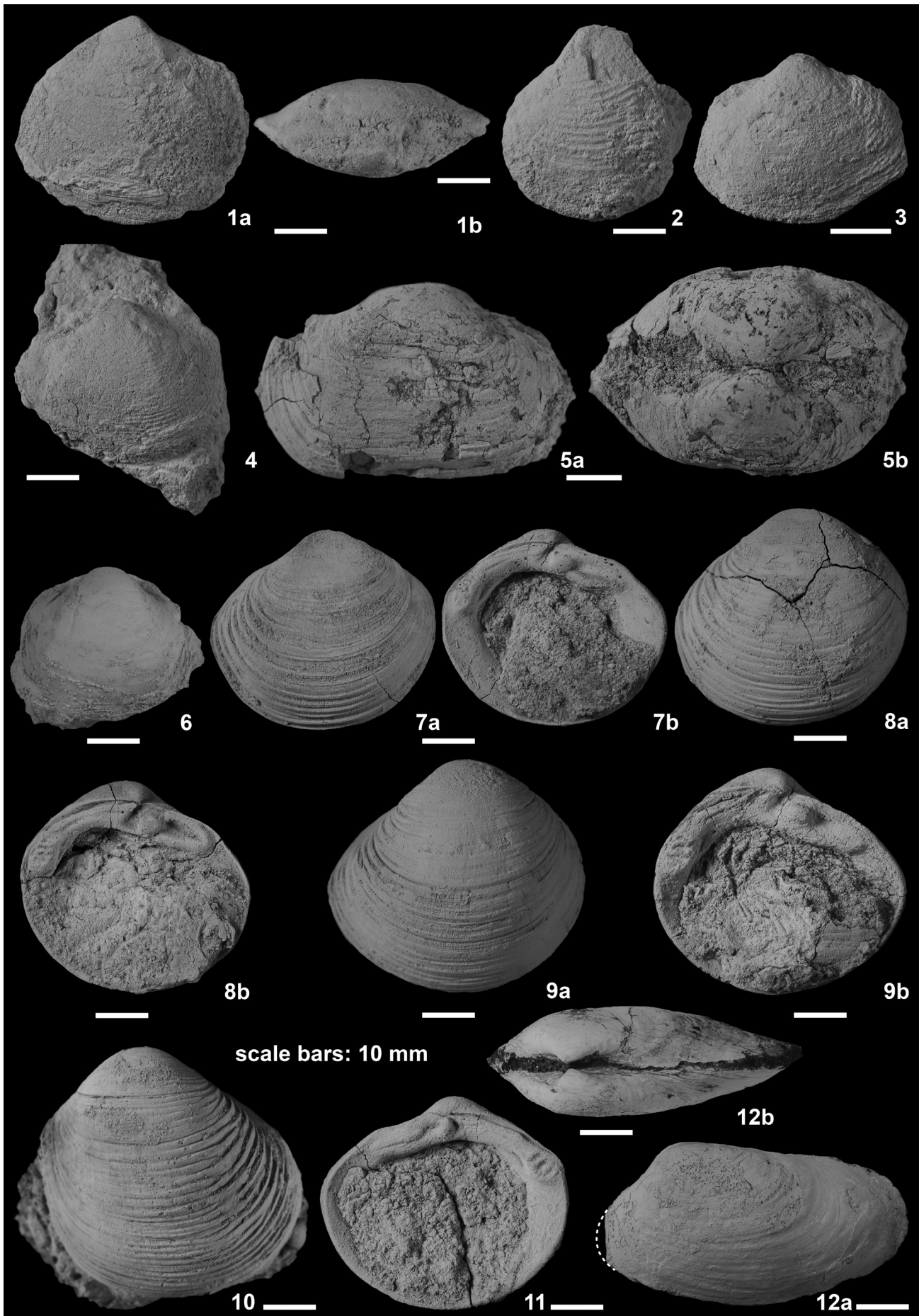
Table 10. Measurements (in mm) of *Eosphaera madagascariensis* (Newton, 1889).

specimen	L	H	I
BSPG 2015 XIII 117	46.9	41.5	39.8
BSPG 2015 XIII 118	43.3	39.0	37.2
BSPG 2015 XIII 119	46.7	39.9	33.4
BSPG 2015 XIII 120a	49.8	44.0	-
BSPG 2015 XIII 120b	49.6	43.5	35.3
BSPG 2015 XIII 120c	48.7	42.8	-
BSPG 2015 XIII 120d	49.6	45.5	-
BSPG 2015 XIII 120e	55.5	49.5	-
BSPG 2015 XIII 121a	42.9	37.5	-
BSPG 2015 XIII 121b	43.9	41.2	32.6
BSPG 2015 XIII 121c	36.0	34.6	-
BSPG 2015 XIII 122a	48.7	43.8	36.4
BSPG 2015 XIII 122b	47.8	45.6	~52.8
BSPG 2015 XIII 123a	44.1	40.1	-
BSPG 2015 XIII 123b	55.4	48.3	-
BSPG 2015 XIII 124	50.3	43.8	41.8

than high. Umbones well developed, beaks slightly prosogyrate. Anterior part of shell slightly expanded. Ligament opisthodontic. Hinge plate thick, widening towards the anterior. RV with upturned, knob-like cardinal tooth 1 and anterodorsally directed cardinal tooth 3a. One distinct anterior lateral tooth and one inconspicuous, faint posterior lateral tooth. LV with large, knob-like cardinal tooth 2a and a questionable, very faintly developed 2b. Two well developed anterior lateral teeth unite distally and enclose a deep elongated groove to receive the lateral tooth of the opposite valve. Posterior lateral tooth tracing the posterior dorsal margin and followed ventrally by a thin groove. In both valves the ventral-most part of the posterior hinge plate is covered with loop-like transversely striated ridges. Shell ornamented with numerous coarse commarginal ribs, which in cross-section are distinctly asymmetric.

Remarks. Our specimens closely correspond in outline and ornamentation to the figure of *E. madagascariensis* in Newton (1889). The figure of the

Plate 10: (1) *Mesomiltha bellona* (d'Orbigny, 1850). Articulated composite mould (BSPG 2015 XIII 265), Bathonian strata, Anjeba; a, right valve view; b, dorsal view. (2–4) *Fimbria* sp., Bathonian strata, Andamilany, 2. Fragmented left valve (BSPG 2015 XIII 247a). 3. Internal mould of right valve (BSPG 2015 XIII 247b). 4. Internal mould of right valve with remains of shell (BSPG 2015 XIII 247c). (5) *Mactromya rugosa* (Roemer, 1836). Articulated specimen (BSPG 2015 XIII 127), Lower Callovian strata, Amparabato; a, right valve view; b, dorsal view. (6) *Mactromyidae?* indet. Composite mould of right valve (BSPG 2015 XIII 128), Lower Kimmeridgian strata, Antsampagna. (7–11) *Eosphaera madagascariensis* (Newton, 1889). 7. Left valve (BSPG 2015 XIII 121a), Lower Callovian strata, Amparabato; a, side view; b, interior view. 8. Left valve (BSPG 2015 XIII 118), Lower Callovian strata, Amparabato; a, side view; b, interior view. 9. Left valve, Lower Callovian strata, Amparabato (BSPG 2015 XIII 122b); a, side view; b, interior view. 10. Right valve, Lower Callovian strata, Amparabato (BSPG 2015 XIII 122a). 11. Right valve (BSPG 2015 XIII 119), Lower Callovian strata, Amparabato; interior view. (12) *Quenstedtia madagascariensis* sp. nov. Articulated internal mould (BSPG 2015 XIII 112b), Middle Oxfordian strata, Andrea; a, left valve view; b, dorsal view.



hinge of the right valve given by Newton (1989: pl. 14, fig. 8) appears, however, highly unrealistic. The specimens occurring in the Callovian Chari Formation of the Kachchh Basin are generally a bit smaller, but correspond well to *E. madagascariensis*. *Corbis (Sphaera) subcorrugata* Dietrich (1933: 49, pl. 6, figs. 81–82) from the Upper Jurassic of Tanzania offers too few features to be confidently placed in *E. madagascariensis*. The same can be said about *Sphaera madagascariensis* of Venzo (1949) from Somalia. In contrast, Douvillé's (1916: 52, pl. 4, fig. 13a, b) specimen of *Sphaera madagascariensis* fits our material closely.

Family Mactromyidae Cox, 1929

Remarks. Monari (2003) regarded the Mactromyidae as the most probable sister-group of the Fimbriidae (now: Fimbriinae).

Genus *Mactromya* Agassiz, 1843

Type species. *Lutraria concentrica* Münster in Goldfuss, 1841 [= *Mactromya rugosa* (Roemer, 1836)].

Mactromya rugosa (Roemer, 1836) Pl. 10, Fig. 5

1836 *Mya rugosa* Nob. – Roemer: 125: pl. 9, figs. 16, 17.

1939 *Mactromya aequalis* Agass. – Stefanini: 239, pl. 27, fig. 1.

? 1959 *Mactromya quadrata* (Roemer) – Jaboli: 64, pl. 8, figs. 5–6.

1965 *Mactromya quadrata* (Roemer) – Cox: 97: pl. 15, fig. 11a, b.

Material. Lower Callovian of Amparambato: 1 AV (BSPG 2015 XIII 127).

Description. The specimen is poorly preserved with remains of shell. Shell subquadrate, longer than high (L: 53 mm; H: 34.6 mm), moderately inflated; umbones mesial, orthogyrate. Ventral margin faintly curved, parallel to dorsal margin, anterior and posterior margins well rounded, but with obtuse anterodorsal and posterodorsal angle. Hinge not seen. Ornamentation consisting of coarse, somewhat irregular commarginal ribs.

Remarks. At present it is not clear, to which extent subquadrate to rectangular species of *Mactromya* are synonyms of *M. rugosa* (Roemer, 1836), the oldest available name. Jaboli (1959: 64, pl. 8, figs. 5, 6) and Cox (1965: 97, pl. 15, fig. 11) used the name *quadrata*, which Roemer (1836: 126) originally had used for this species. However, the name *quadrata* has never been formally introduced and is thus unavailable.

In particular, the difference between *M. rugosa* and *M. aequalis* Agassiz (1842: 196, pl. 9d, figs. 5–8)

is far from clear. The latter species appears to be less elongated, but it may well present only one end of the morphological spectrum. Moreover both species have an identical ornamentation. Thus, *M. aequalis* of Stefanini (1939: 259, pl. 27, fig. 1) is better accommodated in *M. rugosa* based on its elongate shape. *M. quadrata* of Jaboli (1959: 64, pl. 8, figs. 5, 6) may also be better placed in *rugosa*, but its preservation does not allow a precise identification. Agassiz (1842: 197, pl. 9c, figs. 1–23) also described *Mactromya rugosa* and regarded Roemer's *Mya rugosa* as a synonym. Rollier (1913: 234) created the new name *meriani* for Agassiz' *Mactromya rugosa*, which may in fact represent more than one species. Weir (1929: 34, pl. 3, figs. 16–18) referred his material to *M. rugosa* Agassiz. His fig. 18 is fairly elongated and may well belong to *M. rugosa* (Roemer).

The species group *Mactromya rugosa*/*Mactromya aequalis* is also known from other areas of the Ethiopian faunal province, such as Kachchh, East Africa, Tunisia, the Arabian peninsula (e.g., Weir 1929; Cox 1935a, 1965; Stefanini 1939; Ficcarelli 1968; Holzapel 1998; Fürsich et al. 2000), and the Jurassic of western Europe.

Mactromyidae? indet. Pl. 10, Fig. 6

Material. Lower Kimmeridgian of Antsampangna: 1 RV (BSPG 2015 XIII 128).

Description and remarks. Internal mould medium-sized (L: 31.6 mm; H: 29.9 mm), moderately inflated, nearly equilateral, suborbicular; umbones slightly prosogyrate, dorsal margin straight, remaining margins well rounded. Anterodorsal and posterodorsal margins forming an obtuse angle.

The specimen corresponds closely in shape to *Mactromyopsis (Mactromyopsis) hemirhytideus* (Cossman, 1905) from the Bajocian of Normandy, but the presence of a posterior lateral tooth in our specimen precludes an assignment to the genus *Mactromyopsis*. It is therefore kept in open nomenclature.

Order Cardiida Férussac, 1822 Family Quenstedtiidae Cox, 1929 Genus *Quenstedtia* Morris & Lycett, 1855

Type species. *Pullastra oblita* Phillips, 1829.

Quenstedtia madagascariensis sp. nov.

Pl. 10, Fig. 12, Pl. 13, Figs. 1–3
Derivation of name. After Madagascar.

Material. Middle Oxfordian: Andrea: LV, holotype (BSPG 2015 XIII 112a); 2 AV, paratypes (BSPG 2015 XIII 112b, c); 1 RV, 2 AV (BSPG2015XIII 114); Ankilimena: 2 AV (BSPG 2015 XIII 110, 115); Antsampangna: 2 AV (BSPG 2015 XIII 111, 113), Lower Oxfordian of Dongovata: 1 RV, 1 LV, 1 AV (BSPG 2015 XIII 116).

Measurements. Table 11.

Table 11. Measurements (in mm) of *Quenstedtia madagascariensis* sp. nov.

specimen	L	H	La	I
BSPG 2015 XIII112a	47.4	28.2	12.3	-
BSPG 2015 XIII112b	58.0	31.5	13.2	20.5
BSPG 2015 XIII110	67.5	35.9	18.0	23.0

Diagnosis. Elongate *Quenstedtia* with subparallel ventral and dorsal margins and well-rounded anterior and posterior margins. Umbones prominent for the genus, orthogyrate, situated around one-fourth of shell length from the anterior end.

Description. Shell distinctly elongated; ventral and dorsal margins subparallel to very faintly curved, anterior and posterior margins well rounded, anterior end shorter than posterior one. Inflation moderate. Umbones prominent for the genus, orthogyrate, rounded, situated around one-fourth of shell length from the anterior end. Shell surface smooth except for faint growth lines. Hinge with resilifer, right valve with small, narrow, wedge-shaped cardinal tooth and an elongated thickened hinge plate anterior of the socket. Left valve with a knob-shaped cardinal tooth and an elongated, thickened hinge plate anterior of the socket.

Remarks. The most detailed description of Jurassic species of *Quenstedtia* is that of Arkell (1934: 295-301). Arkell described five species of *Quenstedtia*, which differ, however, from the present species above all by their more mesially placed and less pronounced umbones. A number of species have been described from the Ethiopian faunal province, but most of them are based on fairly poor material, for example *Q. cf. angusta* Terquem & Jourdy of Venzo (1949: 157, pl. 16, fig. 26) from the Bathonian of East Africa, *Q. gortanii* n. sp. of Venzo (1949: 159, pl. 16, fig. 27) from the Bathonian-Callovian of the same area, and *Q. jubaensis* n. sp. of Venzo (1944: 23, fig. 9a-c) and *Q. morrissi* Cossmann of Venzo (1949: 156, pl. 16, fig. 20) from the Bathonian of East Africa. In all these species the umbones are more mesially placed than in the present species. Cox (1965: 120, pl. 19, fig. 5) described *Q. jouberti* sp. nov. from Kimmeridgian strata of East Africa, a species more reminiscent of *Q. laevigata* (Phillips, 1829) (Fürsich et al. 2000: 117). Finally *Q. saggersoni* sp. nov. of Cox (1965: 119, pl. 19, figs. 4, 6) is again more equilateral than our species and its umbones are less prominent.

Family Tancrediidae F. Meek, 1864

Genus *Tancredia* Lycett, 1850

Subgenus *Isotancredia* Chavan, 1950

Type species: *Tancredia extensa* Lycett, 1850.

Tancredia (Isotancredia?) sp.

Pl. 11, Fig. 4

Material. Lower Callovian of Amparambato: 1 RV (internal mould) (BSPG 2015 XIII 242).

Description. Specimen poorly preserved (the anterior and posterior ends are slightly damaged), small (H: 7 mm), distinctly elongated, compressed, with mesially placed, anteriorly directed, depressed umbones. Posterior end obliquely truncated, anterior end cuneiform, tapering. Anterodorsal margin much more strongly sloping than the short, straight posterodorsal margin. The latter forms a blunt angle with the middle part of the posterior margin. An even blunter angle exist between the posterior and the straight ventral margin. A distinct posterior umbonal ridge ends at this latter angle.

Remarks. Although poorly preserved, the specimen can be placed with confidence in the genus *Tancredia* and most likely belongs to the subgenus *Isotancredia*, which characteristically is quite small. The similar subgenus *Palaeomya* Zittel & Goubert, 1861 differs in being much more elongated anteriorly. An identification at the species level is not possible.

Family Arcticiidae R. Newton, 1891

Genus *Anisocardia* Munier-Chalmas, 1863

Subgenus *Anisocardia* Munier-Chalmas, 1863

Type species: *Anisocardia elegans* Munier-Chalmas, 1863.

Anisocardia (Anisocardia?) minima (J. Sowerby, 1821)

Pl. 11, Fig. 5

1821 *Isocardia minima* sp. nov. – J. Sowerby: 171, pl. 295, fig. 5.

1965 *Anisocardia minima* (J. Sowerby) – Cox: 112, pl. 18, fig. 8.

v 2000 *Anisocardia (?Anisocardia) minima* (J. Sowerby, 1821) – Fürsich et al.: 124, pl. 15, figs. 4–6, text-fig. 33.

Material. Upper Bathonian of Tongobory: 1 AV (internal mould) (BSPG 2015 XIII 241).

Description and remarks. The tips of the umbones of the articulated internal mould are partly missing. Despite this, the specimen closely resembles *Anisocardia minima* as figured, for example, by Arkell (1934: 275, pl. 36, figs. 8–11). The salient, narrow umbones are distinctly prosogyrate and the anterodorsal margin forms a rounded angle with the broadly curved ventral margin. The posterior margin is well rounded.

Fürsich et al. (2000: 124) discussed the generic placement of *Isocardia minima*, which was shifted by Duff (1978: 104) to the genus *Rollierella* Cossmann, 1924. Details of the hinge of a specimen from Kachchh, however, clearly demonstrate that the species

belongs to *Anisocardia*. Its subgeneric position, i.e. whether it belongs to *Anisocardia* or *Antiquicyprina*, still awaits clarification.

Genus *Pronoella* Fischer, 1887
Subgenus *Pronoella* Fischer, 1887

Type species. *Venulites trigonellaris* Schlotheim, 1820.

Pronoella (Pronoella) pindiroensis Cox, 1965
Pl. 11, Fig. 6

1965 *Pronoella pindiroensis* sp. nov. – Cox: 108, pl. 17, figs. 12–17.

Material. Bajocian of Anamalanga: 1 LV (BSPG 2015 XIII 235).

Description. Shell elongate-triangular (L: 31.5 mm, H: 20.8 mm), moderately inflated, umbones broadly rounded, situated one-third of shell length from the anterior end, beaks prosogyrate. Anterior margin well rounded, ventral margin faintly convex, posteroventral margin obliquely truncated, posterodorsal margin sloping, straight; with broad, inconspicuous posterior umbonal ridge. Shell smooth. Internal features not seen.

Remarks. Although no hinge features are seen, the specimen can be placed with reasonable confidence in *P. (P.) pindiroensis* from the Bajocian? of East Africa as figured and described by Cox (1965).

Genus *Venilicardia* Stoliczka, 1870
Subgenus *Venilicyprina* Fürsich, Heinze & Jaitly, 2000

Type species. *Venilicardia (Venilicyprina) khalii* Fürsich, Heinze & Jaitly, 2000.

Remarks. The subgenus *Venilicyprina* has been erected by Fürsich et al. (2000), based on its intermediate position with respect to shape and hinge structures between *Venilicardia* Stoliczka, 1870 and *Tortartica* Casey, 1961. The latter two genera are restricted to the Cretaceous, whereas *Venilicyprina* is a Middle to Late Jurassic species, apparently endemic to the Malagasy Gulf.

Venilicardia (Venilicyprina) aff. khalii Fürsich, Heinze & Jaitly, 2000
Pl. 11, Fig. 7

aff. v2000 *Venilicardia (Venilicyprina) khalii* sp. nov. – Fürsich, Heinze & Jaitly: 130, pl. 16, figs. 5, 6, text-fig. 40.

Material. Middle Oxfordian of Ankilimena: 1 AV (BSPG2015XIII 209).

Description. The articulated specimen is preserved with shell, but the posterior part of the right valve is missing, and of the left valve only the posteroventral part is preserved. Shell moderately inflated, umbones more or less mesial, prosogyrate, strongly coiled. With rounded posteroventral carina, well developed in the umbonal area. Lunule large, wide, and deep, but not demarcated by ridge. Anterior margin well rounded, anterodorsal margin slightly concave, posterior margin broadly arched and grading into the weakly convex ventral margin. Shell smooth, except for very fine growth lines.

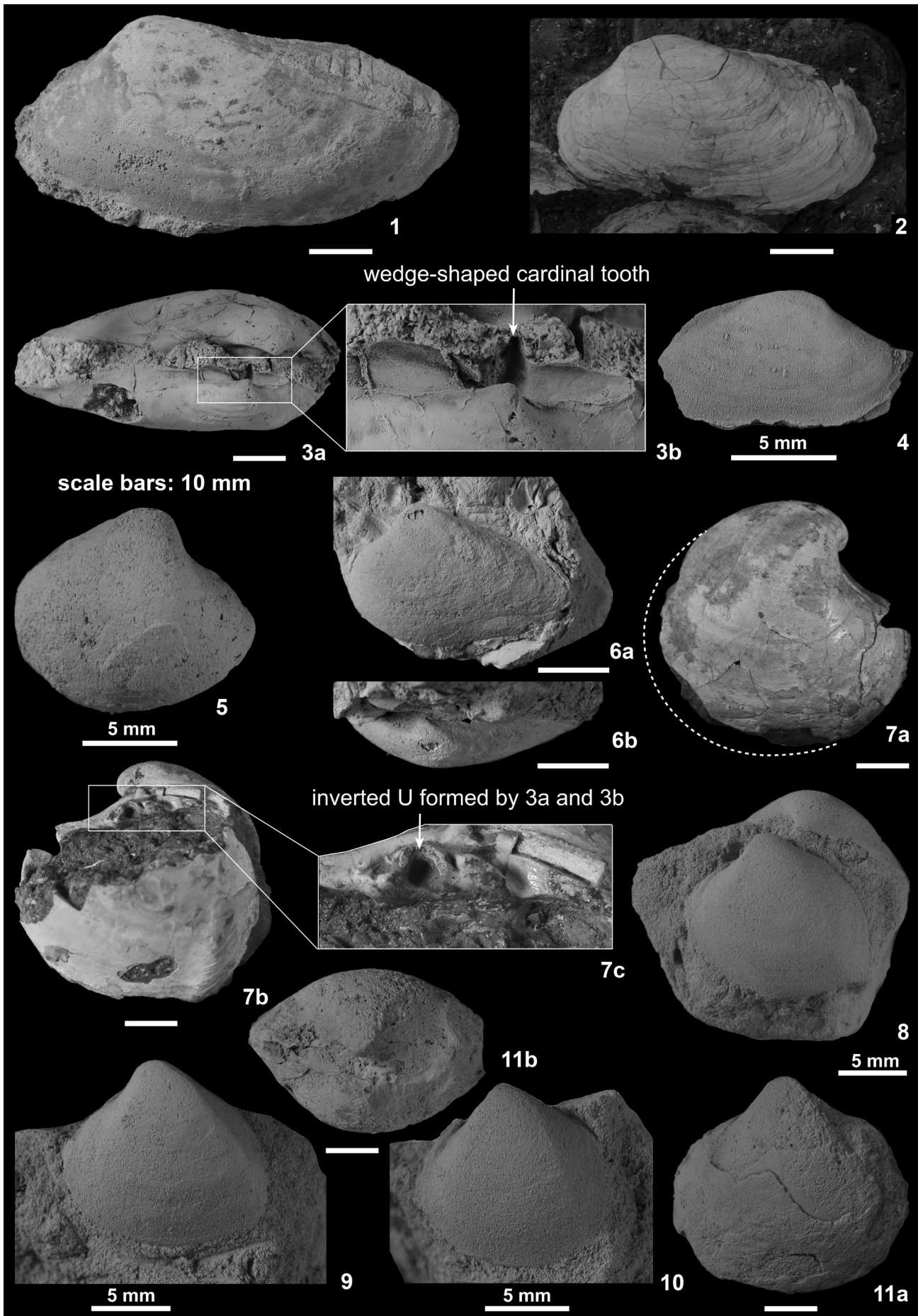
Hinge of right valve with three cardinal teeth, 3b bifid, connected with thin and short 3a in such a way, that the two teeth form an inverted U. Cardinal tooth 1 small, knob-shaped, situated ventrally of 3a. Remaining part of hinge not preserved.

Remarks. The specimen is similar to *Venilicardia (Venilicyprina) khalii* from the Middle Jurassic of Kachchh but differs also in some respects: In the specimens from Kachchh the posterior margin is obliquely truncated as opposed to well rounded in the specimen from Madagascar. Differences exist also in the hinge: The inverted U-shaped structure formed by 3a and 3b is narrower and more anteriorly directed in the Kachchh specimen. Most likely we deal with two closely related species. As the present specimen is fragmentary, better preserved material is needed to finally evaluate the relationship between the two taxa.

Venilicardia hunti Cox (1935a: 182, pl. 19, fig. 14 a, b) from the Oxfordian of Somalia is an internal mould, which is difficult to evaluate as its hinge is unknown.

Family Isocyprinidae R.N. Gardner, 2005
Genus *Isocyprina* Röder, 1882
Subgenus *Isocyprina* Röder, 1882

Plate 11: (1–3) *Quenstedtia madagascariensis* sp. nov. 1. Articulated composite mould, paratype (BSPG 2015 XIII 112b), Middle Oxfordian strata, Andrea; left valve view. 2. Left valve, holotype (BSPG 2015 XIII 112a), Middle Oxfordian strata, Andrea. 3. Articulated internal mould (BSPG 2015 XIII 115), Middle Oxfordian strata, Ankilimena; a, dorsal view; b, enlarged dorsal view of hinge area of right valve. **(4)** *Tancredia (Isotancredia?)* sp. Internal mould of right valve (BSPG 2015 XIII 242), Lower Callovian strata, Amparambato. **(5)** *Anisocardia (Anisocardia?) minima* (J. Sowerby, 1821). Articulated internal mould (BSPG 2015XIII 241), Upper Bathonian strata, Tongobory; right valve view. **(6)** *Pronoella (Pronoella) pindiroensis* Cox, 1965. Left valve (BSPG 2015 XIII 235), Bajocian strata, Anamalanga; a, side view; b, dorsal view. **(7)** *Venilicardia (Venilicyprina) aff. khalii* Fürsich, Heinze & Jaitly, 2000. Fragmented articulated specimen (BSPG 2015 XIII 209), Middle Oxfordian, Ankilimena; a, right valve view; b, c Hinge of right valve. **(8–10)** *Isocyprina (Isocyprina) glabra* (Blake & Hudleston, 1877), Upper Bathonian strata, Tongobory. 8. Internal mould of left valve (BSPG 2015 XIII 245a). 9. Internal mould of left valve (BSPG 2015 XIII 245c). 10. Internal mould of left valve (BSPG 2015 XIII 245b). **(11)** *Protocardia (Protocardia) cf. somaliensis* Cox, 1935. Articulated specimen with remains of shell (BSPG 2015 XIII 222), Lower Kimmeridgian strata, Antsampangna; a, right valve view; b, dorsal view.



Type species: *Cardium cyreniforme* Buvignier, 1852.

Isocyprina (Isocyprina) glabra (Blake & Hudleston, 1877)
Pl. 11, Figs. 8–10

1877 *Cypricardia glabra* sp.nov. – Blake & Hudleston: 397, pl. 15, fig. 2 only.

Material. Upper Bathonian of Tongobory: 4 RV, 8 LV, 2 AV (internal moulds) (BSPG 2015 XIII 243–245).

Measurements. Table 12.

Table 12. Measurements (in mm) of *Isocyprina (Isocyprina) glabra* (Blake & Hudleston, 1877).

specimen	L	H	L/H
BSPG 2015 XIII 243	13.2	12.2	1.08
BSPG 2015 XIII 244a	14.8	14.0	1.06
BSPG 2015 XIII 244b	15.6	12.4	1.26
BSPG 2015 XIII 245a	12.2	11.7	1.04
BSPG 2015 XIII 245b	12.0	10.0	1.2
BSPG 2015 XIII 245c	14.7	12.5	1.17

Description. Internal moulds small, sub-orbicular, slightly longer than high, inequilateral. Umbones prominent, forward directed, submesial. Margins well rounded, but ventral margin distinctly asymmetrical. With distinct posterior umbonal ridge extending to the posteroventral end. Area posterior of the ridge flat to faintly convex.

Remarks. The internal moulds do not yield information on hinge features or surface ornamentation. The specimens strongly resemble *Isocyprina glabra* as figured by Arkell (1934: 267, pl. 35, figs. 9–11, text-fig. 60) from the Oxfordian of Dorset and Yorkshire (England). According to Arkell (1934), who studied topotype material, Blake & Hudleston's figure is quite poor. As the hinge of *I. glabra* is identical to that of *I. cyreniformis* (Buvignier, 1852), the type species of the subgenus, the species is placed in *Isocyprina (Isocyprina)*.

Order Cardiida Férussac, 1822
Family Cardiidae Lamarck, 1809
Genus *Protocardia* von Beyrich, 1845
Subgenus *Protocardia* von Beyrich, 1845

Type species: *Cardium hillanum* J. Sowerby, 1813.

Protocardia (Protocardia) cf. somaliensis Cox, 1935
Pl. 11, Fig. 11

cf. 1935a *Protocardia somaliensis* sp. nov. – Cox: 186, pl. 20, fig. 2a, b.

non 1955 *Protocardia somaliensis* Cox – Basse et al.: 666, pl. 1, fig. 1a–c.

cf. 1998 *Protocardia (Protocardia) somaliensis* Cox 1935 – Holzapfel: 114, pl. 8, figs. 21, 22.

Material. Lower Kimmeridgian of Antsampagna: 1 RV, 1 AV (internal moulds with remains of shell) (BSPG 2015 XIII 222, 230).

Description. Specimens large (H: 46 mm), posterior end damaged, moderately inflated. Outline suborbicular, umbones mesial, salient, orthogyrate. Margins regularly curved, ventral margin slightly less so than the remaining ones. Adductor muscle scars oval. Shell ornamentation not preserved.

Remarks. The poorly preserved specimen closely resemble Cox' specimen from the Oxfordian? strata of Somaliland and may well be conspecific. The characteristic posterior radial ornamentation, a diagnostic feature of (*P.*) *Protocardia*, is faintly visible.

Protocardia sp., described and figured by Nicolai (1950) from Middle Bathonian strata of SW Madagascar, is not well enough preserved to allow a precise identification, but appears to have had a similar outline as the present specimen. *Protocardia somaliensis* as figured by Basse et al. (1955) from the Upper Jurassic strata of Jemen is distinctly elongated and does not belong to Cox' species.

Protocardia (Protocardia) buckmani
(Morris & Lycett, 1853)
Pl. 12, Fig. 1

1853 *Cardium buckmani* sp. nov. – Morris & Lycett: 64, pl. 7, fig. 2.

? 1950 *Protocardia* sp. – Nicolai: pl. 19, figs. 4, 5.

? 1951 *Protocardia* sp. – Nicolai: 21 (49).

Material. Upper Bathonian of Tongobory S: 1 AV (internal mould) (BSPG 2015 XIII 231); Lower Callovian of Amparambato: (BSPG 2015 XIII 226).

Description. Shell large for the genus (specimen BSPG 2015 XIII 231: L: 30.0 mm, H: 26.5 mm), sub-aquilateral, moderately inflated. Shell margins well rounded, except for posterodorsal margin, which is somewhat obliquely truncated. Posterior fifth of shell covered with numerous closely spaced, delicate, radial riblets. Hinge not seen.

Remarks. The present specimen agrees well with *Protocardia (P.) buckmani* (Morris & Lycett, 1853). *Protocardia* sp. of Nicolai (1950, 1951) is also from the Bathonian. Due to its poor preservation it has been included in the synonymy with doubt.

Protocardia (Protocardia) lycetti Rollier, 1912
Pl. 12, Figs. 2–5

1853 *Cardium subtrigonum* n. sp. – Morris & Lycett: 64, pl. 7, fig. 3 (non d'Orbigny, 1850).

- 1863 *Cardium subtrigonum* Morris & Lycett – Lycett: pl. 35, figs. 2, 2a.
 1912 *Cardium (Protocardium) subtrigonum* Morris & Lycett – Rollier: 122.
 1912 *Cardium (Protocardium) lycetti* nom. nov. – Rollier: 122 (for *Cardium subtrigonum* figured in Lycett 1863).
 v 1994 *Protocardia (Protocardia)* sp. A – Fürsich et al.: pl. 2, fig. 5.
 v 2000 *Protocardia (Protocardia) lycetti* Rollier – Fürsich et al.: 105, pl. 12, figs. 4–7, text-figs. 22, 25d.

Material. Bajocian of Analamanga: 1 RV (BSPG 2015 XIII 228); Upper Bathonian: Analamanga: 2 LV (BSPG 2015 XIII 229); Tongobory S: 1 RV (BSPG 2015 XIII 227).

Measurements. Table 13.

Table 13. Measurements (in mm) of *Protocardia (Protocardia) lycetti* Rollier, 19121.

specimen	L	H
BSPG 2015 XIII 229a	18.9	17.1
BSPG 2015 XIII 229bb	16.4	15.8
BSPG 2015 XIII 227	18.9	17.2
BSPG 2015 XIII 228	16.4	14.5

Description. Small *Protocardia*, suborbicular, umbones relatively narrow, protruding, mesial, orthogyrate. Shell margins well rounded. Shell smooth except for posterior part that carries around 20 dense, radial riblets. Internal features not seen.

Remarks. The species has been discussed in some detail by Fürsich et al. (2000: 105). Our material does not exhibit a posterior umbonal ridge, which, according to Fürsich et al. (2000), is present in the material from Kachchh, although only faintly so.

Genus *Integricardium* Rollier, 1912
 Subgenus *Integricardium* Rollier, 1912

Type species. *Cardium dupinianum* d'Orbigny, 1844.

Integricardium (Integricardium) cf. *bannesianum*

(Contejean, 1860)

Pl. 12, Figs. 6, 7

- cf. 1860 *Cardium bannesianum* n. sp. – Contejean: 276, pl. 15, figs. 1–3.
 v cf. 2000 *Integricardium (Integricardium) bannesianum* (Contejean 1860) – Fürsich et al.: 115, pl. 12, figs. 14–18, text-figs. 27–28.

Material. Lower Callovian of Amparambato: 1 LV (internal mould) (BSPG 2015 XIII 225); Middle Oxfordian of Ankilimena: 1 RV (internal mould) (BSPG 2015 XIII 224); Lower Kimmeridgian of Antsampa-gna: 2 RV, 1 LV, 2 AV (internal moulds) (BSPG 2015 XIII 223).

Description. Specimens small for the genus (H: 21.4 mm; L: 24.0 mm), well rounded, moderately inflated, equilateral. Umbones prominent, mesial, orthogyrate. Shell margins evenly curved except posterior margin, which is slightly obliquely truncated. Shell surface smooth. Hinge not seen.

Remarks. The lack of posterior radial riblets places the specimens within *Integricardium*. Of the various species of this genus it is closest to *I. bannesianum* (Contejean, 1860).

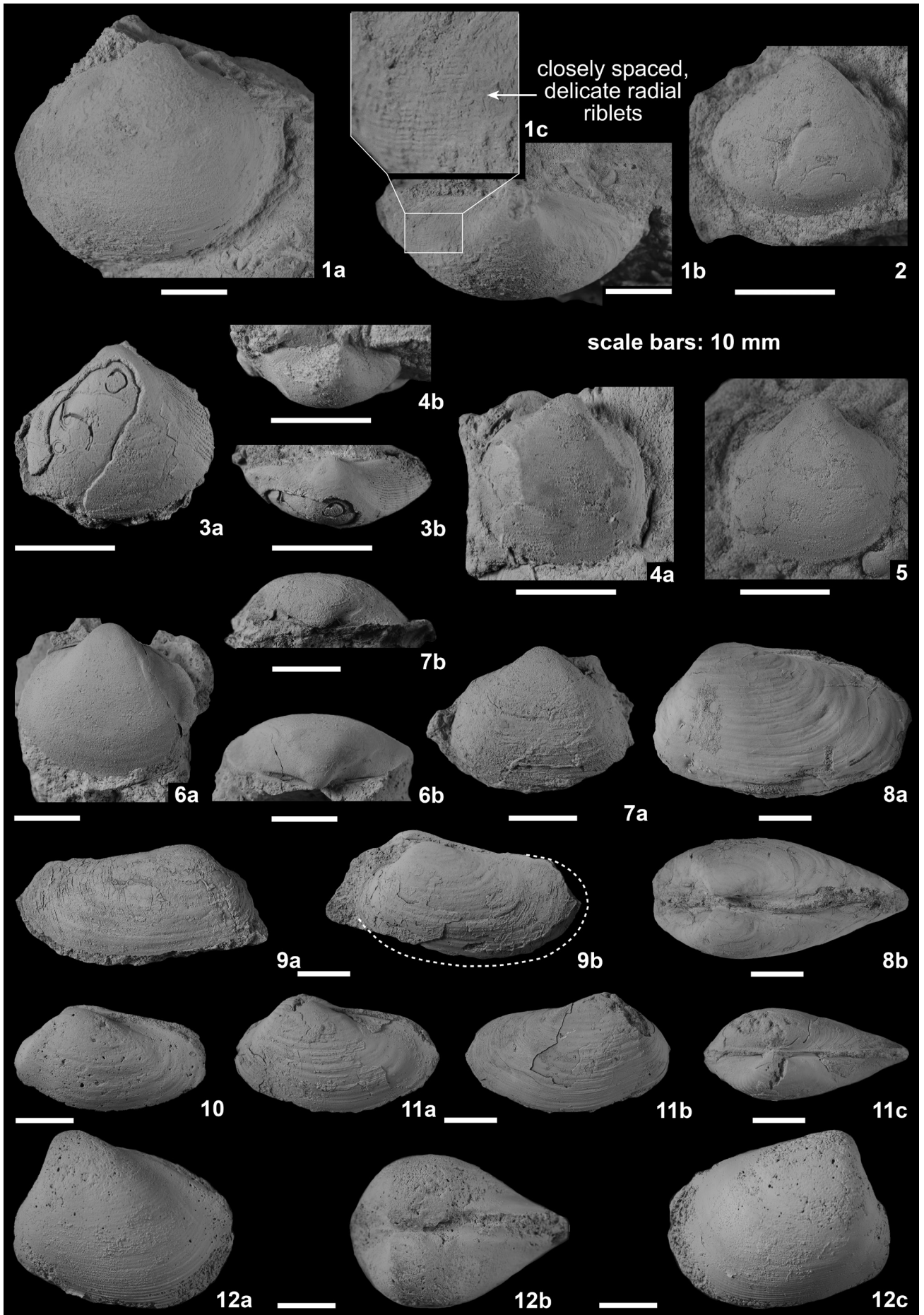
Order Pholadida J. Gray, 1854
 Family Pleuromyidae Zittel, 1895
 Genus *Pleuromya* Agassiz, 1843

Type species. *Mya gibbosa* J. de C. Sowerby, 1826.

Pleuromya uniformis (J. Sowerby, 1813)
 Pl. 12, Figs. 8–11

- 1813 *Unio uniformis* sp. nov. – J. Sowerby: 83, pl. 33, fig. 4.
 v 1840 *Amphidesma? ovalis* sp. nov. J. de C. Sowerby: pl. 21, fig. 11 and explanations.
 v 1840 *Amphidesma (Pleuromya) hians* sp. nov. – J. de C. Sowerby: pl. 21, fig. 12 and explanations.
 1935b *Pleuromya uniformis* (J. Sowerby) – Cox: 15, pl. 2, figs. 9, 10.
 1956 *Pleuromya uniformis* (J. Sowerby) – Agrawal: 119, pl. 11, figs. 1, 2.
 1965 *Pleuromya uniformis* (J. Sowerby) – Cox: 131, pl. 20, fig. 6.
 1979 *Pleuromya uniformis* (J. Sowerby) – Kanjilal: 28, pl. 2,

(Page 186) Plate 12: (1) *Protocardia (Protocardia) buckmani* (Morris & Lycett, 1853). Right valve (BSPG 2015 XIII 226), Upper Bathonian strata, Tongobory S; a, side view; b, dorsal view; c, enlarged posterior radial riblets. (2–5) *Protocardia (Protocardia) lycetti* Rollier, 1912. 2. Internal mould of left valve (BSPG 2015 XIII 228), Upper Bathonian strata, Tongobory S. 3. Left valve (BSPG 2015 XIII 229a), Upper Bathonian strata, Analamanga; a, side view; b, dorsal view. 4. Right valve (BSPG 2015 XIII 229b), Upper Bathonian strata, Analamanga; a, side view; b, dorsal view. 5. Internal mould of right valve (BSPG 2015 XIII 227), Upper Bathonian strata, Tongobory S. (6, 7) *Integricardium (Integricardium)* cf. *bannesianum* (Contejean, 1860). 6. Internal mould of left valve (BSPG 2015 XIII 225), Lower Callovian strata, Amparambato; a, side view; b, dorsal view. 7. Right valve (BSPG 2015 XIII 224), Middle Oxfordian strata, Ankilimena; a, side view; b, dorsal view. (8–11) *Pleuromya uniformis* (J. Sowerby, 1813). 8. Articulated composite mould (BSPG 2015 XIII 83a), Middle Oxfordian strata, Andrea; a, left valve view; b, dorsal view. 9. Articulated composite mould with remains of shell (BSPG 2015 XIII 81a), Lower Oxfordian strata, Dangovato; a, right valve view; b left valve view. 10. Articulated composite mould (BSPG 2015 XIII 90), Lower Callovian strata, Amparambato; left valve view. 11. Articulated composite mould with remains of shell (BSPG 2015 XIII 86), Lower Callovian strata, Amparambato; a, left valve view; b, right valve view; c, dorsal view. (12) *Ceratomya concentrica* (J. de C. Sowerby, 1825). Articulated composite mould (BSPG 2015 XIII 95), Lower Callovian strata, Amparambato; a, left valve view; b, dorsal view; c, right valve view.



figs. 5, 6 (non fig. 4).

- ? 1986 *Pleuromya alduini* (Brongniart) – Jaitly: 42, fig. 7.
 v 1996 *Pleuromya uniformis* (J. Sowerby) – Pandey et al.: 62, pl. 7, figs. 5–11.

Material. Bajocian of Analamanga: 1 AV (BSPG 2015 XIII 79); Upper Bathonian of Tongobory S: 1 RV, 1 AV (BSPG 2015 XIII 91); Lower Callovian: Amparambato: 5 AV (BSPG 2015 XIII 84–86, 88, 90); Atainakanga: 11 AV (BSPG 2015 XIII 77); Lower Oxfordian of Dangovato: 1 LV, 7 AV (BSPG 2015 XIII 81, 87); Middle Oxfordian: Ankilimena: 5 AV (BSPG 2015 XIII 76, 89); Andrea: 2 AV (BSPG 2015 XIII 83); Upper Oxfordian of Dangovato: 1 LV, 8 AV (BSPG 2015 XIII 78, 82); Lower Kimmeridgian of Antsampangna: 6 AV (BSPG 2015 XIII 75, 80).

Measurements. Table 14.

Table 14. Measurements (in mm) of *Pleuromya uniformis* (J. Sowerby, 1813).

specimen	L	H	La
BSPG 2015 XIII81a	44.5	20.7	10.2
BSPG 2015 XIII81b	40.1	21.9	11.1
BSPG 2015 XIII81c	59.3	27.6	16.0
BSPG 2015 XIII81d	42.5	19.8	7.7
BSPG 2015 XIII83a	48.9	29.3	13.4
BSPG 2015 XIII90	33.4	17.3	7.7
BSPG 2015 XIII89	39.1	22.8	8.9
BSPG 2015 XIII82a	40.7	21.7	11.2
BSPG 2015 XIII87	42.5	21.2	10.0
BSPG 2015 XIII79	40.7	21.5	13.6
BSPG 2015 XIII80a	34.9	18.9	10.0
BSPG 2015 XIII80b	33.7	20.1	11.3
BSPG 2015 XIII77a	46.4	25.7	11.2
BSPG 2015 XIII77b	36.1	20.9	9.6
BSPG 2015 XIII78a	32.6	17.5	9.5
BSPG 2015 XIII78b	39.0	21.2	8.9

Description. Individuals commonly preserved as composite moulds, more rarely with remains of shell. Shell ovate-elongated, umbones orthogyrate, slightly depressed, situated one-third to one-fourth of shell length from the anterior end. Dorsal margin nearly straight, ventral margin faintly to distinctly arcuate, anterior margin well rounded, and posterior margin slightly tapering. Posterior end with distinct gape. Ornamentation consisting of growth lines of variable strength. Some specimens with a faint sulcus running from the umbo to the ventral margin. Hinge line anterior of beak of right valve with a small protuberance with a concave dorsal area, followed posteriorly by a triangular socket.

Remarks. *Pleuromya uniformis* is one of the commonest Jurassic bivalves with a stratigraphic range throughout the Jurassic. The species is characterized by a high morphological variability, which is also shown in the present material that represents

most of the Middle and Upper Jurassic stages. The tooth-like structure seen in Pl. 12, Fig. 9b corresponds to what has been described by Arkell (1934: text-fig. 37) and by Cox (1969: N842) as an internal ligamental structure.

Family Ceratomyidae Arkell, 1934
 Genus *Ceratomya* Sandberger, 1864

Type species. *Isocardia excentrica* Roemer, 1836.

Ceratomya concentrica (J. de C. Sowerby, 1825)
 Pl. 12, Fig. 12, Pl. 13, Fig. 1

- 1825 *Isocardia concentrica* sp. nov. – J. de C. Sowerby: 147, pl. 491, fig. 1.
 1925 *Ceromya concentrica* (Sow.) – Weir: 89.
 ?cf. 1929 *Ceratomya cf. wimmisensis* (Gilliéron), 1886 – Weir: 31, pl. 3, fig. 1.
 1929 *Ceratomya wimmisensis* (Gilliéron) – Weir: 31, pl. 3, fig. 2.
 1960 *Ceratomya concentrica* (Sowerby) – Joubert: pl. 10, fig. 9a, b.
 1965 *Ceratomya concentrica* (Sowerby) – Cox: 132, pl. 20, fig. 7.
 v 1996 *Ceratomya wimmisensis* (Gilliéron) – Pandey et al.: 61, pl. 6, figs. 8, 9.

Material. Upper Bathonian of Tongobory S: 1 LV, 1 AV (BSPG 2015 XIII 93); Lower Callovian: Amparambato: 1 LV, 3 AV (BSPG 2015 XIII 94–96, 100); Analamanga: 1 LV (BSPG 2015 XIII 92).

Measurements. Table 15.

Table 15. Measurements (in mm) of *Ceratomya concentrica* (J. de C. Sowerby, 1825).

specimen	L	H	I
BSPG 2015 XIII94	+/-55.3	41.1	35.5
BSPG 2015 XIII95	38.8	28.8	25.6

Description. Shell elongate-ovate, well inflated. Umbones salient, prosogyrate, situated one-sixth to one-seventh of shell length from the anterior end; beaks enrolled. Anterior margin narrowly rounded, ventral margin faintly curved, posterior margin broadly rounded, and dorsal margin regularly curved. Valves with a small posterior gape. Escutcheon faint, long, lanceolate. Ornamentation of shell consisting of numerous closely spaced commarginal ribs.

Remarks. Gilliéron (1886: 141) erected the new species *wimmisensis* for specimens figured by de Loriol (1883) from the “Couches à Mytilus” (Callovian) of the Alpes Vaudoises (Switzerland) as *Ceratomya concentrica*. The most diagnostic feature of *wimmisensis* appears to be certain irregularities in the ribbing pattern. We are, however, of the opinion that these are not distinct enough to warrant a differentiation at the species level. The present mate-

rial is preserved with remains of shells or as internal moulds.

Ceratomya excentrica (Roemer, 1836)
Pl. 13, Fig. 2

- 1836 *Isocardia excentrica* Voltz MS – Roemer: 106, pl. 7, fig. 4a–c.
1897 *Ceromya excentrica* Ag. – Futterer: 608, pl. 22, figs. 2, 2a.
1929 *Ceratomya excentrica* (Weir) – Weir: 31, pl. 3, fig. 4.
1939 *Ceratomya excentrica* (Voltz) – Stefanini: 249, pl. 25, fig. 7.
1959 *Ceratomya cf. excentrica* (Voltz) – Jaboli: 61, pl. 8, figs. 1–3.
1960 *Ceratomya excentrica* (Roemer) – Joubert, pl. 10, fig. 10a, b only.
1965 *Ceratomya excentrica* (Roemer) – Cox: 135, pl. 20, fig. 10.

Material. Aalenian? of Beronono: 1 AV (BSPG 2015 XIII 97); Lower Callovian: Atainakanga: 1 RV (BSPG 2015 XIII 98); Amparambato: 1 AV (BSPG 2015 XIII 99).

Description. Oblique-oval, medium-sized to large composite moulds (maximum length: 78.7 mm, height: 67.8 mm), well inflated, with strongly coiled prosogyrate umbones, situated close to the anterior end. Posterior part of shell distinctly enlarged compared to the small anteroventral region. Ventral margin faintly curved, remaining margins well rounded. Shell ornamented with ribs that range from commarginal to oblique and sinuous. Posterodorsally, the ribs distinctly curve upwards towards the dorsal margin.

Remarks. *C. excentrica* differs from *C. concentrica* above all by its larger size and divaricate ribbing.

Family Corbulidae Lamarck, 1818
Genus *Corbula* Bruguière, 1797

Type species. *Corbula sulcata* Lamarck, 1801.

'*Corbula*' *eamesi* Cox, 1965
Pl. 13, Fig. 3

- 1965 *Corbula eamesi* sp. nov. – Cox: 123, pl. 19, fig. 19a–c.

Material. Bajocian? of Beronono: 2 RV, 4 LV, 2 AV (BSPG 2015 XIII 236–237).

Measurements. Table 16.

Table 16. Measurements (in mm) of '*Corbula*' *eamesi* Cox, 1965.

specimen	L	H	I
BSPG 2015 XIII 237a	17.4	11.6	>11
BSPG 2915 XIII 237b	14.3	9.7	9.8

Description. Specimens of medium size, commonly somewhat distorted and fragmented. Shells inequilateral, subequal, the left valve being slightly smaller than the right one; strongly inflated. Area of greatest inflation around one-third of shell length from the anterior end. Umbones prominent, situated one-third to two-fifths of the total shell length from the anterior end, broad, turning towards the prosogyrate beaks. Lunule large, moderately deep, but poorly demarcated. Anterodorsal margin faintly concave, grading into well rounded anteroventral margin. Ventral margin asymmetrically curved; posterodorsal margin faintly convex, sloping; posterior end narrowly rounded to obliquely truncated and slightly rostrate. With faint carina running from the umbo to the posterior margin; area posterodorsally of it slightly concave. Shell surface covered with numerous regularly spaced commarginal ribs.

Right valve with an upward-curved shoehorn-shaped chondrophore and posterior lateral tooth, left valve with short posterior lateral tooth and large triangular resilifer.

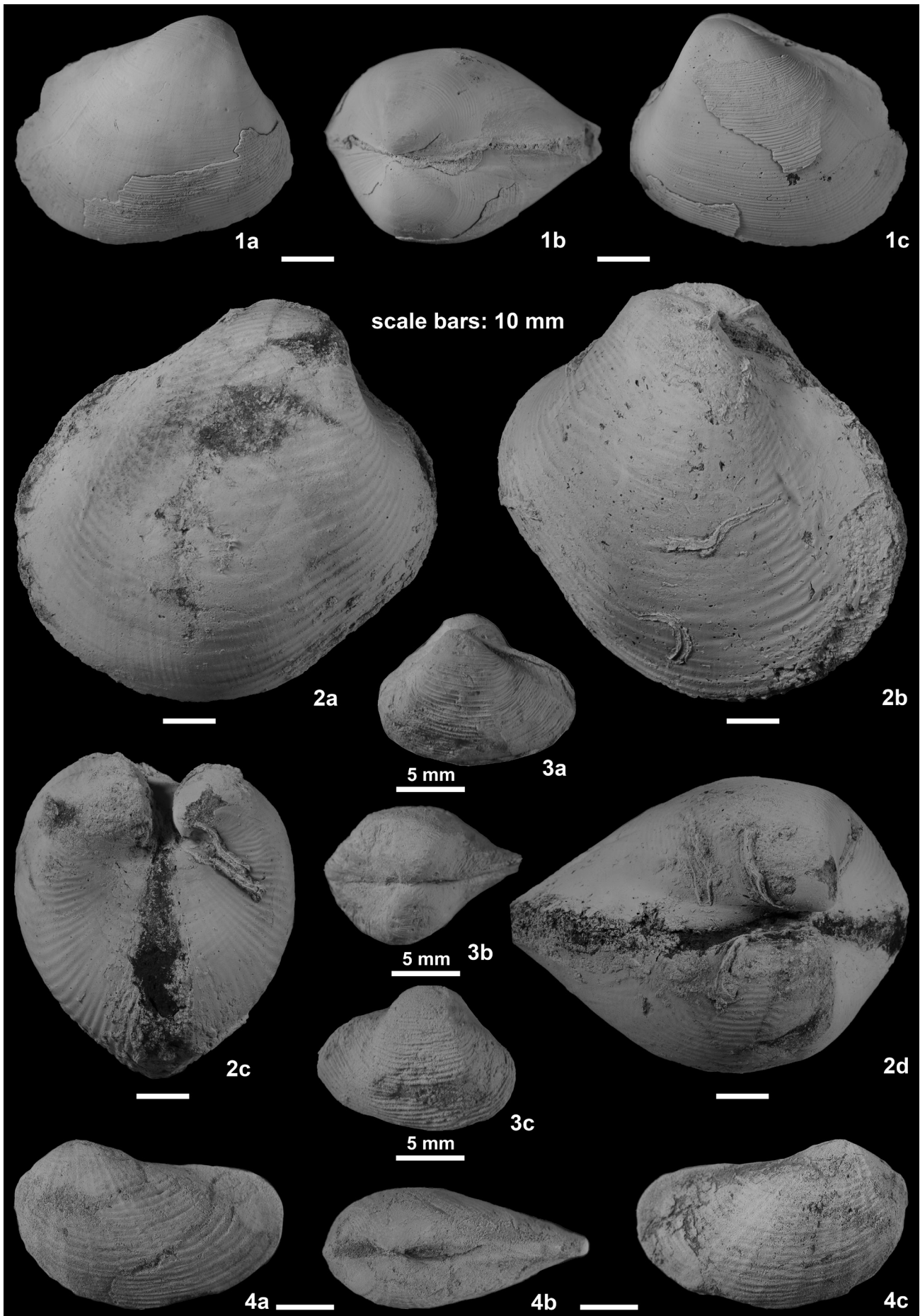
Remarks. Cox (1965) described a number of new species of "*Corbula*", commonly based on just a single specimen. Most of these species are quite small. His *Corbula eamesi* is distinctly larger and corresponds well in size and in most other features to the present material. In contrast to other species of the family, where the chondrophore is situated in the left valve, the hinge features are transposed. As it is not clear at present, into which of the numerous corbulid genera our material should be placed, it is informally kept in "*Corbula*".

Order Pholadomyidae Newell, 1965
Family Pholadomyidae W. King, 1844
Genus *Pholadomya* G.B. Sowerby, 1823
Subgenus *Pholadomya* G.B. Sowerby, 1823

Type species. *Pholadomya candida* Gray, 1847.

Pholadomya (Pholadomya) kachchhensis Pandey,
Fürsich & Heinze, 1996
Pl. 13, Fig. 4, Pl. 14, Figs. 1, 2

Plate 13: (1) *Ceratomya concentrica* (J. de C. Sowerby, 1825). Articulated specimen with remains of shell (BSPG 2015 XIII 94), Lower Callovian strata, Amparambato; a, right valve view; b, dorsal view; c, left valve view. **(2)** *Ceratomya excentrica* (Roemer, 1836). Articulated composite mould (BSPG 2015 XIII 99), Lower Callovian strata, Amparambato; a, right valve view; b, left valve view; c, anterior view; d, dorsal view. **(3)** '*Corbula*' *eamesi* Cox, 1965. Articulated specimen (BSPG2015XIII 236a), ?Bajocian strata, Beronono; a, left valve view; b, dorsal view; c, right valve view. **(4)** *Pholadomya (Pholadomya) kachchhensis* Pandey, Fürsich & Heinze, 1996. Articulated composite mould (BSPG 2015 XIII 59), Lower Callovian strata, Amparambato; a, left valve view; b, dorsal view; c, right valve view.



- 1905 *Pholadomya protei* Brongniart – Daqué: 140, pl. 15, fig. 3 (non figs. 1, 2).
- 1916 *Pholadoma inornata* J. de C. Sowerby – Douvillé: 55, pl. 4, fig. 5 (non J. de C. Sowerby, 1840).
- 1925 *Pholadomya (Homomya) gibbosa* J. Sowerby var. nov. *asiatica* – Cox: 178, pl. 14, fig. 8a, b.
- ? 1935b *Pholadomya (Indomya) inornata* J. de C. Sowerby – Cox: 192, pl. 21, figs. 6, 7 (non fig. 8).
- 1968 *Homomya inornata* (Sowerby) – Ficcarelli: 41, pl. 4, figs. 2, 2a, 2b.
- 1970 *Homomya douvillei* nom. nov. – Rossi-Ronchetti: 66, pl. 10, fig. 2, pl. 11, fig. 6.
- v? 1986a *Pholadomya (Indomya) rajnathi* subgen. et sp. nov. – Jaitly: 458, figs. 1–4.
- v 1994 *Pholadomya (Pholadomya) inornata* J. de C. Sowerby – Fürsich et al.: pl. 2, fig. 4.
- v 1996 *Pholadomya (Pholadomya) kachchhensis* nom. nov. – Pandey et al.: pl. 1, figs. 1–4, 6–10.
- 1827 *Pholadomya aequalis* – J. de C. Sowerby: 88, pl. 546, fig. 3 (nom. nov.)
- 1939 *Pholadomya aequalis* Sow. – Stefanini: 262, pl. 27, fig. 5.

Material. Lower Oxfordian of Dangovato: 2 AV (BSPG 2015 XIII 67, 68); Lower Kimmeridgian: Ampampagna: 2 AV (BSPG 2015 XIII 66); Amparambato: 1 RV (BSPG 2015 XIII 69).

Description. Shells elongated, varying between 32 and 59 mm in length, well inflated, with moderately protruding umbones. Ventral margin faintly curved, dorsal margin straight, anterior and posterior margins regularly rounded. Umbones situated one-third to one-fourth of shell length from the anterior end. Ornamentation consisting of commarginal growth rugae and 8 to 10 spaced radial ribs of moderate strength. Posterior gape narrow.

Remarks. The present specimens correspond well to the material figured by Arkell (1935: 330, pl. 46, figs. 1–4) from the Corallian Group of England. They also fit *Pholadomya ovulum* Agassiz (1841: 119, pl. 3b, figs. 1–6) from the Middle Jurassic of the Swiss Jura Mountains (“l’oolithe inférieure”) remarkably well. However, to decide whether *Ph. ovulum* is a junior synonym of *Ph. aequalis* requires a study of Agassiz’ type material.

Subgenus *Bucardiomya* Rollier in Cossmann, 1912

Type species. *Pholadomya bucardium* Agassiz, 1842.

Pholadomya (Bucardiomya) lirata (J. Sowerby, 1818)
Pl. 14, Figs. 5, 6

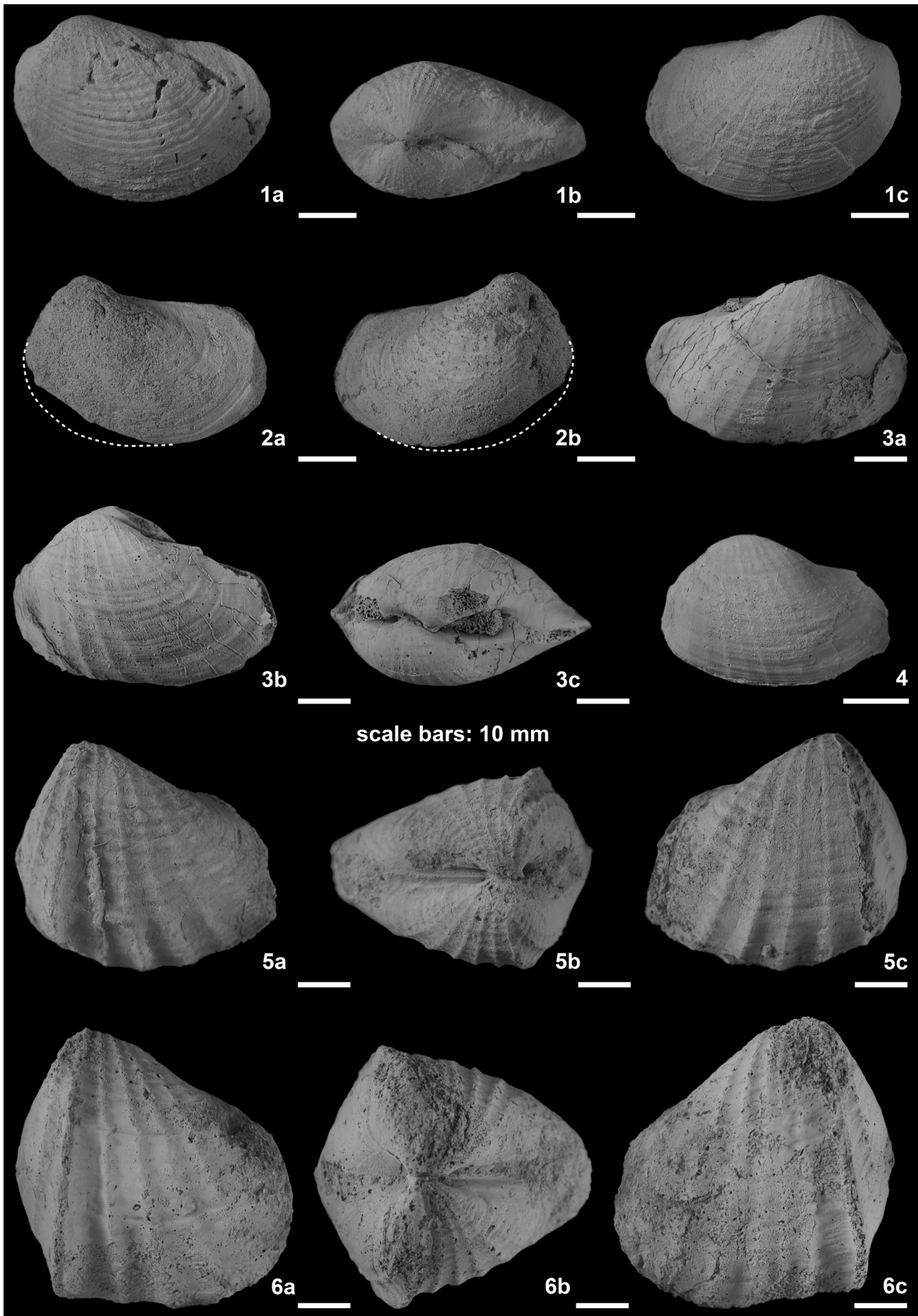
Remarks. *Pholadomya (Ph.) kachchhensis* is a new name for *Homomya douvillei* nom. nov. of Rossi-Ronchetti (1970). The latter species name is no longer available after the species was transferred from *Homomya* to *Pholadomya* (Pandey et al. 1996). The species is characterized by the faint development of radial ribs, a feature based on which such specimens were included by some authors in *Homomya* in the past. If *Pholadomya (Indomya) rajnathi* of Jaitly (1986) can be demonstrated to belong to the present taxon without any doubt, *rajnathi* would have priority over *kachchhensis*.

Pholadomya (Pholadomya) aequalis
J. de C. Sowerby, 1827
Pl. 14, Figs. 3, 4

1819 *Lutraria ovalis* sp. nov. – J. Sowerby: 47, pl. 226, fig. 2 only.

- 1818 *Cardita ? lirata* sp. nov. – J. Sowerby: 220, pl. 197, fig. 3.
- v 1840 *Pholadomya granosa* sp. nov. – J. de C. Sowerby: pl. 21, fig. 9 and explanation.
- v 1840 *Pholadomya angulata* sp. nov. – J. de C. Sowerby: pl. 21, fig. 10 and explanation.
- 1840 *Pholadomya granosa* J. de C. Sowerby – Medlicott & Blanford: 262, pl. 12, fig. 8.
- 1897 *Pholadomya protei* Brongn. sp. – Futterer: 606, pl. 21, fig. 7.
- 1897 *Pholadomya Ragazzii* Pant. sp. indet. – Futterer: 603, pl. 21, figs. 4–6.
- 1929 *Pholadomya protei* (Brongn.) – Weir: 33, pl. 3, fig. 10.
- 1929 *Pholadomya ragazzii* (Pantaneli) – Weir: 33, pl. 3, fig. 11.
- 1929 *Pholadomya* sp. aff. *percarinata* Gillieron – Weir: 34, pl. 3, figs. 12–14.
- 1929 *Pholadomya lirata* Sow. – Barrabé: 124, pl. 7, fig. 21.
- 1935a *Pholadomya lirata* (Sow.) – Cox: 190, pl. 21, figs. 8, 9.

Plate 14: (1, 2) *Pholadomya (Pholadomya) kachchhensis* Pandey, Fürsich & Heinze, 1996. 1. Articulated composite mould (BSPG 2015 XIII 61), Upper Bathonian strata, Tongobory; a, left valve view; b, dorsal view; c, right valve view. 2. Articulated composite mould (BSPG 2015 XIII 62), Upper Bathonian strata, Tongobory; a, left valve view; b, right valve view. (3, 4) *Pholadomya (Pholadomya) aequalis* J. de C. Sowerby, 1827. 3. Articulated composite mould (BSPG 2015 XIII 68), Lower Oxfordian strata, Dangovato; a, right valve view; b, left valve view; c, dorsal view. 4. Articulated composite mould (BSPG 2015 XIII 67), Lower Oxfordian strata, Dangovato; left valve view. (5, 6) *Pholadomya (Bucardiomya) lirata* (J. Sowerby, 1818). 5. Articulated composite mould (BSPG 2015 XIII 52), Lower Callovian strata, Amparambato; a, left valve view; b, dorsal view; c, right valve view. 6. Articulated composite mould (BSPG 2015 XIII 58), Lower Callovian strata, Amparambato; a, left valve view; b, dorsal view; c, right valve view.



- 1939 *Pholadomya protei* (Brgn.) – Stefanini: 263, pl. 27, figs. 6, 7, 8?
 1939 *Pholadomya carinata* Goldf. – Stefanini: 259, pl. 27, fig. 2a–c.
 1956 *Pholadomya lirata* (J. Sowerby) – Agrawal: 125, pl. 11, fig. 9.
 ? 1959 *Pholadomya Protei* (Brongniart) – Jaboli: 67, pl. 9, figs. 1–3.
 ? 1960 *Pholadomya lyrata* J. de C. Sowerby – Joubert: pl. 11, fig. 6.
 1965 *Pholadomya lirata* (J. Sowerby) – Cox: 126, pl. 20, fig. 8.
 1968 *Pholadomya cf. protei* (Brongniart) – Ficarelli: 42, pl. 3, fig. 8, 8a.
 v 1994 *Pholadomya (Bucardiomya) lirata* (J. Sowerby) – Fürsich et al.: pl. 2, figs. 2, 3.
 v 1996 *Pholadomya (Bucardiomya) lirata* (J. Sowerby) – Pandey et al.: pl. 2, figs. 8–11, pl. 3, figs. 1–4.

Material. Upper Bathonian of Tongobory S: 1 LV, 1 AV (BSPG 2015 XIII 56, 57); Lower Callovian: Atainakanga: 2 AV (BSPG 2015 XIII 53); Amparambato 7 AV (BSPG 2015 XIII 52, 54, 55, 58),

Description: Elongate-subtrigonal to subquadrate shell with distinctly projecting umbones, situated one-fifth of shell length from the anterior end. Greatest inflation at mid-flank in the area of the most prominent radial rib, i.e. in the anterior fifth of the shell. Anterior part of shell only slightly convex. Posterior end somewhat tapering. Ornamentation consisting of weak commarginal ribs and 6–8, rarely up to 10, radial ribs. The third of these ribs, counting from the anterior end, distinctly stronger than the remaining ones, and the strength of ribs generally decreasing in a posterior direction. At the intersection points of the commarginal and radial ribs distinct nodes are developed.

Remarks. Many of the specimens have been preserved in growth position, and this is the reason why the anterior part of the shell commonly has been somewhat flattened during compaction. This feature prompted several authors to include their material in *Pholadomya protei* (e.g., Weir 1929; Stefanini 1939; Joubert 1960) rather than in *P. (Bucardiomya) lirata*, although the ribbing pattern clearly identifies them as belonging to the latter species.

Genus *Homomya* Agassiz, 1843

Type species. *Mactra gibbosa* J. Sowerby, 1813.

Homomya pachchhamensis Pandey, Fürsich & Heinze, 1998
 Pl. 15, Figs. 1, 2

- 1984 *Homomya* sp. A, sp. nov. – Pandey & Agrawal: 187.
 v 1994 *Homomya cf. hortulana* Agassiz – Fürsich et al.: pl. 2, fig. 1.
 v 1998 *Homomya pachchhamensis* sp. nov. – Pandey et al.: 58, pl. 4, figs. 10, 11, pl. 5, fig. 1.

Material. Lower Lower Callovian of Atainakanga: 1 AV (BSPG 2015 XIII 41); upper Lower Callovian of Amparambato: 2 AV (BSPG 2015 XIII 42); Middle Oxfordian of Andrea: 1 AV (BSPG 2015 XIII 40).

Description. Large, short, well inflated *Homomya* (largest specimen 110 mm long and 80 mm high) with distinctly arcuate ventral margin, a truncated anterior margin and a gaping posterior end. Shells apparently also gaping at the anterior end. No anterior umbonal depression developed. Shell thin, ornamented with distinct, fine, commarginal growth rugae. Some specimens exhibit a few, very faint radial striae in the umbonal area, which die out after 10 to 15 mm. Specimen BSPG 2015 XIII 42a exhibits very faint, widely spaced radial striae, that extend to the ventral margin also on the posterior flank.

Remarks. The specimens are very close in outline and ornamentation to *Homomya pachchhamensis* from the Bathonian of Kachchh (Pandey et al. 1996), except that the radial striae, that are present on some of the specimens from Madagascar, have not been recorded from the Indian material. The present material comes from Lower Callovian to Middle Oxfordian strata and thus is younger than the Kachchh specimens.

Homomya vezelayi (d'Archiac, 1843)
 Pl. 16, Fig. 1

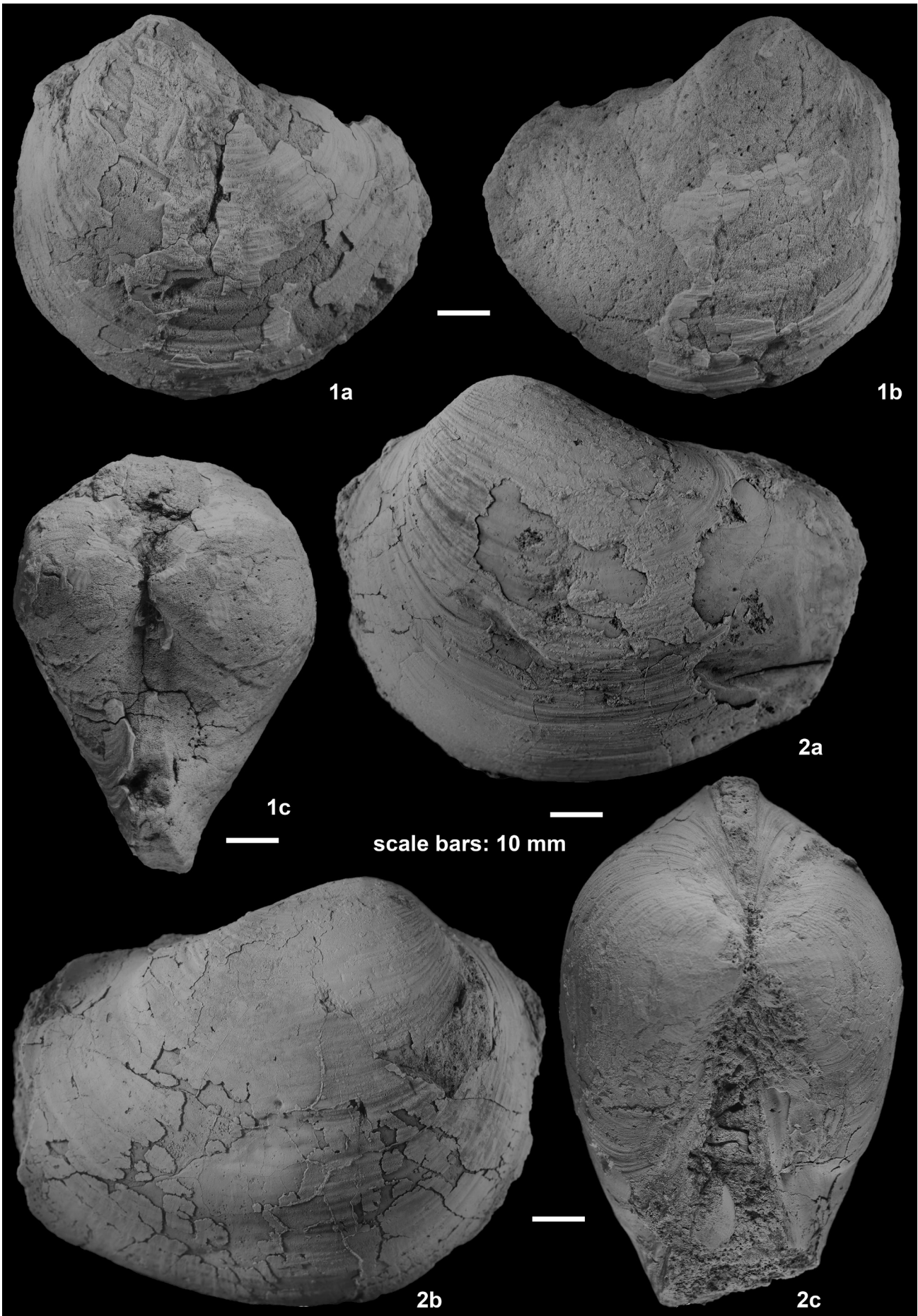
- 1843 *Mya vezelayi* sp. nov. – d'Archiac: 370, pl. 25, figs. 4a, 4b.

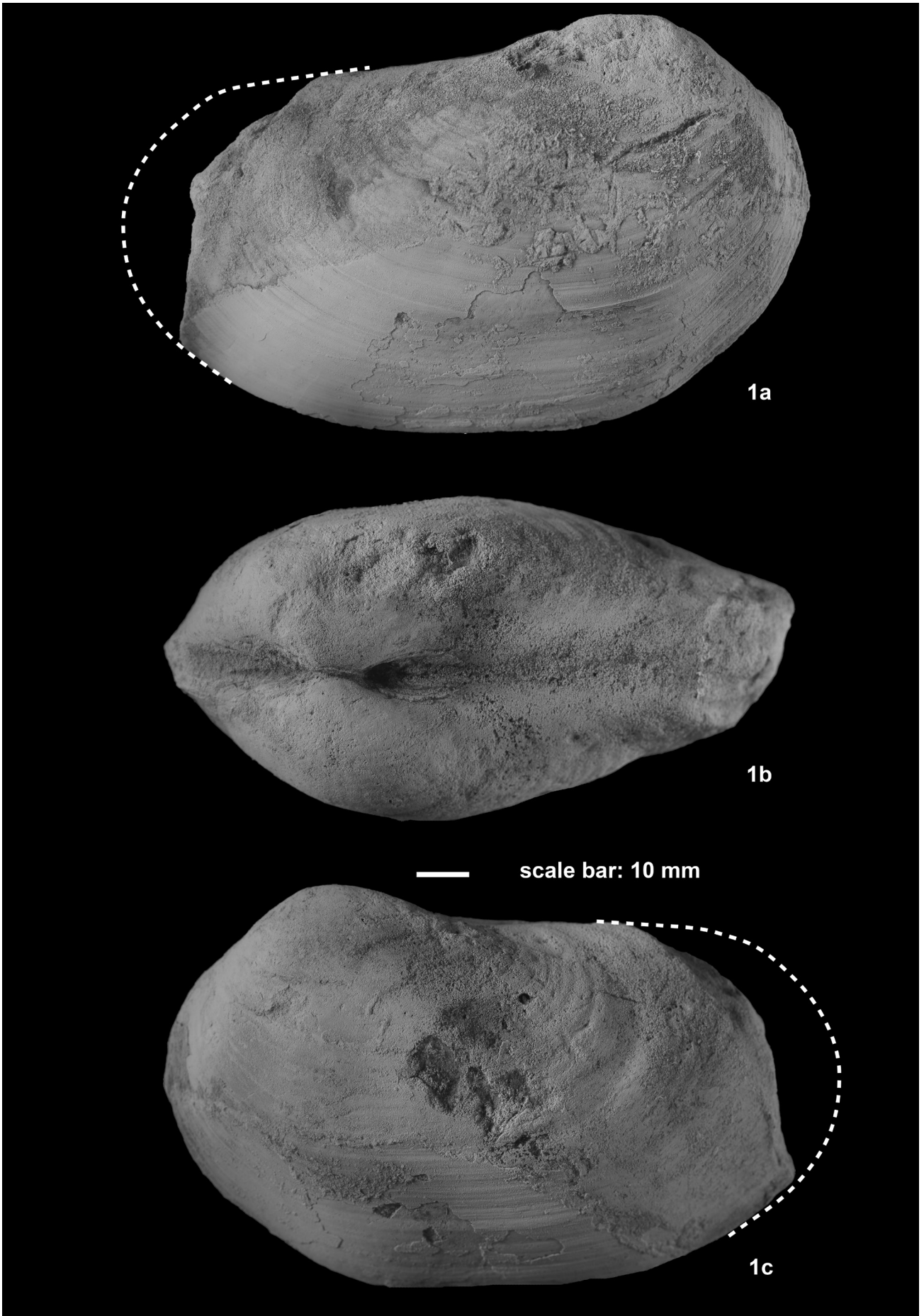
Material. Upper Bathonian of Tongobory S: 2 AV (composite moulds) (BSPG 2015 XIII 44 45); Callovian of Ranonda: 2 AV (BSPG 2015 XIII 43).

Description. Large (L: 1050 mm, H: 72.5 mm in specimen BSPG 2015 XIII 42a), elongated *Homomya* with faintly convex ventral margin, regularly curved anterior margin and straight posterodorsal margin. Distinct posterior gape developed. Umbones situated between one-fourth and one-fifth of shell length from the anterior end. Surface ornamented with irregular growth lines. In the umbonal area of specimen BSPG 2015 XIII 44 about ten radial striae are developed, which extend towards the ventral margin for a distance of up to 25 mm.

(Page 193) Plate 15: (1, 2) *Homomya pachchhamensis* Pandey, Fürsich & Heinze, 1996. 1. Articulated composite mould with remains of shell (BSPG 2015 XIII 40), Middle Oxfordian strata, Andrea; a, left valve view; b, right valve view; c, dorsal view. 2. Articulated specimen (BSPG 2015 XIII 42a), Lower Callovian strata, Amparambato; a, left valve view; b, right valve view; c, dorsal view.

(Page 194) Plate 16: (1) *Homomya vezelayi* (d'Archiac, 1843). Articulated composite mould with remains of shell (BSPG 2015 XIII 40), Upper Bathonian strata, Tongobory S; a, right valve view; b, dorsal view; c, left valve view.





Remarks. *Homomya vezelayi* differs from *H. pachchhamensis* in being much more elongated and in having subparallel dorsal and ventral margins. Our material compares well with the specimens figured by Dainelli (1903: 321, pl. 12, figs. 3, 10) from the Bathonian of Sardinia and by Arkell (1935: 338, pl. 49, fig. 1) from the Oxfordian of England.

Homomya sp.
Pl. 17, Fig. 2

Material. Middle Oxfordian: Andrea: 4 AV (internal moulds) (BSPG 2015 XIII 49–51, 65); Ankilimena: 1 RV (BSPG 2015 XIII 48).

Description. Small *Homomya*, moderately elongated and moderately inflated. Umbones situated one-third of shell length from the anterior end. Umbones broad, slightly flattened. Dorsal margin straight, ventral margin regularly curved, anterior and posterior margins well rounded; valves gaping posteriorly. Shell ornamented with irregular growth lines.

Remarks. The specimens are not well preserved, which makes a precise identification difficult. With respect to size and outline they compare reasonably well with *Homomya obtusa* Agassiz, 1842 from the Middle Jurassic of Lorraine (France).

Genus *Goniomya* Agassiz, 1841
Subgenus *Goniomya* Agassiz, 1841

Type species. *Mya angulifera* J. Sowerby, 1819.

Goniomya (Goniomya) literata (J. Sowerby, 1819)
Pl. 17, Fig. 3

1819 *Mya literata* sp. nov. – J. Sowerby: 45, pl. 224, fig. 1.
1939 *Goniomya literata* (Sow.) – Stefanini: 254, pl. 26, fig. 3.

Material. Lower Oxfordian of Dongovato: 1 AV (BSPG 2015 XIII 71).

Description and remarks. The articulated internal mould lacks the posterior end. Umbones submesial, slightly anterior of the centre. The characteristic feature of the species are V-shaped ribs. For the first 8 mm the divaricate anterior and posterior ribs are joined by a horizontal bar. The Vs are directed slightly backwards. This ornamentation fades towards the ventral margin and the lower third of the flank displays only faint commarginal growth folds.

Our specimen differs from typical *Goniomya literata* by its weaker ornamentation, a feature thought by us to lie within the range of variation of the species. *Goniomya intersectans* (Smith, 1812) recorded from the Kachchh Basin by Pandey et al. (1996: 57, pl. 4, figs. 4, 5) differs in a more anterior position of the umbones and the V-shaped ornamentation, but

it is questionable whether the two species represent separate taxa.

Within the Ethiopian faunal province the species has also been described from Somalia by Stefanini (1939: 254, pl. 26, fig. 3).

Genus *Osteomya* Moesch, 1874

Type species. *Mya dilata* Phillips, 1829.

Osteomya dilata (Phillips, 1829)
Pl. 17, Fig. 4

1829 *Mya dilata* sp. nov. – Phillips: 155, pl. 11, fig. 4.
1986b *Oestomya* [sic!] cf. *dilata* – Jaitly: 42, figs. 5, 6.
v 1996 *Osteomya dilata* (Phillips) – Pandey et al.: 60, pl. 5, figs. 7–9, pl. 6, figs. 1–5.

Material. Upper Bathonian of Tongobory S: 1 LV (BSPG 2015 XIII 72).

Description and remarks. Shell small for the species (L: 34.5 mm, H: 16.7 mm), compressed. Umbo situated one-third of shell length from the anterior end. Ventral margin only faintly convex, anterior margin well rounded, posterior end expanded and truncated, dorsal margin upturned posteriorly. With distinct posterior gape. A wide shallow sulcus runs from the umbones towards the ventral margin. Area anterior of the sulcus with distinct commarginal growth folds except for the anterior-most area which is smooth. Flank posterior of the sulcus smooth, but towards the posterior end growth folds become very conspicuous in the posterodorsal area.

Apart from its occurrence in the Kachchh Basin this is the only record of the species from the Ethiopian faunal province.

Genus *Pachymya* J. de C. Sowerby, 1826.
Subgenus *Arcomya* Agassiz, 1843

Type species. *Solen helveticus* Roemer, 1839.

Pachymya (Arcomya) tunisiensis Holzapfel, 1998
Pl. 17, Fig. 5

1998 *Arcomya tunisiensis* sp. nov. – Holzapfel: 122, pl. 11, figs. 1–4b.

Material. Lower Callovian of Amparambato: 1 LV, 1 AV (BSPG 2015 XIII 73, 74).

Description and remarks. Shell very elongated (L = 81.5 mm, H = 35.5 mm), weakly inflated, umbones strongly depressed, situated comparatively close to the anterior margin (La = 18.0 mm). Dorsal and ventral margins straight, parallel, anterior margin well rounded, posterior margin truncated, with distinct posterior gape. Posterior umbonal carina broad, conspicuous near umbones and fading towards the

posteroventral margin. Another conspicuous ridge runs from the umbo to the posterodorsal margin, separating a narrow area from the rest of the shell. Surface covered with commarginal growth rugae.

P. (A.) tunisiensis has been erected by Holzapfel (1998) based on its strong elongation and anterior position of the umbones, a feature also observed in our specimens. The second diagnostic feature mentioned by Holzapfel, the expanded posterior end (produced by the upturned posterodorsal margin) is regarded here of less significance as in many pholadomyid species this is a feature characteristic of gerontic individuals.

The closest related species appears to be *P. (A.) helvetica* (Agassiz, 1842: 167, pl. 10, figs. 7–10) from the Portlandian of northern France.

Order Pandorida R. Stewart, 1930
Family Laternulidae Hedley, 1918
Genus *Platymyoidea* Cox, 1964

Type species. *Platymya dilatata* Agassiz, 1843.

Remarks. A diagnostic feature of members of the family Laternulidae is the presence of a transverse to oblique internal plate, which on internal moulds is generally seen as a slit (Keen & Cox 1969: N844). However, in many of the genera of the family such as *Cercomya*, *Plectomya* and *Platymyoidea* internal moulds do not show this feature (e.g., Keen & Cox 1969: fig. F23) or only in one of several specimens (e.g., Damborenea & Gonzales 1997: 193, fig. 9.8). However, such a slit should be seen even in poorly preserved specimens. This raises the question whether the internal plate is a feature of high diagnostic value, or, in reality, is present only in some members of the family, and may even not be present in all species assigned to a given genus. This aspect clearly deserves to be studied in detail.

Platymyoidea? sp.
Pl. 17, Fig. 6

Material. Upper Bathonian of Tongobory N: 1 AV (external mould), 1 AV (composite mould) (BSPG 2015 XIII 233).

Description. Specimen small, strongly elongated, posterior end missing, highly compressed. Ventral margin straight, anterior margin well rounded, anterodorsal margin straight and slightly sloping, posterodorsal margin subparallel to ventral margin. Umbones small, depressed, slightly opisthogyrate, situated approximately two-fifth of the shell length from the

anterior end. With rounded anterior umbonal ridge. Ornamentation consisting of rounded commarginal folds, fading towards the ventral margin and towards the posterior part of the shell. The external mould shows numerous rows of radially arranged punctae. Internal features not seen.

Remarks. The specimen is provisionally placed in the genus *Platymyoidea* rather than *Plectomya* de Loriol, 1868 due to the less symmetrical valves. None of the figured members of the genus fits the outline of the specimen from Madagascar. Its incomplete nature precludes its accommodation in a new species.

5. Concluding remarks

Most of the bivalves described above come from Callovian to Oxfordian strata, which represent a number of shallow-marine environments, many of them of mixed carbonate-siliciclastic nature (Geiger 2004; Geiger & Schweigert 2006). Table 17 lists the stratigraphic distribution of the bivalves. From Bajocian strata only seven taxa have been recorded, as opposed to 19 from the Bathonian. Peak diversity is reached in the Callovian (39 taxa), whereas diversity declines again during the Oxfordian (22 taxa) and Kimmeridgian (17 taxa). Bajocian and Lower Bathonian beds are mainly sandy and their low-diversity bivalve fauna locally suggests brackish conditions. Kimmeridgian strata are mainly fine-grained siliciclastic in nature (mudstones). It is therefore not surprising that their bivalve diversity is lower. One has to keep in mind, however, that these diversity figures do not represent the general bivalve diversity of Madagascar but only give an impression of the fauna in the southern Morondawa Basin. Even there the total number of Jurassic bivalve taxa should be higher than recorded here, because collecting bivalves was not the primary aim of the field work during which the present collection was obtained.

The bivalve assemblages are very characteristic of the Ethiopian faunal province with several Callovian to Oxfordian *Indogrammatodon* species and Oxfordian to Kimmeridgian species of *Seebachia* and *Eoseebachia*. The greatest similarity exists with the bivalve faunas from the Callovian to Kimmeridgian of the neighbouring Kachchh Basin. Collignon (1963) discussed the great similarity of the macroinvertebrates from the two regions but, with few exceptions, restricted himself to cephalopods. It is clear that the comparison between the two areas would become more meaningful, if the faunas from other basins in

Plate 17: (1) *Homomya vezelayi* (d'Archiac, 1843). Articulated composite mould (BSPG 2015 XIII 44), Upper Bathonian strata, Tongobory S; a, left valve view; b, dorsal view. **(2)** *Homomya* sp. Articulated composite mould (BSPG 2015 XIII 50), Middle Oxfordian strata, Ankilimena; left valve view. **(3)** *Goniomya (Goniomya) literata* (J. Sowerby, 1819). Fragmented articulated composite mould (BSPG 2015 XIII 71), Lower Oxfordian strata, Dongovato; right valve view. **(4)** *Osteomya dilata* (Phillips, 1829). Composite mould of left valve (BSPG 2015 XIII 72), Upper Bathonian strata, Tongobory S. **(5)** *Pachymya (Arcomya) tunisiensis* Holzapfel, 1998. Internal mould of left valve (BSPG 2015 XIII 73), Lower Callovian strata, Amparambato; a, side view; b, dorsal view. **(6)** *Platymyoidea?* sp. Articulated composite mould (BSPG 2015 XIII 233), Upper Bathonian strata, Tongobory N; a, right valve view; b, dorsal view.

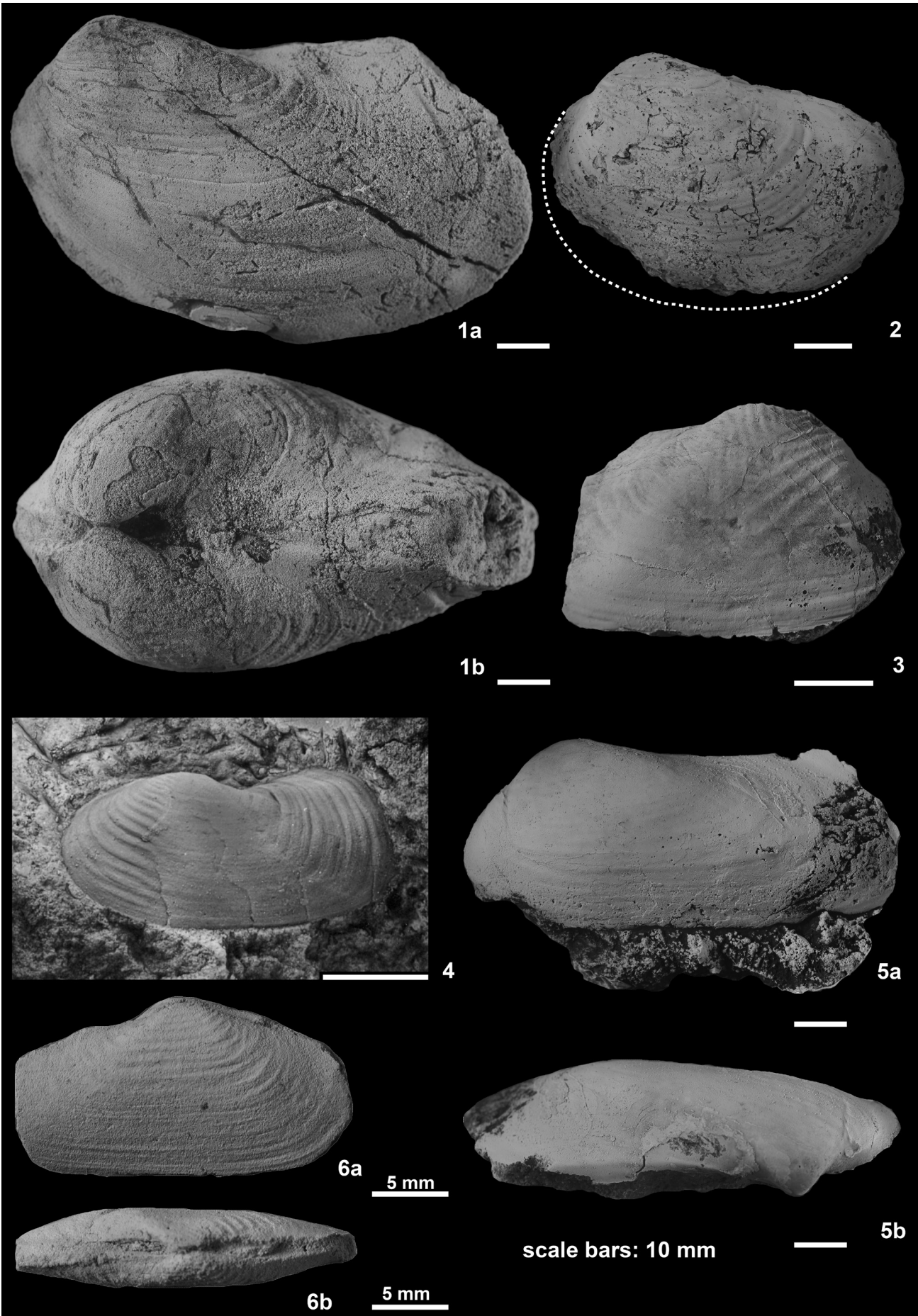


Table 17. Stratigraphic distribution of bivalves in the southwestern Morondava Basin. Bj., Bajocian; B., Bathonian; C., Callovian; O., Oxfordian; K., Kimmeridgian.

Taxon	Bj.	B.	C.	O.	K.
<i>Palaeonucula cuneiformis</i> (J. de C. Sowerby, 1840)		●	●		
<i>Arcomytilus laitmairensis</i> (de Loriol, 1883)			●		
<i>Lycettia indica</i> Cox, 1940					●
<i>Regulifer beirensis</i> Fürsich & Werner, 1988			●		
<i>Regulifer?</i> sp.	●				
<i>Lithophaga</i> (<i>Lithophaga</i>) cf. <i>alsus</i> (d'Orbigny, 1850)					●
<i>Inoperna khadirensis</i> Fürsich & Jaitly, 1995		●			
<i>Grammatodon</i> (<i>Cosmetodon</i>) <i>elongatum?</i> (J. de C. Sowerby, 1824)			●		
<i>Grammatodon</i> (<i>Indogrammatodon</i>) <i>iddhurgurensis</i> Cox, 1940				●	
<i>Grammatodon</i> (<i>Indogrammatodon</i>) <i>virgatus</i> (J. de C. Sowerby, 1840)			●	●	●
<i>Grammatodon</i> (<i>Indogrammatodon</i>) <i>blakei</i> Cox, 1940				●	
<i>Grammatodon</i> (<i>Indogrammatodon</i>) <i>kantkotensis</i> Cox, 1940				●	
<i>Actinostreon marshii</i> (J. Sowerby, 1814)					●
<i>Actinostreon gregareum</i> (J. Sowerby, 1815)			●		
<i>Eligmus rollandi</i> (Douvillé, 1907)		●	●		
<i>Gryphaea</i> (<i>Bilobissa</i>) cf. <i>hennigi</i> Dietrich, 1925				●	
<i>Gryphaea</i> (<i>Bilobissa</i>) <i>balli</i> (Stefanini, 1925)				●	●
<i>Gryphaea</i> (<i>Catinula?</i>) <i>stoliczkai</i> Cox, 1952			●		
" <i>Exogyra</i> " <i>fourtaui</i> Stefanini, 1925				●	●
" <i>Exogyra</i> " <i>tramausensis</i> Cox, 1952				●	●
<i>Pinna</i> (<i>Pinna</i>) cf. <i>mitis</i> Phillips, 1829			●		
<i>Pteria</i> sp.			●		
<i>Bakevellia waltoni</i> (Lycett, 1863)	●				
<i>Gervillella aviculoides</i> (J. Sowerby, 1814)			●		
<i>Chlamys curviviarians</i> Dietrich, 1933			●		
<i>Indoweyla coxi</i> Fürsich & Heinze, 1995			●		
<i>Spondylopecten</i> (<i>Spondylopecten</i>) <i>palinurus</i> (d'Orbigny, 1850)		●			
<i>Ctenostreon rugosum</i> (Smith, 1817)			●		
<i>Plagiostoma</i> sp. A			●		
<i>Plagiostoma</i> sp. B			●		
<i>Plagiostoma</i> sp. C			●		●
<i>Plagiostoma rodburgense</i> (Widborne, 1883)			●	●	
<i>Peudolimea duplicata</i> (J. de C. Sowerby, 1827)			●		●
<i>Trigonia</i> sp. A	●	●			
<i>Trigonia</i> (<i>Trigonia</i>) <i>elongata</i> J. de C. Sowerby, 1823			●		
<i>Indotrigonia</i> sp.					●

<i>Vaugonia (Orthotrigonia) hispida</i> (Kitchin, 1903)		•	•		
<i>Neocrassina (Pruvostiella) madagascariensis</i> sp. nov.				•	
<i>Neocrassina (Pruvostiella) rajnathi</i> Agrawal, 1956				•	
<i>Neocrassina (Neocrassina)</i> sp. A			•		•
" <i>Coelastarte</i> " sp.			•		
<i>Nicaniella</i> cf. <i>phillis</i> (d'Orbigny, 1850)			•		
<i>Coelopsis (Coelopsis) deshayesii</i> (Morris & Lycett, 1853)			•		
<i>Seebachia (Seebachia) aff. bronni</i> (Krauss, 1850)				•	
<i>Seebachia (Eoseebachia) sowerbyana</i> (Holdhaus, 1913)				•	•
<i>Ceratomyopsis striata</i> (d'Orbigny, 1822)			•	•	
<i>Mesomiltha bellona</i> (d'Orbigny, 1850)		•			
<i>Fimbria</i> sp.		•			
<i>Mactromya rugosa</i> (Roemer, 1836)			•		
Mactromyidae? indet.					•
<i>Eosphaera madagascariensis</i> (Newton, 1889)			•		
<i>Quenstedtia madagascariensis</i> sp. nov.				•	
<i>Tancredia (Isotancredia?)</i> sp.			•		
<i>Anisocardia (Anisocardia?) minima</i> (J. Sowerby, 1821)		•			
<i>Pronoella (Pronoella) pindiroensis</i> Cox, 1965	•				
<i>Venilicardia (Venilicyprina) aff. khali</i> Fürsich, Heinze & Jaitly, 2000				•	
<i>Isocyprina (Isocyprina) glabra</i> (Blake & Hudleston, 1877)		•			
<i>Protocardia (Protocardia) cf. somaliensis</i> Cox, 1935					•
<i>Protocardia (Protocardia) buckmani</i> (Morris & Lycett, 1853)		•	•		
<i>Protocardia (Protocardia) lycetti</i> Rollier, 1912	•	•			
<i>Integricardium (Integricardium) cf. bannesianum</i> (Contejean, 1860)			•	•	•
<i>Pleuromya uniformis</i> (J. Sowerby, 1813)	•	•	•	•	•
<i>Ceratomya concentrica</i> (J. de C. Sowerby, 1825)		•	•		
<i>Ceratomya excentrica</i> (Roemer, 1836)	•		•		
<i>Pholadomya (Pholadomya) kachchhensis</i> Pandey, Fürsich & Heinze, 1996		•	•		
<i>Pholadomya (Pholadomya) aequalis</i> J. de C. Sowerby, 1827				•	•
<i>Pholadomya (Bucardiomya) lirata</i> (J. Sowerby, 1818)		•	•		
<i>Homomya pachchhamensis</i> Pandey, Fürsich & Heinze, 1998			•	•	
<i>Homomya vezelayi</i> (d'Archiac, 1843)		•	•		
<i>Homomya</i> sp.				•	
<i>Goniomya (Goniomya) literata</i> (J. Sowerby, 1819)				•	
<i>Osteomya dilata</i> (Phillips, 1829)		•			
<i>Pachymya (Arcomya) tunisiensis</i> Holzapfel, 1998			•		
<i>Platymyoidea?</i> sp.		•			

Madagascar would be incorporated. Unfortunately, such data are still scant.

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