

## On Some Pteriomorph and Heterodont Bivalvia from the Jurassic Rocks of Habo Hill, District Kutch (Gujarat), W. India

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Eighteen pteriomorph (families Entoliidae, Pectinidae and Plicatulidae) and six heterodont species (families Lucinidae and Mactromyidae), all bivalves, are described from the Jurassic rocks of Habo Hill, Kutch. Of these, four taxa, namely *Spondylopecten chiplonkari*, *Eopecten bhattii*, *Plicatula (Plicatulo) lunata* and *Mactromya? inequilateralis*, are new. *Entolium (Entolium) corneolum* (Young & Bird), *Chlamys (Chlamys) splendens* (Dollfus), "*Lucina*" *kirtlingtonensis* Cox & Arkell and *Mactromya aequalis* Agassiz are being described for the first time from India. Stratigraphic range of *Chlamys (Chlamys) ambigua* (Muenster) and "*L.*" *kirtlingtonensis* Cox & Arkell has been raised and that of *Spondylopecten rogeri* Agrawal lowered. Stratigraphic significance of a few of these forms on a broad scale has been discussed.

**Key Words:** Pteriomorph, Heterodont, Bivalvia, Jurassic, Habo Hill, Kutch

### Introduction

About 200 different taxa of bivalvia are known so far from the Jurassic strata of Kutch, of which the pteriomorphs and heterodonts form a very common constituent. The pteriomorphs are represented by the superfamilies Arcacea, Mytilacea, Pteriacea, Pectinacea, Limacea and Ostreacea, while the heterodonts are represented by Lucinacea, Carditacea, Tellinacea, Arcticea, Glos-sacea, Corbiculacea and Myacea. The present paper is concerned with some forms of Pectinacea (families Entoliidae, Pectinidae and Plicatulidae) and Lucinacea (families

Lucinidae and Mactromyidae) from the Upper Jurassic (Callovian-Oxfordian) rocks of Habo Hill, which is the second largest hill (after the Jhura Hill) in the mainland of Kutch (Rajnath 1932).

The taxa described belong to the genera *Entolium*, *Chlamys*, *Spondylopecten*, "*Pecten*," *Eopecten*, *Plicatula*, "*Lucina*" and *Mactromya*, and together number about ten dozens in all. All the described specimens are lodged in the Department of Geology, Banaras Hindu University, Varanasi.

**Systematic Description**

- Class—BIVALVIA Linné 1758  
 Subclass—PTERIOMORPHIA Beurlen 1944  
 Order—PTERIOIDA Newell 1965  
 Superfamily—PECTINACEA Rafinesque 1815  
 Family—ENTOLIIDAE Korobkov 1960  
 Genus—*Entolium* Meek 1865  
 Type Species—*Pecten demissus* Phillips (as illustrated by Quenstedt, 1858) Upper Jurassic; Europe  
 Subgenus—*Entolium* s.s.

*Entolium (Entolium) corneolum* (Young & Bird) (plate 1, figure 1)

*Pecten corneolus* Young & Bird 1828, p. 234, plate 9, figure 5

*Pecten demissus* Phillips: Morris & Lycett 1855, p. 127, plate 14, figure 7

*Pecten solidus* Roemer: Thurmann & Etallon 1862, p. 262, plate 37, figure 4

*Entolium solidum* (Roemer): Weir 1929, p. 23, plate 1, figure 33

*Entolium demissum* (Phillips): Arkell 1930, p. 91, plate 7, figure 4; plate 9, figure 8; text figures 15-17

*Entolium demissum* (Phillips): Weir 1930, p. 87, plate 10, figures 4, 9

*Entolium corneolum* (Young & Bird): Arkell 1935, p. xi

*Entolium demissus* Phillips: Dechaseaux 1936, p. 61, text figures 14a, c

*Entolium demissum* (Phillips): Stefanini 1939, p. 173, plate 20, figure 12

*Entolium corneolum* (Young & Bird): Cox & Arkell 1948, p. 15

*Material*: One right valve.

*Horizon and Locality*: Bed No. 2 (Upper Callovian) — E of Rudra Mata.\*

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)	Apical Angle
H/99/93	31.5 mm	119.0	8.6	100°

*Description*: Shell of medium size for the genus, obovate, equilateral, orthocline, and highly compressed. Umbo small, pointed, orthogyrous. Anterior and posterior margins equally convex and diverge from the umbo at equal inclination to merge with the highly convex, symmetrical ventral margin smoothly.

Left auricle partly broken but seems to have been equal to the right one. Dorsal margins of the auricles straight and diverge from the umbo at obtuse angle to rise above the hinge line.

Surface smooth except for growth lines.

*Remarks*: The present specimen compares well with *E. demissum* (Phillips) as described and illustrated by Arkell (1930) in every respect except that it is slightly less elongate. However, this feature does not seem to be of much importance.

Arkell (1935) and Dechaseaux (1936) consider *Pecten solidus* Roemer to be a synonym of *E. demissum* (Phillips) which, in turn, has been taken to be conspecific with *E. corneolum* (Young & Bird) by the former author. In his view, *corneolum* represents only the young stage of *demissum* and, since the former has a priority over the latter by thirty

\*For Bed Nos. and Locality names, see Kanjilal 1978.

years, the latter must lapse in favour of the former. Cox (1965, p. 51) also holds similar view.

*E. hehli* (d'Orbigny) from the Lower Jurassic of Belgium (Dechaseaux 1936, p. 60, plate 8, figures 10-11) is distinguished by its orbicular outline, with a smaller apical angle (90°) and more prominent growth lines. *E. disciformis* Schuebler from the Lower and Middle Jurassic of Europe (Dechaseaux 1936, p. 61, plate 8, figures 12-13; text figure 14b) is also orbicular in outline, with a greater apical angle (120°) and well-marked concentric threads. *E. japonicum* Kurata & Kimura (Kimura 1951, p. 345, plate 1, figures 16-17), from the Jurassic Torinosu Group of Japan, is of such smaller size, with unequal ears, smaller apical angle, and a gently concave anterior margin. *E. kimurai* Tamura (1959a, p. 60, plate 6, figure 23-24; also 1959b, p. 176, plate 19, figure 27) from the Upper Jurassic of Japan differs from the present one mainly in its smaller size and perfectly smooth

surface. The Lower Jurassic species *E. fossatum* Marwick (1953, p. 99, plate 13, figures 1-4) from New Zealand can be distinguished by its smaller size, smooth surface and unequal ears.

The specimen was recorded for the first time by Kanjilal (1974) prior to which the species was unknown in India.

*Entolium (Entolium) partitum* (J. de C. Sowerby)

*Pecten partitus* J. de C. Sowerby 1840, p. 328, plate 22, figures 5, 5a

*Entolium partitum* (J. de C. Sowerby): Cox 1952, p. 35, plate 3, figures 11-13

*Material:* Several specimens

*Horizons and Localities:* Bed No. 4 (Upper Callovian)—N of Paiya; Bed No. 2 (Upper Callovian)—S and SW of Lodai, and E of Rudra Mata; Bed No. 1 (Oxfordian)—SW of Lodai.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)	Apical Angle
H/3/10	14.0 mm	112.1	9.3-SV*	90°
H/3/11	14.7 mm	110.2	10.2-SV	85°
H/3/12	15.5 mm	112.9	12.9-SV	90°

\*SV—Single Valve

*Remarks:* The present species has been recorded from India in recent years by Cox (1952), Agrawal (1956, p. 80) and Singh (1961, p. 79). A close examination of the specimens studied by them and those in the present collection shows that its height varies from 110-124% of the length, apical angle from 85° to slightly more than 100° and the angle between the internal ridges from 70° to 80°. The presence of concentric ridges over the shell-surface in pairs, as

observed by Cox, is not an original pattern of shell ornamentation. In fact, this apparent pairing is a secondary feature developed due to erosion of the crests of originally thick but interiorly hollow ridges. Extremely fine radial, 'rays' are seen to radiate out from the umbo on outer and inner surfaces of some shells which have escaped erosion. None of the specimens studied by the present author, however, show auricles rising above the umbo as seen in the Sowerby's

original syntypes (British Museum, Geol. Soc. Coll. 9960) from the present area, refigured by Cox (1952, plate 3, figure, 13).

The Khera Hill specimen (Geological Survey of India No. K 40/649), collected by Wynne from an uncertain horizon, has been referred to as *partitum*. This specimen with its interior exposed shows closely spaced fine concentric lines and delicate radial rays but the two internal ridges, so characteristic of the species, are not there. In addition, a weak byssal notch is observable below one of the subequal auricles. Therefore, it can not belong to *partitum*.

The figure of *E. cingulatum* (Goldfuss) recorded from the Jurassic of Tanganyika by Cox (1965, p. 52, plate 6, figure 5) has an outline and a pair of internal ridges very similar to those in the present specimens. But the external characters are not seen in the figure and, therefore, a precise comparison is not possible. It may be added here that supposed difference in the horizons of *partitum* (*anceps* zone, Callovian) and *cingulatum* (the White Jura), as stated by Cox (1965), does not hold good in view of the record of the former from the Divesian and Argovian by Cox (1952), Singh (1961) and by the present author (Oxfordian), and the latter species from a horizon as low as Lias by Dechaseaux (1936, p. 60). The other distinguishing character according to Cox is said to be the absence of strongly developed concentric ridges and their paired arrangement in *cingulatum* also appears to be essentially an outcome of poor preservation. There is every likelihood of these two species finally merging into one after a thorough study of a good number of representatives of both the forms from their type localities. *E. briconense* (Cossmann), from the Callovian of Tanganyika (Cox 1965, p. 51, plate 6, figure 6) has identical ornamentation but is larger in size. Further, its interior is not known and, therefore, an attempt to unite it with *partitum* would be premature.

The Japanese species *E. yatsujicuse* Kurata & Kimura, recorded by Kimura (1951, p. 346, plate 1, figure 18) and Tamura (1959a, p. 60, plate 6, figure 30; also 1959b, p. 176, plate 19, figure 41) from the Jurassic horizons, differs from the present examples in having short shoulders and smooth exterior. *E. kimurai* Tamura (1959a, p. 60, plate 6, figures 23-29) from the Upper Jurassic Sakamoto Formation of Japan has comparatively shorter shoulders and different ornamentation pattern. *E. japonicum* Kurata & Kimura (Kimura 1951, p. 345, plate 1, figures 16-17) from the Jurassic Torinosu Group is easily differentiated from the present one by its smooth surface, lesser apical angle, concavity in [the antero-dorsal margin and unequal wings.

**Genus—*Chlamys* Bolten MS,  
Roeding 1798**

Type Species—*Pecten islandicus* Mueller 1776; SD Herrmannsen 1847. Recent; Circumboreal

Subgenus—*Chlamys* s.s.

*Chlamys* (*Chlamys*) *ambigua* (Muenster)  
(plate 1, figure 2)

*Pecten ambiguus* Muenst.: Goldfuss 1833,  
p. 46, plate 90, figure 5

*Chlamys ambigua* (Muenst.): Weir 1930, p. 85,  
plate 10, figure 5

*Chlamys* cf. *ambigua* (Muenst.): Weir 1930,  
p. 86, plate 10, figures 1-2

*Chlamys* cf. *dewalquei* (Oppel): Weir 1930,  
p. 86, plate 10, figure 6

*Chlamys ambiguus* Muenster: Dechaseaux  
1936, p. 14, plate 2, figure 2; plate 3,  
figure 1

*Chlamys ambigua* (Muenster): Cox 1952, p. 4,  
plate 1, figures 2-4

*Material*: Several specimens.

*Horizons and Localities:* Bed No. 4 (Upper Oxfordian)—SW of Lodai, NW of Jhikadi and Callovian)—N of Paiya; and Bed No. 1 and S of Kotai.

*Dimensions:*

Sp. No	Length	Height (%)	Inflation (%)	Apical Angle	No. of radials
H/29/14	38.0 mm	121.1	14.5-RV <sup>1</sup>	75°	25
H/2/19	31.0 mm	112.9	32.3-BV <sup>2</sup>	77°	24
H/11/20	32.5 mm	128.6	14.8-LV <sup>3</sup>	80°	23

<sup>1</sup>Right Valve

<sup>2</sup>Both Valves

<sup>3</sup>Left Valve

*Remarks:* The present material includes well preserved specimens of bivalved as well as isolated left and right valves. On the whole they match well with the Kutch specimens described by Cox (1952) in shape and details of ornamentation but some of them occasionally show a few variations. The dorsal margins are not always straight and one or both of them may be slightly concave (as in the Sp. No. H/2/19, plate 1, figure 2). The apical angle is usually about 70°–72° but in a few cases it is 80° or even slightly more. The variations, however, need not be surprising since specimens from the 'lower *macrocephalus* Beds' of Kutch (G.S.I. No. K 40/603) referred by Cox (1952) to this species on measurement were found to have apical angles varying from 70°–80°. The figures given by Dechaseaux (1936) also show the apical angle varying from 75°–90°.

*C. subtextoria* (Muenster), as described by Cox (1952, p. 6, plate 1, figure 5–7), is very closely allied to it and differs only in its slightly greater number of radials. The four specimens (G.S.I. Nos. K 40/609, 610) from the 'Divesian' of Kutch, which have been recorded by Cox as *C. cf. episcopalis* (de Loriol) (1952, p. 7, plate 1, figure 1), look very similar to the present ones except in

having slightly greater number of radial ribs.

This species was so far known to range from Bajocian to Callovian. Present occurrence in Oxfordian is, therefore, of interest. This is incidentally the first record of the species from the present area.

*Chlamys (Chlamys) subtextoria* (Muenster)  
(plate 1, figure 3)

*Pecten subtextoria* Muenster: Goldfuss 1833, p. 48, plate 90, figure 11

*Pecten subtextorius* (Muenster): Thurmann & Etallon 1862, p. 256, plate 36, figure 4

*Chlamys subtextorius* Goldfuss: Dechaseaux 1936; p. 19, plate 3, figure 2

*Chlamys subtextoria* (Muenster): Cox 1952, p. 6, plate 1, figures 5–7

*Chlamys (Chlamys) subtextoria* (Muenster): Agrawal 1956, p. 68, plate 8, figure 8

*Chlamys subtextoria* (Muenster); Cox 1965, p. 55, plate 7, figure 8

*Material:* One bivalved specimen and two right valves.

*Horizon and Locality:* Bed No. 1 (Oxfordian)—SW of Lodai

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)	Apical angle
H/11/113	40.8 mm	113.7	9.0-RV	80°

*Remarks:* The present specimens match well with the examples from Kutch, referred to this species by Cox (1952). The specimens recorded as *C. cf. episcopalis* (de Loriol) by Cox (1952, p. 7, plate 1, figure 1) also compare well with these specimens in nature and number of radial ribs but their apical angle is a little smaller. *C. etiveyensis* de Loriol described by Dechaseaux (1936, p. 18, plate 3, figures 3-4), from the Upper Jurassic of France, has been considered by Cox (1965) to be a synonym of this species with some reservations but as judged from the figures given by Dechaseaux the French specimens have a more acute apical angle than in *subtextoria* and there are distinct nodosites at the crest of the radial ribs.

To the present material may be added a specimen (G.S.I. No. K 40/700; collected by W T Blanford) from the 'Divesian' of Jhura, Kutch, which with its 33 ribs and an apical angle of 80° is indistinguishable from

the present species. Another specimen having the same number (i.e. K 40/700) and possessing only 11 ribs is an example of *Ctenostreon proboscidium* (J Sowerby) which has been assigned by Cox (1952, p. 66) to the present species.

*Chlamys (Chlamys) splendens* (Dollfus)  
(plate 1, figure 4)

*Pecten splendens* Dollfus 1863, p. 78, plate 14, figures 7-9

*Pecten articulatus* Schloth.: Lycett 1863, p. 32, plate 33, figure 12 (*non* Schlothheim)

*Chlamys splendens* (Dollfus): Arkell 1926, p. 539, plate 31, figures 1-4

*Chlamys (Chlamys) splendens* (Dollfus): Arkell 1931, p. 107, plate 10, figures 1-5; plate 14, figure 5

*Material:* One left valve,

*Horizon and Locality:* Bed No. 1 (Oxfordian)—SW of Lodai

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)	Apical angle
H/14/4	43.9 mm	112.3	13.4	85°

*Description and Remarks:* This specimen of rather unsatisfactory preservation and with broken auricles is equilateral with sub-orbicular outline and even inflation. Its surface is ornamented with 31 primary radial ribs and a few secondaries which appear in the ventral half only. The transverse ornamentation is mostly eroded but a few remnants of the concentrics are seen to produce knots at their intersections with and at the

top of the radials. In addition, these concentrics impart to the sulci a V-shaped structure directed away from the umbo. In view of these characters and the dimensions it can be unhesitatingly referred to *splendens*. However, this specimen falls in the 'non-typical' variety of Arkell (1931, p. 109) due to presence of a few more radials. *C. (C.) aff. splendens* (Dollfus) (Agrawal, 1956, p. 67, plate 8, figure 11) is a poorly preserved

specimen which is shorter in height (104%) and has slightly greater number of radials (34) at the ventral margin.

This is the first record of the species from India.

*Chlamys (Chlamys) curviviarians* Dietrich  
(plate 1, figure 8)

*Chlamys* aff. *palmyrensis* (Krumbeck): Weir 1929, p. 24, plate 1, figures 34–35

*Chlamys* sp., in Weir 1929, p. 25, plate 1, figure 38

*Pecten (Chlamys) curviviarians* Dietrich 1933, p. 63, plate 8, figures 122–123

*Chlamys curviviarians* Dietrich: Cox 1935, p. 176, plate 18, figures 14–15

*Chlamys curviviarians* Dietr.: Stefanini 1939, p. 183, plate 21, figure 9

*Chlamys curviviarians* Dietrich: Cox 1952, p. 8, plate 2, figures 5, 8

*Chlamys (Chlamys) curviviarians* Dietrich: Agarwal 1956, p. 66

*Chlamys curviviarians* Dietrich: Joubert 1960; p. 1, plate 7, figure 1

*Chlamys (Chlamys) curviviarians* Dietrich: Freneix 1965, p. 22, text figure 5

**Material:** A dozen specimens including both left and right valves.

**Horizons and Localities:** Bed No. 15 (Lower Callovian)—SW of Lodai, N of Habae and S of Dhrang; Bed No. 13 (Lower Callovian)—S of Lodai, Kotai and Fulae; Bed No. 7 (Middle Callovian)—N of Jhikadi; Bed No. 5 (Middle Callovian)—SW of Lodai; and Bed No. 3 (Upper Callovian)—SE of Habae.

**Dimensions:**

Sp. No.	Length	Height (%)	Inflation (%)	Apical Angle	No. of radials (Primary/Total)
H/29/9	17.0 mm	107.1	16.5–LV	103°	21/28
H/27/1	19.0 mm	104.7	13.2–RV	101°	22/24
H/51/45	22.1 mm	102.7	13.6–RV	100°	20/31

**Remarks:** All the specimens are ornamented with several fan-wise radiating ribs—a characteristic of the present species. They are gently to sharply rounded and number 17–21 in the dorsal region but increase by dichotomisation and/or intercalation ventrally where they vary from 20–31. Their apical angle is also a little more than that of the Kutch specimens previously recorded. However, these differences fall within the range of individual variations shown by the Somaliland specimens referred by Cox (1935) to this species.

*C. metapwaensis* Cox (1965, p. 56, plate 7, figures 1–2) described from the Upper Kimmeridgian of Tanganyika, with 22 rounded radial ribs which may increase by

dichotomisation or intercalation or both is said to differ from *curviviarians* in its thicker and less numerous ribs. The specimen figured by Cox is very small (11 mm) and it is not known whether it is mature or juvenile form. In the latter case the number of ribs may be expected to increase with further growth since the ribs show bifurcation or intercalation. Even if the specimen is a mature one the present number of ribs (22) is within the limits of *curviviarians* and in all probability the Tanganyikan form is conspecific with the present species. However, any attempt at uniting both the species does not appear desirable until a good number of specimens of the Tanganyikan form are studied.

*Chlamys* (*Chlamys*) sp. indet  
(plate 1, figure 9)

slab with a specimen of *Trigonia kheraensis*  
Cox.

*Material*: One right valve associated on a

*Horizon and Locality*: Bed No. 15 (Lower  
Callovian)—SW of Lodai.

*Dimensions*:

Sp. No.	Length	Height (%)	Inflation (%)	Apical Angle
H/ $\frac{84}{83}$	41.5 mm	113.7	9.6	80°

*Description*: Shell trigonally ovate, higher than long and inequilateral. Umbo depressed, slightly prosogyrous. Postero-dorsal margin almost straight and descends to about half the height of the shell. Antero-dorsal margin straight in the dorsal-quarter and then curves anteriorly. Ventral margin strongly convex meeting the postero-dorsal one in an obtuse angle and the antero-dorsal in an evenly rounded curve. Hinge line straight, slightly more than half the length of the shell. Posterior auricle small, triangular; its posterior margin straight and postero-dorsal angle is about 100°. Anterior auricle moderately large, and 'acute (60°) with a deep byssal notch below; its anterior margin is straight.

Flank ornamented with 18 rounded, equidistant radial ribs and four more comparatively slender ones restricted in the vicinity of the postero-dorsal margin. Both the ribs and the interspaces are traversed by crowded growth lines, forming small imbrications over the walls of the ribs as well as in the interspaces, besides producing regularly arranged low tubercles on the crest of each rib. Posterior auricle is covered with transverse rugae, parallel to the posterior margin, crossed by discontinuous fine radial lines. Anterior auricle bears coarse, wavy rugae and grooves. A shallow depression runs from the umbo at an angle of 30° to the dorsal margin on this auricle on either side of which the rugae and grooves bend.

Between the groove and the dorsal margin at least three radial threads, visible only in the umbonal vicinity, cross over the transverse elements.

*Remarks*: Test from the centre is completely eroded and that near the ventral margin is almost smoothed. On the whole the shell-ornamentation has been affected by erosion.

*Chlamys* sp. indet. from the 'macrocephalus beds' of Jhura (Cox 1952, p. 9, plate 1, figure 8) approximates the present one in dimensions, but has a greater apical angle, smaller posterior auricle, fewer and smooth radial ribs, and less conspicuously ornamented auricles. *C. (C.) natheimensis* de Loriol, from the Oxfordian of England (Arkell 1930, p. 104, plate 10, figures 6-8), matches the present one in apical angle and somewhat in transverse ornamentation, but is taller, having shorter dorsal margins, less obtuse-angled posterior wing and less acute-angled anterior wing. The same species, as described by Dechaseaux (1936, p. 22, plate 3, figure 7, text figure 12 A) from Callovian to Rauracian horizons of France, has a slightly lesser apical angle and rather angular ribs without tubercles at their crests. *C. (C.) splendens* (Dollfus) from the British Oxfordian beds (Arkell 1931, p. 107, plate 10, figures 1-5; plate 14, figure 5) has similar wings but differs readily owing to much greater number of radial ribs, greater apical angle, and larger size.



The present specimen in all probability belongs to a new species but for its unsatisfactory preservation no formal name has been proposed till better preserved specimens are available.

*Chlamys (Chlamys) sp.*  
(plate 1, figure 7)

*Material:* One right valve.

*Horizon and Locality:* Bed No. 4 (Upper Callovian)—N of Paiya.

*Dimensions:*

Sp. No.	Length	Height (%)	Number of radials
H/110/28	20.0 mm	107.5	17

*Description:* Shell subtrigonal, higher than long, very weakly inflated. Dorsal margins covered under stiff matrix, probably straight. Umbo acute. Apical angle about 75°. Wings not preserved. Surface covered with 17 narrow, elevated, steep-sided, smooth radial ribs separated by much wider interspaces.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)	Apical angle
H/116/8	20.9 mm	104.3	36.8	70°
H/116/15	20.3 mm	100.0	18.7+	—

*Description:* Shell trigonally ovate, slightly inequilateral. Umbo acute, prominent. Anterior margin short, almost straight; posterior longer, straight. Ventral margin symmetrically convex. Surface evenly inflated but that adjoining the anterior and posterior margins are almost vertical.

Flank ornamented with about 20 angular ribs separated by equally wide regularly angular interspaces. In the type material, the interspaces bear a delicate median thread

*Remarks:* The single right valve, for its poor preservation, does not allow even a tentative specific identification. But the manner of ribbing and very wide interspaces indicate the presence of yet another form in Kutch probably not known before. One unidentified specimen of *Chlamys* s.s. in G.S.I. collection (No. K 40/616) has 17 ribs similar to those in the present one but the interspaces are narrow.

**Genus—*Spondylopecten* Roeder 1882**

Type Species—*Pecten (Spondylopecten) cf. erinaceus* Buvignier, Roeder 1882  
(=*Pecten (Chlamys) roederi* de Loriol, 1901); M.

*Spondylopecten rogeri* Agrawal  
(plate 2, figures 1, 4)

*Spondylopecten rogeri* Agrawal 1956, p. 73, plate 8, figures 4-7, text figure 15

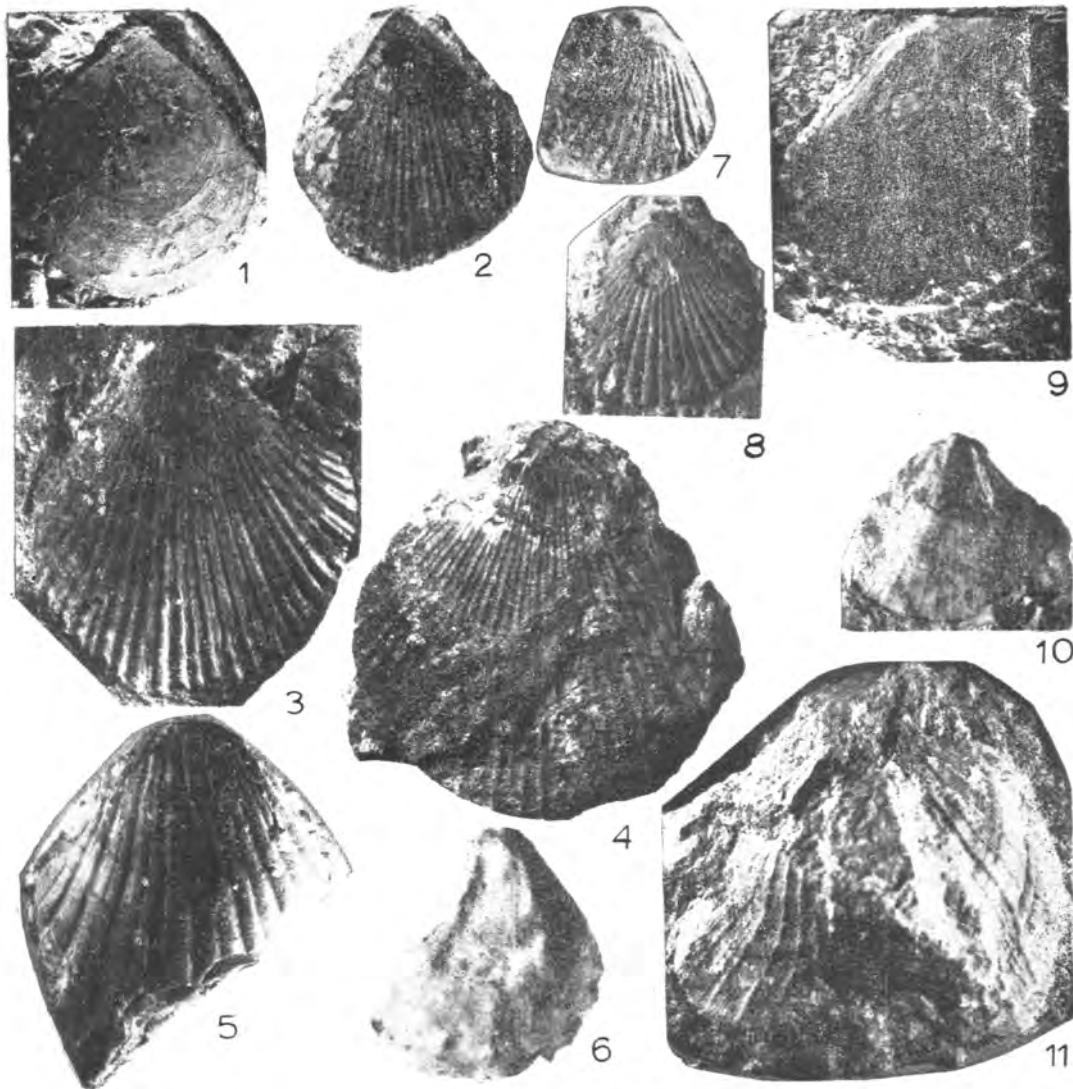
*Material:* Two right valves.

*Horizon and Locality:* Bed No. 3 (Upper Callovian)—SE of Habac.

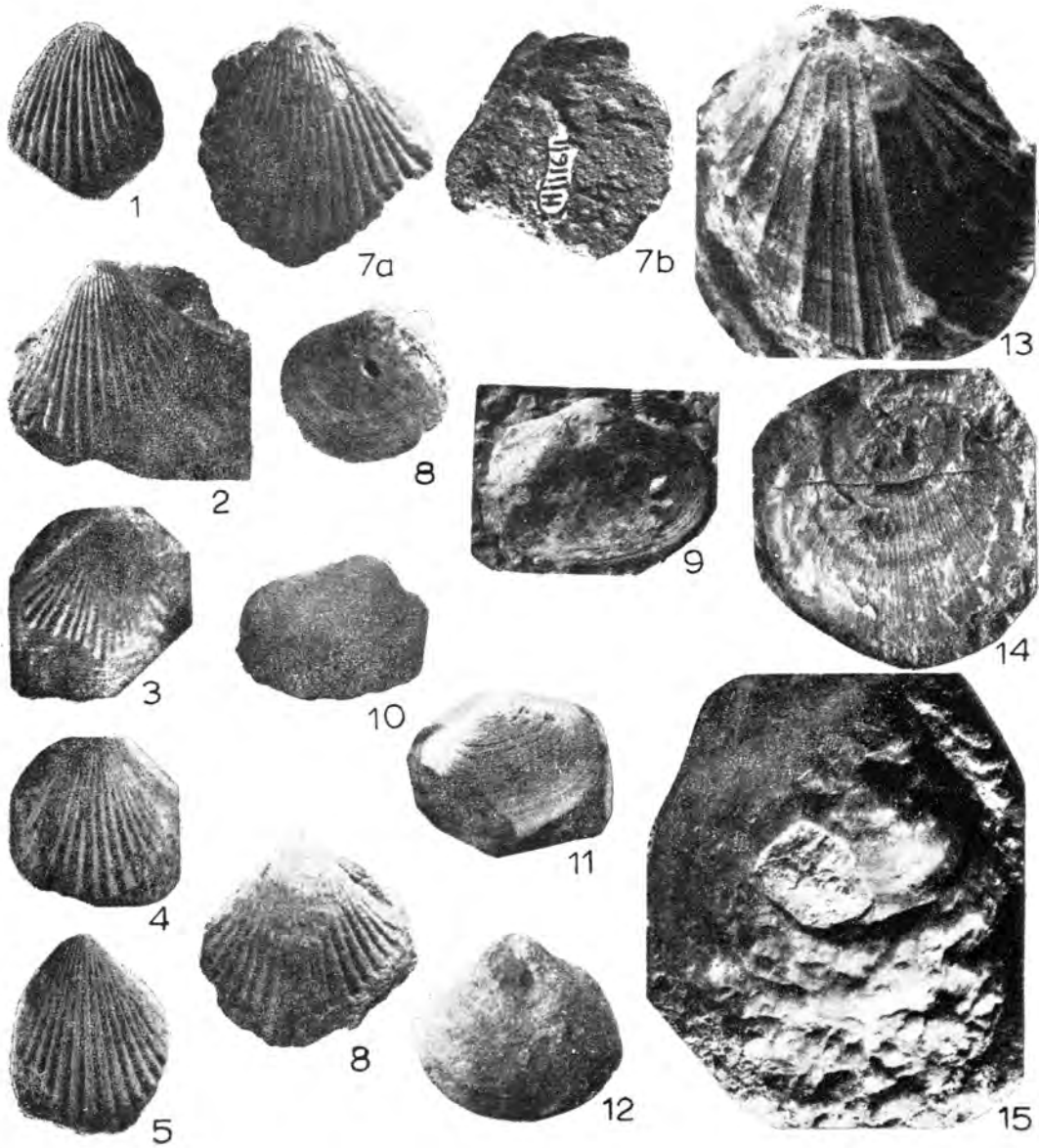
right from the umbo to the ventral margin. Transverse ornamentation consists of growth lines making V-shaped structures over the interspaces and inverted V-shaped ones over the ribs. Very minute oblique striations can be seen in the neighbourhood of the posterior margin.

*Remarks:* The present examples match well with the type specimens in general outline, ornamentation and dimensions. The apical angle is smaller than that of the

Some Pteriomorph and Heterodont Bivalvia



**Plate 1** Figures 1-11 1, *Entolium (Entolium) corneolum* (Young & Bird): Sp. No. H 99 93 from Bed No. 2, Rudra Mata Member (Upper Callovian) of E of Rudra Mata. RV ext.; 2, *Chlamys (Chlamys) ambigua* (Muenster): Sp. No. H 2/19 from Bed No. 1, Lodai Member (Oxfordian) of SW of Lodai. LV ext.; 3, *Chlamys (Chlamys) subtectoria* (Muenster): Sp. No. H 11 113 from the same horizon and locality as above. RV ext.; 4, *Chlamys (Chlamys) splendens* (Dollfus): Sp. No. H 14 4 from the same horizon and locality as above. LV ext.; 5, "*Pecten*" *rochi* Agrawal: Sp. No. H/51 43 from Bed No. 15, Dhrang Member (Lower Callovian) of N of Habae RV ext.; 6, *Plicatula (Plicatula) lunata* n. sp.: Sp. No. H/16/23 (Holotype) from Bed No. 1, Lodai Member (Oxfordian) of S of Dhrang. RV ext.; 7, *Chlamys (Chlamys)* sp.: Sp. No. H.110 28 from Bed No. 4, Rudra Mata Member (Upper Callovian) of N of Paiya. RV ext.; 8, *Chlamys (Chlamys) curviviarians* Dietrich: Sp. No. H  $\frac{84}{g_3}$  56 from Bed No. 15, Dhrang Member (Lower Callovian) of SW of Lodai. RV ext. ( $\times 1.1$ ); 9, *Chlamys (Chlamys)* sp. indet.: Sp. No. H:  $\frac{84}{g_3}$  /83 from the same horizon and locality as above. RV ext. ( $\times 0.98$ ); 10-11, *Eopecten tegulatus* (Morris & Lycett): 10, Sp. No. H/33/13 from Bed No. 15, Dhrang Member (Lower Callovian) of S of Kotai. LV ext.; 11, Sp. No. H/15/36 from Bed No. 1, Lodai Member (Oxfordian) of S of Lodai. LV ext.  
(All figures are of natural size except otherwise mentioned)



holotype but more or less equal to those of the paratypes.

This species differs from *C. (S.) stoliczkai* Cox (1952, p. 15, plate 3, figures 14–20), its nearest ally, recorded from the 'base of *macrocephalus* Beds' of Kutch, in its slightly more trigonal outline and smaller apical angle (85°–90°). An undescribed specimen (G.S.I. No. K 40/614) labelled as '*Chlamys* sp. indet.; Dhosa Oolite, near Wanda-pseudobiplicata bed', matches well with Agrawal's species. It is a crushed bivalved shell (L—20.5 mm; H—104.4%; A.A.—75°) comparing well in dimensions, number of radial ribs and apical angle, and may, therefore, be conspecific with the present species.

This is the first record of the species from the Habo Hill.

*Spondylopecten chiplonkari* n. sp.  
(plate 2, figures 2, 5–7)

*Chlamys curviviarians* Dietrich: Maithani 1968, p. 504, plate 31, figure 4 (*non* Dietrich)

*Material*: One Left and four right valves.

*Derivation of Name*: The species has been named after Professor Dr G W Chiplonkar.

*Horizon and Localities*: Bed No. 3 (Upper Callovian)—S of Lodai and SE of Habae.

*Dimensions*:

Sp. No.	Length	Height (%)	Inflation (%)	Apical Angle
Holotype—H/116/13	30.6 mm	99.3	30.4—RV	85°
Paratype—H/116/10	25.5 mm	101.9	25.1—RV	85°

**Plate 2 Figures 1–15** 1, 4, *Spondylopecten rogeri* Agrawal: 1, Sp. No. H/116/8 from Bed No. 3, Rudra Mata Member (Upper Callovian) of SE of Habae. RV ext.; 4, Sp. No. H/116/15 from the same horizon and locality as above. RV ext.; 2, 5–7, *Spondylopecten chiplonkari* n. sp.: 2, Sp. No. H/116/13 (Holotype). RV ext.; 5, Sp. No. H/116/9. RV (posterior broken) ext.; 6, Sp. No. H/116/10 (Paratype). RV ext.; 7, Sp. No. H/116/12: A—RV ext.; B—RV int. showing the posterior set (anterior set not preserved) of prominent teeth (thin white arrow) and the overlying pit (black arrow) both reaching the ligamental pit (thick white arrow). Horizon and Locality same as above; 3, *Spondylopecten* sp. indet.: Sp. No. H/123/43B from Bed No. 13, Dhrang Member (Lower Callovian) of S of Lodai. LV ext.; 8, "*Lucina*" *kirtlingtonensis* Cox & Arkell: Sp. No. H/7/57 from Bed No. 9, Jhikadi Member (Middle Callovian) of SW of Lodai. LV ext.; 9, *Mactromya* sp.: Sp. No. H/99/25 from Bed No. 2, Rudra Mata Member (Upper Callovian) of E of Rudra Mata. RV ext.; 10, *Mactromya? inequilateralis* n. sp.: Sp. No. H/99/51 (Holotype) from the same horizon and locality as above. RV ext. ( $\times 1.5$ ); 11, *Mactromya aequalis* Agassiz: Sp. No. H/99/60 from the same horizon and locality as above. RV ext.; 12, "*Lucina*"? sp.: Sp. No. H/65/25 from Bed No 7, Jhikadi Member (Middle Callovian) of SW of Lodai. LV ext. ( $\times 0.97$ ); 13–14, *Eopecten aubryi* (Douvillé): 13, Sp. No. H 16/14 from Bed No. 1, Lodai Member (Oxfordian) of S of Dhrang. LV ext.; 14, Sp. No. H/90/12 from the same horizon as above of S of Kunaria. RV ext.; 15, *Eopecten bhattii* n. sp.: Sp. No. H/ $\frac{84}{g_3}$ /82 from Bed No. 15, Dhrang Member (Lower Callovian) of SW of Lodai. LV ext.

(All figures are of natural size except otherwise mentioned)

**Description:** Shell trigonally ovate, flabelliform, with its length and height nearly equal, slightly inequilateral, moderately and homogeneously inflated, maximum convexity being at the centre. Umbo acutely pointed, prominent; umbonal pole slightly salient dorsal to the hinge line. Dorsal margins long, concave; ventral margin symmetrically semicircular, merging with the dorsal ones in equal, rounded-off obtuse angles.

Surface sculptured with 20–22 prominent angular radial ribs, straight in middle portion but gently fan-wise towards the anterior and posterior margins; they are separated by V-shaped interspaces, slightly narrower than the width of the ribs. Dorsal margins bordered by two narrow carinae separating the auricles from the main body of the shell. Surface adjacent to the auricles bears weak oblique striations which continue up to the auricles.

Anterior auricle projects as far as the anterior limit of the body of the shell, with a shallow byssal notch and bears several knotted radial ribs separated by narrower grooves which may also contain weak knotted threads. Posterior auricle smaller than the anterior one.

Hinge (in the right valve) consists of a small, triangular pit just below the umbo

and two horizontal, prominent teeth on either side of the pit, involving almost the entire length of the wings.

**Remarks:** *S. badiensis* Cox (1952, p. 16, plate 1, figure 14) from the Callovian of Kutch is its closest ally which differs in having a slightly symmetrical ventral margin, depressed rounded radial ribs and presence of a deep byssal notch below the right anterior auricle. *Chlamys (Aequipecten) macfadyeni* Cox (1935, p. 176, plate 18, figure 11) from the Jurassic of Somalia is a little taller with shorter and less concave dorsal margins, larger posterior auricle, and bears fewer and comparatively widely spaced radials. *C. (S.) stoliczkai* Cox (1952, p. 15, plate 3, figures 14–20) differs mainly in its inclined cardinal area, oblique striations on the sides occupying a large area, and slightly greater height percentage.

*Spondylopecten* sp. indet.  
(plate 2, figure 3)

**Material:** A left valve attached on a slab with *Palaeonucula kaoraensis* Cox, *Meleagrinnella echinata* (Smith) and *Camptonectes (Indonectes) obscurus* (J. Sow.).

**Horizon and Locality:** Bed No. 13 (Lower Callovian)—S of Lodai.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)	Apical Angle
H/123/43B	19.6 mm	107.1+	24.5	90°

**Description:** This ventrally incomplete specimen appears to have been originally trigonally ovate in outline. It is apparently equilateral and evenly inflated with long and concave dorsal margins. Posterior auricle is small and obtuse-angled; anterior auricle is partly broken. Surface bears 22 angular, radial ribs which are straight and separated by interspaces of equal width in the middle

portion but fan-like and separated by interspaces of greater width towards the dorsal margins. The posterior auricle bears striations parallel to its distal margin and the anterior one has four radial riblets.

**Remarks:** Exact outline of the specimen is not known and hence a precise identification or even comparison is not possible. However, on the basis of whatever characters are

available for study it is distinguished from *Chlamys* (*Spondylopecten*?) *badiensis* Cox (1952, p. 16, plate 1, figure 14) by its interspaces of unequal width and from *S. chip-lonkari* n. sp., described earlier, also by greater apical angle. *C. (Aequipecten) macfadyeni* Cox (1935, p. 176, plate 18, figure 11) from the Jurassic of Somalia is comparatively more inflated and has fewer ribs with equal interspaces.

#### Genus—*Pecten* Mueller 1776

Type Species—*Ostrea maxima* Linné, 1758;  
SD Schmidt, 1818. Recent;  
European seas

*Remarks:* Generic affinity of *Pecten*-like forms recorded from the Jurassic rocks has been discussed from time to time by different authors. A different genus, *Weyla*, was proposed more than half a century ago by Boehm (1920) to receive strongly inequivalve Liassic forms. A few years later Lissajous (1923) created another genus *Pseudovola* to accommodate the French Bathonian species *P. deperti*. The former genus is characterised by both valves sculptured with coarse radial costae while the latter, although strongly inequivalve, has only fine radial threads instead of strong ribs on the prominently convex right valve. The two forms, *Pecten kachhensis* Cox (1952, p. 21, plate 2, figure 4) and *P. rochi* Agrawal (1956, p. 75, plate 9, figures 1-2), from the Jurassic of Kutch differ from both *Weyla* and *Pseudovola* in ornamentation of equally convex right valve. On the other hand, in general configuration and strong convexity of the right valve they much resemble the Recent species of *Pecten* s.s. characterised by inequivalve shell with appreciably convex right valve but concave, flat or feebly bulging left one, essentially ornamented by radial ribs which are usually dissimilar in the two valves. This group has, however, been con-

sidered by earlier worker as well as Hertlein (in Moore and others, 1969, p. N 336) restricted to the Tertiary and Recent. Unfortunately there is no other genus in Pectinidae to receive forms like *kachhensis* and *rochi*. Cox did not get any left valve (1952) nor Agrawal (1956) had any at his disposal. The much sought for left valve, which could have provided some clue as to their generic assignment, is again missing from the present material. It has been, therefore, considered proper to assign these problematic forms provisionally to "*Pecten*" following Cox, and Agrawal.

#### "*Pecten*" *rochi* Agrawal (plate 1, figure 5)

*Pecten rochi* Agrawal 1956; p. 75, plate 9,  
figures 1-2

*Material:* One incomplete right valve.

*Horizon and Locality:* Bed No. 15 (Lower Callovian)—N of Habae.

*Remarks:* The present specimen, though incomplete posteriorly, matches very well with the plaster cast of the holotype (which has been very kindly provided by Professor Dr J. Sornay of Muséum National d'Histoire naturelle, Institute de Paléontologie, Paris) as well as the paratype in the Banaras Hindu University collection, in its typical paired, flat topped, rounded radial ribs of low relief and separated by much narrower interspaces or sulci. Two single ribs, however, are also present, in addition.

From "*P.*" *Kachhensis* Cox (1952, p. 21, plate 2, figure 4), it readily differs by its paired arrangement of the radial ribs.

The form was previously known only from the Callovian of Madagascar (holotype) and Jhura dome (paratype, Kutch). This is the first record from the present area.

**Genus—*Eopecten* Douvillé, 1897**

Type Species—*Spondylus tuberculosus*  
Goldfuss, 1836 (cited as "*Hinnites*  
*tuberculatus* Goldfuss"); OD.  
Inferior Oolite; Germany

*Eopecten tegulatus* (Morris & Lycett)  
(plate 1, figures 10–11)

*Hinnites velatus* Goldfuss: Morris & Lycett  
1853, p. 14, plate 2, figure 2, 2a (*non*  
Goldfuss)

*Hinnites tegulatus* Morris & Lycett 1853; p. 14,  
plate 2, figure 3, 3a

*Velata abjecta* Phillips: Weir 1930, p. 88,  
plate 9, figures 7, 8 (?) (*non* Phillips)

*Eopecten tegulatus* (Morris & Lycett): Cox  
1952, p. 29, plate 3, figure 5–7

*Material*: Three left valves.

*Horizons and Localities*: Bed No. 15  
(Lower Callovian)—S of Kotai; and Bed  
No. 1 (Oxfordian)—S of Lodai and Dhrang.

*Dimensions*:

Sp. No.	Length	Height %	Inflation %
H/16/17	34.0 mm	108.8	16.2

*Remarks*: The present specimens, although not well preserved, compare well with *E. tegulatus* in general configuration, and nature and number of radial riblets. Hence, they have been assigned to this species.

Cox had at his disposal all the bivalve material when he was describing the Jurassic lamellibranch fauna of Kutch. But surprisingly a specimen of a right valve (G.S.I. No. K 40/635) labelled as '*Eopecten sublaevis*' (now a synonym of *E. tegulatus*) is not listed under "Occurrence and Material" given by him (1952, p. 30). Most probably the specimen escaped his notice thereby leading him to state that "no specimen of right valve is in the material examined".

This specimen shows the internal surface which bears evidence of 45 radial riblets including a few paired ones.

The Oxfordian species *Velata bonjourii* (de Loriol) (Dechaseaux 1936, p. 70, plate 8, figure 14) agrees in pattern of ornamentation with the specimens here recorded, but shows a tendency of anterior obliquity in the shell outline. *E. kurisakensis* Tamura (1960, p. 235, plate 2, figure 18) from the Upper Jurassic of Japan has more numerous radial riblets of scarcely differing strength. Maithani (1968, p. 506, plate 30, figure 6) has erroneously described a specimen of *Meleagrinnella echinata* (W. Smith) from the present area as *E. tegulatus*.

This is the first record of the species from the present area. *E. tegulatus* is generally known from Bathonian and Lower Callovian horizons. Its present occurrence in Oxfordian should not be, however, considered unusual, since *Velata jason* (d'Orbigny), which has been considered to be synonymous with *tegulatus*, has already been recorded from Oxfordian beds of France by Dechaseaux (1936, p. 69).

*Eopecten aubryi* (Douvillé)  
(plate 2, figures 13–14)

*Pleuromectites aubryi* Douville 1886; p. 228,  
plate 12, figure 3

*Velata aubryi* (Douv.): Weir 1929; p. 7,  
plate 1, figure 40

*Velata aubryi* (Douv.): Stefanini 1939; p. 186,  
plate 21, figures 10–11; plate 22, figure 1

*Eopecten aubryi* (Douvillé): Cox 1952; p. 31,  
plate 3, figure 8–10

*Eopecten aubryi* (Douvillé): Agrawal 1956;  
p. 79, plate 8, figure 10

*Eopecten aubryi* (Douvillé): Joubert 1960;  
p. 1, plate 8, figure 10

*Eopecten aubryi* (Douvillé): Cox 1965; p. 52,  
plate 6, figure 3–4

*Eopecten aubryi* (Douvillé): Freneix 1965;  
p. 21, plate 2, figure 15

**Material:** Eleven bivalved, eleven left and seven isolated right valves. In most of the bivalved specimens the right valve is partly or completely covered by matrix such that only the margins are visible.

**Horizons and Localities:** Bed No. 7 (Middle Callovian)—N of Jhikadi; Bed No. 5 (Middle Callovian)—SW of Lodai; Bed No. 3 (Upper Callovian)—SW of Lodai; and Bed No. 1 (Oxfordian)—SW of Lodai, SE of Habae, N of Boladi, S of Kunaria, Kotai and Dhrang.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
H/11/20	32.0 mm	115.6	34.4-BV
H/64/1	31.2 mm	112.2	19.2-LV
H/1/31	22.0 mm	109.1	—-RV

**Remarks:** The specimens now recorded show considerable individual variation in respect of surface ornamentation. A majority of the specimens bear 10 to 14 radial riblets on the left valve with a weak radial riblet of secondary strength in the middle of each interspace in addition to fine threads of tertiary strength ornamenting the remaining surface. But there are some specimens which differ from normal ones in having two secondaries in each interspace (e.g. No. H/16/14), or by their secondaries attaining the prominence of a primary in the ventral region (e.g. No. H/16/28). The right valves bear 45-50 closely spaced radial threads of uniform strength, which sometimes increase ventrally by intercalation. The G.S.I. collection at Calcutta (which was studied by Cox) includes some specimens (e.g. K 40/638) without secondary riblets, and a few others (e.g. No. K 40/640) in which the secondaries are present but not in all the interspaces of the left valve. The Habo examples fall well within the range of variation of this species

as seen in the Indian specimens and in published figures by authors quoted in the synonymy.

It may be added here that the specimens of right valve collected from the present area, which are fairly well preserved and complete, do not show any indication of the presence of an attachment area either in the umbonal region or anywhere else on the surface. This fact clearly rules out the possibility of right valves being always attached to other objects by a small and inconspicuous part of its surface as suspected by Cox (1952).

*Velata tuberculosa* Goldfuss (Dechaseaux 1936, p. 68, plate 9, figure 2) from the Aalenian and Bajocian of France has identical number of primary radials but differs from *aubryi* in its larger size and regularly nodose radial ribs. A specimen of a right valve from the Jurassic of Japan described by Kimura as *Velata puncta* (1951, p. 348, plate 1, figure 21) differs from the present specimens in being more elongate, more inequilateral, and in having prominent concentric threads. The left valve of the same species has been recorded by Tamura (1959b, p. 175, plate 19, figures 18-21) which differs in having lesser number of radial ribs and conspicuous concentric wrinkles.

*Eopecten bhattii* n. sp.  
(plate 2, figure 15)

**Material:** One left valve attached on a slab with a left valve of *Neocrassina* (*Neocrassina*) *pandei* Maithani.

**Derivation of Name:** The specimen has been named after Shri P.H. Bhatti of Bhuj (Kutch) who has always been of much help to the members of the Banaras Hindu University team during their field work in different parts of Kutch.

**Horizon and Locality:** Bed No. 15 (Lower Callovian)—SW of Lodai.



*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
Holotype—H/ $\frac{84}{g_3}$ / 82	47.8 mm	125.5	20.3

*Description:* Shell of moderately large size for the genus, inequilateral, subovate in outline with posterior obliquity, higher than long. Umbo prominent, acute, mesial (with respect to the shell length), placed at the posterior end of the short and straight dorsal margin. Anterior auricle large, flat, undifferentiated; posterior one not preserved, probably rudimentary. Anterior margin, first feebly concave in the dorsal-third region where it meets the hinge line at an angle of about 110°, then becomes obtusely convex and finally merges with the slightly asymmetrically convex ventral margin uninterruptedly. Posterior margin broadly convex except for a slight concavity below the umbo where it makes an angle of about 125° to the hinge line. Maximum width at about the middle of the height of the shell.

Shell surface highly irregular; maximum convexity being at the umbonal region. Flank ornamented with about 17 weak, primary radial threads, separated by much wider and unequal interspaces bearing one secondary and two to three tertiary radial threads crossed over by few irregular comarginal folds. Ventral-third surface highly undulated and free of any radial element. Surface of the anterior auricle smooth except for the undulations of the surface and weak comarginal folds.

*Remarks:* The present new species, based on a single specimen, is somewhat peculiar in its shape, but posterior obliquity of the shell, undulatory surface, large and undemarcated anterior wing, and three sets of radial ornamentation justify its present generic placement. Probably the only

comparable form is *Velata hettangiensis* Dechaseaux (1936, p. 71, plate 9, figure 1, 1a) which, however, differs from the present one in its lesser posterior obliquity, different outline and stronger ornamentation. Besides, the French form comes from a much lower horizon (Hettangian).

Family—PLICATULIDAE Watson 1930

Genus—*Plicatula* Lamarck 1801

Type Species—*Spondylus plicatus* Linné, 1758; SD Schmidt, 1818

Subgenus—*Plicatula* s.s.

*Remarks:* Arkell (1930, p. 90) considered the convex valve of Plicatulids as the left one while Cox (1952, p. 40), just the reverse. Cox & Hertlein (*in* Moore & others 1969, p. N 377) have mentioned that individuals may be "subequivalve or with right valve usually more convex". All these authors, however, regarded that the shells are projected posteriorly. Further, Arkell (1930) observed that the shells are "not generally attached by the right valve", while Cox (1952), and Cox & Hertlein (*in* Moore & others 1969) thought just the opposite. Thus, it seems that some uncertainty prevailed among the workers in regard to the determination of the left and right valves particularly when they tried to decipher on the basis of convexity of any valve and attachment area. Examples showing the interior would readily suggest that Plicatulids are monomyarian shells having the lone muscle scar situated posteriorly. For specimens showing only the external surface, the tendency of the shell to project posteriorly would be an important criterion to determine the left and right valves.

In view of the above, it may be suggested that in this genus either valve may be more convex and attached at the umbo.

*Plicatula (Plicatula) peregrina* d'Orbigny

*Plicatula pectinoides* J. de C. Sowerby 1840, plate 22, figure 6 (non *Placuna pectinoides* Lamarck, 1819, first referred to *Plicatula* by J. de C. Sowerby, 1823)

*Plicatula peregrina* d'Orbigny 1850, p. 342

*Plicatula cochlear* Stefanini 1939, p. 192, plate 21, figure 6-12; plate 22, figure 1

*Plicatula peregrina* d'Orbigny: Cox 1952, p. 40, plate 4, figure 2-6

*Plicatula peregrina* d'Orb.: Agrawal 1956, p. 81, plate 9, figure 7-9

**Material:** One fragmentary bivalved specimen.

**Horizon and Locality:** Bed No. 15 (Lower Callovian)—S of Kotai.

**Remarks:** The presents pecimen with its slightly broken dorsal region is orbicular in outline. Its right valve is convex and left concave. It is similar in shape and ornamentation to the one figured by Cox (1952, plate 4, figure 6) and the Jhura specimens recorded by Agrawal (1956).

One of the specimens in G.S.I. collection (No. K 40/659, non figure 4, plate 4 of Cox 1952) referred to *P. peregrina* is semilunate in outline with a smooth surface except for radially and concentrically arranged tiny nodosites. It matches the most with the specimens of *P. blanfordi* Cox (1952, p. 42, plate 4, figures 7-9).

This is the first record of the species from the present area.

*Plicatula (Plicatula) lunata* n.sp.  
plate 1, figure 6

**Material:** The holotype only.

**Derivation of Name:** The trivial name pertains to the more or less lunate outline of the shell.

**Horizon and Locality:** Bed No. 1 (Oxfordian)—S of Dhrang.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
H/16/23	31.0 mm	100	32.3—BV

**Description:** Shell moderately large for the genus, lunate, posteriorly extended, and strongly inequivalve. The left valve is concave while the right one convex with an attachment area in its umbonal region, and a broadly rounded, lunate umbonal ridge which divides the surface in an almost flat area sloping gently to the dorsal and posterior margins and a convex one descending rather steeply to the anterior and ventral margins.

Surface sculpture consists of numerous prominent, slightly undulating radial threads superimposed on about six thick but faint radiating ribs which appear only at about middle of the height. Each rib bears two rows of spinose scales in the vicinity of the ventral margin. The radials are crossed by weak growth-halts.

**Remarks:** The concavity of the left valve is filled up with very stiff matrix and, therefore, its ornamentation is not known. But the shell-outline and ornamentation of the right valve are sufficient to distinguish this specimen from other known Jurassic species. *P. blanfordi* Cox (1952, p. 43, plate 4, figures 7-9) is its nearest ally in view of a similar outline but differs in being more inflated and lacking both the indistinct radial ribs and spinose scales.

*Plicatula (Plicatula) sp.*

**Material:** One bivalved specimen.

**Horizon and Locality:** Bed No. 1 (Oxfordian)—SW of Lodai.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
H/11/23	32.0 mm	109.4	43.8

*Description:* The specimen is of moderate size, irregular outline and inequilateral, the posterior being slightly produced. It is inequivalve with a concave left valve and a convex right one with a large attachment area in the umbonal region. Surface of the right valve is uneven and bears fine radial threads impressed upon some inconspicuous radial riblets which have some irregularly disposed spinose scales. The radials are crossed by growth laminae.

*Remarks:* The left valve is mostly covered with hard matrix and part of the right valve's surface has been eroded away. The exposed surface features are not of much help in precise identification. The only form bearing some resemblance is *P. badiensis* Cox (1952, p. 42, plate 4, figures 10–11) which has similar proportional dimensions but differs in its less produced posterior region and stronger and more numerous spinose scales over the surface.

Subclass—HETERODONTA Neumayr  
1884

Order—VENEROIDA Adams &  
Adams 1856

Superfamily—LUCINACEA Fleming 1828

Family—LUCINIDAE Fleming 1828

Genus—*Lucina* Bruguiere 1797

*Type Species*—*Venus jamaicacensis* Spengler, 1784; SD Gray, 1847. Recent; U.S.A.

*Remarks:* Chavan has made a very elaborate study of the family Lucinidae and precisely identified a score of genera and subgenera (*in* Moor & others 1969, p. N 492). He

based his classification mainly on internal characters of the shell. But the abbreviated descriptions are often inadequate for proper identification of a genus particularly in those genera in which the internal features, for some reason or other, are not observable. None of the specimens collected from Kutch so far shows the interior clearly. One specimen (No. FW/9/23 in B.H.U. collection) was subjected to rigorous treatment for development of its dentition (Singh, 1961, p. 130) but with not much success. In fact, the specimens are mostly bivalved which on grinding do not reveal the internal features clearly owing to the matrix which is of same colour and hardness as that of the shell itself. No other literature was available for a correct generic assignment of the specimens on the basis of external morphology only. Under such circumstances, the author was obliged to refer all the lucinid specimens described below simply as "*Lucina*".

"*Lucina*" *kirtlingtonensis* Cox & Arkell  
plate 2, figure 8

*Lucina striatula* Buvignier (var.): Lycett 1863,  
p. 58, plate 38, figure 7 (*non* Buvig.)

*Lucina kirtlingtonensis* Cox & Arkell 1948,  
p. 34

*Material:* Four bivalved specimens.

*Horizons and Localities:* Bed No. 15 (Lower Callovian)—S of Fulae; Bed No. 9 (Middle Callovian)—SW of Lodai.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
H/ $\frac{28}{i}$ /43	19.8 mm	96.5	47.9
H/7/57	22.5 mm	93.3	44.4

*Description:* Shell inequilateral, equivalve, moderately inflated. Umbo small, depressed,

prosogyrous, situated slightly posterior to the median. Antero-dorsal and postero-dorsal margins almost straight merging imperceptibly into strongly and moderately convex anterior and posterior margins respectively, which in turn pass gradually into strong and symmetrically arched ventral margin. Lunule shallow; ligament external, posterior, bounded by sharp ridges. Surface ornamented with closely-spaced, fine, comarginal threads at regular intervals with a few growth halts.

*Remarks:* The specimens here recorded are specifically inseparable from the form described and illustrated by Lycett (1863) as *L. striatula* Buvignier (*non* Buvignier), which was subsequently renamed as *L. kirtlingtonensis* by Cox & Arkell (1948). This species came from the Bathonian of England and, therefore, the stratigraphic range of the taxon has to be extended now upwards into Lower Callovian. *L. rotundata* (Roemer), described by Arkell (1934, p. 279, plate 37, figure 3-10; text figure 62) from the Oxfordian of England, is more inflated and comes from a higher zone.

This is the first record of the species from India.

"*Lucina*"? sp.  
plate 2, figure 12

*Material:* Four specimens—all bivalved.

*Horizons and Localities:* Bed No. 15 (Lower Callovian)—S of Fulae; and Bed No. 7 (Middle Callovian)—SW of Lodai.

*Dimensions:*

Sp. No	Length	Height (%)	Inflation (%)
H/65/25	28.7 mm	89.5	54.0
H/ $\frac{28}{1}$ /15	30.8 mm	88.3	54.2

*Description:* Shell of small to medium size, equivalve, only slightly inequilateral and subtrapezoidal outline. Umbo pointed, acute, incurved, orthogyrous, contiguous and placed slightly anterior to the median; umbonal pole salient, dorsal to the hinge. Dorsal margins straight to feebly arched, sloping and meeting the straight to gently convex anterior and posterior margins in rounded-off obtuse angles. Ventral margin symmetrical, feebly convex joining the anterior and posterior ones in rounded-off angles slightly exceeding 90°. Two weak, rounded umbonal ridges run obliquely from the umbo towards the antero-ventral and postero-ventral corners of the shell. Test mostly eroded, hence ornamentation not well preserved, but the surface appears to have been smooth. Interior not visible.

*Remarks:* All the four specimens are rather unsatisfactorily preserved. However, they do not possess close similarity to any of the known species of "*Lucina*". These specimens also remind of the genus *Mactromya* Agassiz, and particularly *M. acesta* (d'Orb.) from the British Corallian rocks (Arkell 1934, p. 306, plate 42, figures 1-5), which has a similar outline and two umbonal ridges. However, that species is characterised by prominent growth rugae, greater inflation, more anteriorly placed umbones and a strongly convex posterior margin passing uninterruptedly into the dorsal and ventral ones. These differences rule out any possibility of the specimens now described being assigned to it. Probably these specimens belong to the genus "*Lucina*" and not *Mactromya* which fact can be, however, ascertained only when the internal characters are known.

Family—MACTROMYIDAE Cox 1929

Genus—*Mactromya* Agassiz 1843

*Type Species*—*Mya rugosa* Roemer

(=*Lutraria concentrica* Muenster in Goldfuss, 1840); SD Herrmannsen, 1847. Upper Jurassic; Germany.

*Mactromya aequalis* Agassiz  
plate 2, figure 11

*Mactromya aequalis* Agassiz 1843, p. 196, plate 9d, figure 5-8

*Mactromya aequalis* Agassiz: Cox 1935, p. 183, plate 19, figure 16-17

*Mactromya aequalis* Agassiz: Cox 1965, p. 97, plate 15, figure 7

**Material:** One left and one right valve specimens.

**Horizon and Locality:** Bed No. 2 (Upper Callovian)—E of Rudra Mata.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
H/99/20	21.0 mm	76.2	28.6—LV
H/99/60	24.5 mm	75.5	24.5—RV

**Description:** Shell of rather small size, subquadrate outline and slightly inequilateral. Inflation moderate, its maximum coinciding with an anterior-posterior line at about middle of the height; surface of the shell slopes from this line equally on dorsal and ventral sides. Umbo prominent, slightly incurved, rather orthogyrous and situated slightly anterior to the median. Dorsal margins almost straight, sloping gently from below the umbo and making slightly obtuse angles with the anterior as well as posterior margins, both of which in turn merge smoothly with the more or less straight ventral margin. A rounded and oblique ridge runs from the umbo towards the postero-ventral corner of the shell. Surface ornamented with irregularly spaced comarginal rugae, threads and striations.

**Remarks:** In outline and L/H ratio the present specimens agree well with those described by Agassiz (1843), and others. However, the Somalian specimens recorded by Cox (1965) besides being slightly less inflated (as measured from the figures) have a coarser ornamentation. *M. rugosa* (Roemer), as described by Agassiz (1843, p. 197, plate 9c, figures 1-23), can be easily distinguished by its truncated anterior and posterior ends.

This is the first record of the species from India.

*Mactromya mehrotraï* Agrawal

*Mactromya mehrotraï* Agrawal 1956, p. 116, plate 11, figure 7

**Material:** Seven bivalved, two left and three right valve specimens. One of them (No. H/91/11b) is associated with *Palaeonucula kaoraensis* Cox.

**Horizons and Localities:** Bed No. 13 (Lower Callovian)—S of Lodai; Bed No. 6 (Middle Callovian)—E and NE of Rudra Mata; Bed No. 4 (Upper Callovian)—S of Kunaria; and Bed No. 2 (Upper Callovian)—E of Rudra Mata.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
H/99/49	30.8 mm	70.8	31.2—RV

**Remarks:** These specimens match well with the holotype and the example recorded from south of Bhuj (Singh 1961, p. 133) in outline and dimensional proportions. They show, however, some variation in position of the umbo which may be from anterior-third to anterior-two-fifths of the shell length. The coarseness of the surface rugae present in Singh's specimen (No. SF/17/10; B.H.U. collection) is not seen in any of the present specimens. *M. aequalis*, just described,

differs by its outline and almost mesial umbo.

This species was so far not known from rocks older than 'Reineckeia beds'. The present record from the 'macrocephalus beds', therefore, lowers its range to Lower Callovian.

This is the first record of the species from the present area.

*Mactromya* sp.  
plate 2, figure 9

*Material:* A right valve.

*Horizon and Locality:* Bed No. 2 (Upper Callovian)—E of Rudra Mata.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
H/99/25	28.9 mm	72.7	33.2

*Description:* Shell of medium size, trapezoidal, well inflated and slightly inequilateral. Umbo broadly rounded, slightly incurved, prosogyrous and situated just anterior to the middle of the shell; umbonal pole salient, dorsal to the hinge. Antero-dorsal and postero-dorsal margins almost straight, sub-horizontal; the former merges into the broadly rounded anterior margin in a rounded-off obtuse angle, while the latter meets the feebly arched, rather truncated, posterior one in a well-defined obtuse angle.

*Dimensions:*

Sp. No.	Length	Height (%)	Inflation (%)
Holotype—H/99/51	16.8 mm	75.6	33.3—RV
Paratype—H/99/18	13.8 mm	78.3	29.7—LV

Ventral margin symmetrically and gently arched, grading imperceptibly into the anterior but making a rounded-off obtuse angle with the posterior. A rounded oblique ridge runs from the umbo towards the postero-ventral corner of the shell; surface posterior to this ridge slopes rather steeply to the margins. Surface mostly eroded but remnants bear strong comarginal threads and rugae and very fine radial striations in the umbonal region.

*Remarks:* *M. mehrotrai* Agrawal, described earlier, is the closest ally of the present species, from which it can be distinguished, however, by its anteriorly placed umbo, non-development of dorsal angles, a truncated posterior margin, presence of radial striations in the umbonal region and a somewhat greater inflation. *M. aequalis* Agassiz, also described earlier, differs mainly by its equally rounded anterior and posterior ends, the absence of radial ornamentation, and considerably weak inflation. *M. rugosa* (Roemer) (Agassiz, 1843, p. 197, plate 9c, figures 1-23) can be easily distinguished by its truncated anterior end.

*Mactromya? inequilateralis* n. sp.  
plate 2, figure 10

*Material:* Four left and two right valves.

*Derivation of Name:* The species is named by its markedly inequilateral outline.

*Horizon and Locality:* Bed No. 2 (Upper Callovian)—E of Rudra Mata.



- 22. *M. mehrotra* Agrawal (f) \* \* \* \*
- 23. *M. sp.* \*
- 24. *M.? inequilateralis* n. sp. \*

**IMPORTANT AMMONOID GROUPS**

- (i) Mayaitids, *Perisphinctes*, *Allgaticeras* (Oxfordian) <- - - - ->
- (ii) Hectioceratids (Mid. & Up. Callovian) <- - - - ->
- (iii) Proplanulitids (Mid. & Up. Callovian) <- - - - ->
- (iv) Reineckeids (Mid. & Up. Callovian) <- - - - ->
- (v) Eucycloceratids (Mid. Callovian) <- - - - ->
- (vi) Macrocephalitids (Lr. Callovian) <- - - - ->

- (F)—First Report from India
- (f)—First Report from the Habo Hill
- (R)—Stratigraphic Range Raised
- (L)—Stratigraphic Range Lowered





**Description:** Shell small, broadly ovate, well inflated, highly inequilateral and almost equivalve. Umbo broadly rounded, prosogyrous, placed more or less at anterior-quarter of the shell length; umbonal profile much salient dorsal to the hinge. Dorsal and ventral margins only feebly arched, subparallel; joined together in rounded-off obtuse angles by the gently curved posterior and more or less straight anterior margin. Lunule small but wide. Two very weak bluntly rounded, oblique umbonal ridges, one each on the anterior and posterior sides of the umbo, are perceptible in the dorsal region which, however, disappears before reaching the middle of the height. Maximum shell-inflation in the centre of the surface from where it curves down equally and gently in all directions except the anterior towards which the slope is steeper. Flank ornamented with comarginal, irregular threads and rugae. Interior not seen.

**Remarks:** The markedly inequilateral nature of the shell casts some doubt upon its placement in the genus *Mactromya*, but in view of forms like *M. varicosa* (J. Sow.), *M. verioti* (Buvignier), etc., which are also very inequilateral, the present new species has been tentatively referred to this genus. *Unicardium vericosum* Sow. (Morris & Lycett 1853, p. 73, plate 8, figures 7, 7a-b, 8a-b) from the Bathonian of England is larger in size and its surface bears strong grooves. *M. verioti* (Buv.) (Spath 1936, p. 122, plate 46, figures 2-3) coming from a much higher horizon (Portlandian) is also much larger in size with more salient umbo and coarser ornamentation.

From all the other known species of *Mactromya* the form described here differs essentially by its anteriorly placed umbones.

### Discussion of the Fauna

Bivalvia, except for few cases, are not much suitable for designating finer stratigraphic subdivisions. In the present study also it is evident that no finer biozonation is possible with the forms described as they occur in most of the beds (table 1). Either this or the earlier records reveal that they occur in Callovian as well as the Oxfordian beds except for the taxa *C. (C.) curvivarans*, "*P.*" *rochi*, and *P. (P.) peregrina* which are restricted to the Callovian only. Of these, "*P.*" *rochi* (as well its ally "*P.*" *kachhensis* Cox) has not been found so far in a horizon higher than the Lower Callovian in Kutch. Thus, it is apparent that these three forms can only broadly delineate the Callovian horizon in Kutch and may be useful for the purpose in areas where ammonoids are scarce such as the 'islands' on the southern border of the Great Rann of Kutch.

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