

ON SOME JURASSIC ASTARTID BIVALVES FROM THE HABO HILL IN KUTCH

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ABSTRACT

Apparently many bivalve families from the Jurassic rocks of Kutch, lent to late Dr. L. R. Cox (deceased 1965) of the British Museum by the Geological Survey of India, have neither been described nor probably returned.

In spite of fair abundance in Kutch the family Astartidae d'Orbigny was never studied comprehensively. In Habo Hill this group comprises two subfamilies, namely Astartinae d'Orbigny and Opinae Chavan. Only the former subfamily, represented by the genera *Astarte* J. Sowerby, *Neocrassina* Fischer (including the subgenera *Neocrassina* s.s., *Pruvostiella* Agrawal and *Coelastarte* Boehm) and *Nicaniella* Chavan, has been studied here.

Altogether 20 taxa (two of *Astarte*, seven of *Neocrassina* s.s., seven of *Pruvostiella*, one of *Coelastarte* and three of *Nicaniella*) have been reported here of which five, viz. *Neocrassina* (*Neocrassina*) *singhi*, *N. (N.) agrawali*, *N. (N.) haboensis*, *N. (Pruvostiella)* *panti* and *N. (P.) subtriangularis*, are new.

The subgeneric rank of *Pruvostiella* has been reinstated, but under *Neocrassina*. Stratigraphic ranges of a few species have been modified. *Coelastarte* was not described previously from India. *N. (P.) sowerbyana* (Holdhaus), a Spiti Shale form, is being described for the first time from Kutch.

INTRODUCTION

The Jurassic strata of Kutch are well known for the affluence of their fossil content. Amongst the megainvertebrates, bivalves are by far the richest in variety as well as number. Although these are rather long ranging, their true potentiality as tools in biostratigraphic studies has not been tested. This is because of the availability of ammonites, the precise time markers, in several of the strata in which the bivalves occur. However, in view of the problem in the field to recognise the beds in different sections owing to quick and sometimes sudden lateral changes of their physical characters, and also for the fact that the ammonites do not occur in every bed and everywhere, such as in the 'islands', their importance, at least locally, is considerably felt.

For their sheer abundance and diversity the bivalves have attracted a greater attention than even the cephalopods. Some monographs and several smaller papers are accredited to them. The most important of these are by Kitchin (1903) on the trigoniid bivalves, and Cox (1940, 1952) on several bivalve families. The latter author's monographs are all time great works of reference on the Kutch Jurassic bivalves, although many more families remained for him to investigate. Cox, while commencing the examination of the Kutch bivalves had, in fact, expressed the desire to "... complete the systematic study of the fauna in three or four parts of about the same size as the present one" (1940, p. 1), indicating the vast collection at his disposal from the various

sources duly acknowledged by him. However, he could publish only two parts out of the recommended numbers, suggesting a more or less equal number of taxa to be dealt with. Probably most of this total material (barring those of the Blake collection at the British Museum, Natural History) belongs to the Geological Survey of India, but the whereabouts of the undescribed ones are not known!

Of the 'remaining' groups, the heterodonts are the prevalent ones and of these the family Astartidae d'Orbigny is the most important. Although the Kutch Astartids have never been studied comprehensively by any one, they are not altogether unnoticed either. J. de C. Sowerby (1840a, b) had recorded a few forms, such as *Astarte unilateralis*, *A. pisiformis*, *A. major*, etc. Spath (1933) mentioned several astartids from various horizons in Kutch. Cox, too, mentioned the occurrences of at least three different astartid fossils from Kutch, e.g. "*A. pisiformis* from a few localities (1940, pp. 8, 18, 34, etc.), "...from upper *anceps* or lower *athleta* Beds,... abundant species of a medium-sized, flat, ribbed *Astarte* (G. S. I. No. K40/351, Colld. A. B. Wynne" (1940, p. 49), and an '*Astarte* shell' (G. S. I. No. K40/668) on which is shown adhering a specimen of *Placunopsis* cf. *semistriata* (Bean) from Callovian or Divesian horizon (1952, pl. 4, fig. 15a). Next important publications are by Agrawal (1956a, b) where he described 10 taxa and one subgenus, namely *Pruvostiella* Agrawal. The last published account of astartid bivalves from the Jurassics of Kutch is by Maithani (1968). Since then the B.H.U. team studying

the Jurassic fauna of Kutch has collected and studied a good number of these heterodonts.

In the Habo Hill, district Kutch (Gujarat), the family Astartidae is represented by the subfamilies Astartinae d'Orbigny and Opinae Chavan. Taxa of the latter subfamily have been described earlier by Kanjilal (1979). Purpose of the present paper is to provide a comprehensive account of the different forms belonging to the subfamily Astartinae which comprise (in the Habo Hill) the genera *Astarte* J. Sowerby (subgenus *Astarte* s. s.: two forms), *Neocrassina* P. Fischer (subgenera—*Neocrassina* s.s.: seven forms, *Pruvostiella* Agrawal: seven forms, and *Coelastarte* Boehm: one form) and *Nicaniella* Chavan (subgenus *Nicaniella* s.s.: three forms). Out of these 20 taxa, five, belonging to *Neocrassina* s. s. and *Pruvostiella*, are new to science. Most of these forms are described in detail and illustrated, and additional observations on the known ones are appended in order to understand their variability to a greater extent.

The described specimens are lodged in the Department of Geology, Banaras Hindu University.

SYSTEMATIC DESCRIPTION

<i>Class</i>	Bivalvia LINNÉ, 1758
<i>Subclass</i>	Heterodonta NEUMAYR, 1884
<i>Order</i>	Veneroida ADAMS & ADAMS, 1856
<i>Superfamily</i>	Crassatellacea FERUSSAC, 1822
<i>Family</i>	Astartidae D'ORBIGNY, 1844
<i>Subfamily</i>	Astartinae D'ORBIGNY, 1844
<i>Genus</i>	<i>Astarte</i> J. SOWERBY, 1816
<i>Subgenus</i>	<i>Astarte</i> s. s.

Astarte (Astarte) pandei AGRAWAL
(Pl. 1—3)

Astarte (Astarte) pandei Agrawal, 1956b, p. 102, pl. 10, fig. 8.

Material: One left valve.

Remarks: The present specimen is broken along its ventral margin. It compares well, at equal height, in length, inflation and number of concentric costae with the holotype of the species which is characterised by somewhat acutely rounded and projected anterior margin, almost straight dorsal one and a posterior widening of the shell surface, except that it is larger in size.

It is hereby recorded for the first time from the present area.

Horizon and Locality: Bed No. 1 (Lodai Member—Oxfordian)¹, S of Kotai.

Astarte (Astarte) sp. indet.
(Pl. I—2)

Material: One right valve.

Description: Shell small, subovate, inequilateral, almost flat. Umbo small, pointed, obtuse, compressed, situated at anterior two-fifths of the shell-length. Antero-dorsal margin concave and anterior one broadly rounded, passing smoothly into gently convex ventral margin which, in turn, merges imperceptibly into the posterior one. Postero-dorsal margin feebly arched. Shell-surface bears about 17 broad, coarse, concentric ribs of which those in the ventral region are relatively weaker.

Interior not visible.

Dimensions:

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/28/i/105 ..	22.7	81.9	almost flat

Remarks: The present specimen, owing to its extremely flat shell, is easily distinguished from all other known species. In all probability it belongs to an undescribed form but a new name is being deferred till more material is available.

Horizon and Locality: Bed No. 15 (Dhrang Member—Lower Callovian), S. of Fulae.

Genus *Neocrassina* P. FISCHER, 1887

Type species: *Astarte obliqua* DESHAYES, 1830; SD DALL, 1903 Bajocian; France

Subgenus *Neocrassina* s.s.

Neocrassina (Neocrassina) rajnathi AGRAWAL
(Pl. I—4-5)

Astarte (Neocrassina) rajnathi Agrawal, 1956a, p. 433, pl. 21, figs. 1-4.
Astarte (Neocrassina) compressa J. de C. Sowerby; Maithani, 1968, p. 511, pl. 32, figs. 1-2 (non J. de C. Sowerby).

Astarte (Neocrassina) rajnathi Agrawal; Maithani, 1968, p. 511, pl. 32, figs. 3-4.

Astarte (Pruvostiella) unilaterialis J. de C. Sowerby; Maithani, 1968, p. 513, pl. 32, fig. 6 (non J. de C. Sowerby).

Astarte (Pruvostiella) murthi Maithani, 1968, p. 515 (pars.)

Material: Thirtyeight specimens.

Dimensions:

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/98/19 ..	34.0	93.2	62.9—BV
H/98/37 ..	34.0	89.1	55.0—BV
H/98/6 ..	24.2	87.6	46.7—BV
H/16/24 ..	27.5	85.5	25.5—BV
H/98/23 ..	37.8	83.6	55.3—BV
H/98/32 ..	31.7	82.0	51.2—BV
H/25/8 ..	48.0	79.2	58.3—BV

Remarks: Original description of this commonly occurring species was based on eight specimens from the Jhura Hill, Kutch. The specimens collected by subsequent workers (e.g. Singh, 1961, p. 125, figs. 75 a, b) as well as those in the present material show more

¹For geology and stratigraphy of the Habo Hill, see Kanjilal (1978).

variation in proportionate dimensions which are, of course, not abrupt but smoothly intergrading. As is evident from the table of dimensions given above, the height and inflation vary from 79.2—93.2 percent and 44.6—62.9 percent of the length respectively. Consequently the outline is also variable.

Two additional features are noted which, though present in the type material, are not recorded so far. First is the presence of a more or less well marked, broadly rounded umbonal ridge running from the umbo towards the postero-ventral corner of the shell. The inclination of the surface posterior to this ridge is steeper than the rest. The posterior margin is feebly arched to almost straight, rather truncated. The second feature is a crenulated internal margin.

All the five specimens (Geological Survey of India Type Nos. 17938-42) identified as *Astarte* (*Neocrassina*) *compressa* J. de C. Sowerby by Maithani (1968, p. 511) have about 30 concentric costae within 20 mm from the umbo as against 40 in that species. They, in fact, match very well with the specimens in the present collection in all essential characters and hence conspecific. Similarly reference of the four specimens (G.S.I. type Nos. 17948-51) from the same area and by the same author to *A. (Pruvostiella) unilateralis* J. de C. Sowerby is erroneous. They are typical representatives of the present species. Further, a specimen (G. S. I. Type No. 17960) assigned to *A. (P.) murthi* Maithani (1968, p. 515) agrees well with a specimen collected from south of Bhuj (Singh, 1961, p. 125) which is an undoubted example of *rajnathi*.

Astarte pindiensis Cox (1965, p. 86, pl. 13, figs. 4-5) from the Bajocian (?) of Tanzania is very similar to *rajnathi* in outline and nature of the posterior umbonal ridge but differs in its ornamentation which consists of concentric lines.

Maithani, while describing this species from the Habo Hill records it from his 'Pleurotomaria' and 'Astarte' zones (1968, p. 512) but later in the appendix (p. 523) he restricts its occurrence in the former zone only.

The range of the present species is to be extended down into the Callovian.

Horizons and Localities: Bed No. 3 (Rudra Mata Member—Upper Callovian), E of Rudra Mata; Bed No. 2 (Rudra Mata Member—Upper Callovian), E of Rudra Mata; and Bed No. 1 (Lodai Member—Oxfordian), SW of Lodai, NW of Jhikadi, E and NE of Rudra Mata, S of Kunaria, Fulac and Dhrang.

Neocrassina (Neocrassina) singhi n. sp.
(Pl. I—1)

Material: Holotype only.

Description: Shell small, subovate, equilateral, moderately strongly inflated, maximum inflation being at

the centre from where the shell surface slopes uniformly in all directions. Umbo pointed, acutely rounded, prosogyrous, mesial. Antero-dorsal margin slightly concave; postero-dorsal gently arched. Ventral margin strongly and symmetrically arched (as shown by the growth lines) and meets the anterior and posterior ones in unbroken curves; the latter two meeting their dorsal components in rounded, broad, obtuse angles. Lunule wide, elongated, deep; escutcheon narrow, slit-like.

Surface ornamented with sharp, narrow, closely-spaced and elevated concentric costae numbering about 40.

Dimensions:

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/98/41	22.0	88.6	50.0—BV

Remarks: Although the present new species is known by a single specimen only, its features are distinct enough to justify its formal specific status. *Astarte subdepressa* Blake & Hudleston (Arkell, 1934, p. 235, pl. 33, figs. 1-9) is the nearest ally which also bear 40 concentrics within 20 mm from the umbo. The present species, however, differs from *subdepressa* in its ovate outline, mesial umbo and more projected anterior margin. *N. (N.) rajnathi* Agrawal, just described, has a more anteriorly placed umbo, comparatively lesser and coarser concentric costae and its region of maximum convexity lying along the posterior umbonal ridge.

Horizon and Locality: Bed No. 1 (Lodai Member—Oxfordian), E of Rudra Mata.

Etymology: The species has been named in honour of late Professor S. N. Singh, one of the foremost workers amongst the contemporary Indian palaeontologists.

Neocrassina (Neocrassina) sp. indet.

Material: Two bivalved specimens and a fragmentary left valve.

Description: Shell of medium size, elongated, subovate, highly inequilateral. Umbo small, actually pointed forward, situated at about anterior-quarter of the shell-length. Inflation moderate, maximum being in the dorsal-third region and slightly posterior to the umbones. Postero-dorsal margin almost straight, subhorizontal merging smoothly into broadly rounded posterior one which, in turn, curves forward to meet the straight ventral margin in a wide, smooth curve. Anterior margin feebly arched, merging with the ventral one uninterruptedly and joining the concave antero-dorsal one in a rounded-off obtuse angle. Lunule narrow and elongated.

Surface ornamented with about 30-40 concentric costae which somewhat fade out ventrally. Interior not seen.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/47/i/34 ..	40.0	80.0	40.0—BV
H/47/i/35 ..	41.0	81.7	37.8—BV

Remarks : The poor preservation of the specimens does not permit precise identification. However, they bear some resemblance to *N. (N.) rajnathi* Agrawal, described earlier, in its L/H ratio and position of the umbo but can be distinguished by its ovate outline, absence of any posterior umbonal ridge, and region of maximum inflation which is comparatively less.

Horizon and Localities : Bed No. 15 (Dhrang Member—Lower Callovian), N of Boladi and S of Fulae.

Neocrassina (Neocrassina) pandeyi MAITHANI
(Pl. I—6-8)

Astarte (Neocrassina) pandeyi Maithani, 1968, p. 512, pl. 32, fig. 8.

Material : Numerous specimens. One of them (No. H/84/g3/10b) is associated with *N. (C.) aff. cotleausia* (d'Orbigny). Another (No. H/84/g3/41) has a specimen of *Trigonia kheraensis* Cox attached to its inner surface. A third specimen (No. H/84/g3/44) has an isolated shell of *Pseudolimea duplicata* (J. de C. Sowerby) attached to its external surface.

Description : The present species was originally described on its holotype (G.S.I. Type No. 16947) only which is a poorly preserved specimen. The present collection, consisting of about 100 individuals, has many excellently preserved samples and shows very well the range of variation of the species in respect of its dimensions, outline and position of the umbo. In order to have a better conception of the variable nature of this species the description is being modified as given below :

Shell of moderate size, inequilateral and sub-orbicular to ovate in outline ; test thick. Umbo small, obtusely pointed, prosogyrous, rather prominent, situated at anterior-quarter to anterior-two-fifths of the shell-length. Height varies from 83-103 percent and inflation from 31-58 percent of the shell-length. Antero-dorsal margin feebly to moderately concave ; anterior one moderately to broadly rounded. Ventral margin more or less symmetrical and feebly to strongly arched. Postero-dorsal margin straight to moderately convex ; Posterior one usually gently inclined and straight, weakly or moderately arched ; when straight or weakly convex, it appears truncated making rounded-off obtuse angles with both the dorsal and ventral ones, otherwise makes a continuous curve with them. Lunule moderately wide and deep. Escutcheon very long, lanceolate, deep and bounded by sharp ridges. Maximum thickness in the dorsal-third region, slightly posterior to the umbo.

Ornamentation consists of concentric ribs in the dorsal region and weak comarginal rugae in the ventral one. Besides, concentric bands of dark grey and dull brownish colour are noticed on some specimens.

Dentition typical of *Neocrassina* s.s. Margin crenulate.

Dimensions :

sp. No.	Length	Height	Inflation
H/84/g3/2 ..	51.5	85.2	21.2—LV
H/84/g3/13 ..	51.4	89.7	21.8—LV
H/84/g3/35 ..	50.0	93.4	21.0—RV
H/84/g3/5a ..	46.9	98.5	23.5—RV
H/84/g3/9 ..	44.6	102.7	24.9—LV

Remarks : All the specimens show such permutation of the features mentioned above that no subgrouping is possible—they show a perfect intergradation in their characters.

Some of the figures of *Astarte ovata* Smith (Arkell, 1934, p. 231, pl. 32, figs. 1-12 ; text-figs. 55-56), itself a very variable species, appear similar to a few of the present specimens but in general the English species is more elongate with comparatively weakly convex ventral margin and a more projected umbo. Besides, *ovata* comes from the Oxfordian and the Lower Kimmeridgian beds only. *A. hilpertonsensis* Lycett (1863, p. 78, pl. 37, fig. 10), which comes from the Bathonian, has a shorter posterior end, almost straight ventral margin and more delicate ornamentation. On the other hand the specimen described by Fischer (1969, p. 101, pl. 11, fig. 18) as *hilpertonsensis* is quite near to some of the individuals of the present species and may turn out to be conspecific with it. *A. venkatappayyai* Sahni & Prasad (1957, p. 431, text-figs. 1, 1a) is almost orbicular in outline and has very coarse and persistent ornamentation throughout the surface.

This is the most abundant astartid and the most frequently occurring bivalve next only to *Palaeonucula kaoraensis* Cox in the Macrocephalus Beds of the present area.

It was previously recorded from a Lower Callovian (Maithani's Bathonian) bed only. The present find extends its range up into Middle Callovian.

Horizon and Localities : Bed No. 15 (Dhrang Member—Lower Callovian), SW of Lodai, N of Habae and Boladi, S of Fulae and Dhrang ; Bed No. 13 (Dhrang Member—Lower Callovian), S of Lodai ; and Bed No. 7 (Jhikadi Member—Middle Callovian)—N of Jhikadi.

Neocrassina (Neocrassina) agrawali n. sp.
(Pl. I—16)

Material : Four isolated valves.

Description : Shell of moderate size, trigono-orbicular

in outline, almost equilateral, very compressed; maximum inflation in the dorsal-third region below the umbo. Umbo small, depressed, slightly prosogyrous and placed mesially or just anterior to the middle of the shell-length; apical angle only slightly exceeding a right angle. Dorsal margins straight or only feebly arched, equally long and sloping at similar angles from the umbo to meet the strongly and symmetrically arched ventral margin at points slightly below the middle of the shell-height in rounded-off obtuse angles. Lunule small, narrow and deep; escutcheon narrow but elongate, slit-like.

Saving fine concentric ribs around the umbo and in the vicinity of the dorsal margins, the shell surface is smooth. Some broad, irregularly wide concentric bands of greyish black and dull brownish colour cover the whole surface.

Dentition (in the left valve) consists of two cardinal teeth, one below the umbo and almost vertical while the other slightly posterior and oblique to the former, enclosing narrow, deep, triangular socket. Posterior to the second cardinal there is another deep, triangular socket, wider than the earlier one, with a strong, raised posterior lateral bordering its posterior margin. Margins not crenulate.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
Holotype H/84/g3/40	51.5	95.5	20.2—LV
Paratype H/10/g3/4	48.4	96.7	17.8—LV

Remarks : The present specimens can be distinguished from most of the Jurassic astartids by their outline, almost mesial placement of the umbo and nature of the lunule.

Astarte orbicularis J. de C. Sowerby (1826, p. 35, pl. 520, fig. 2 = *A. rotundata* J. de C. Sowerby, 1835, index, p. 2; *non*. 1824) from the Bathonian of England has a similar outline and position of the umbo but can be distinguished from the present species by its strong inflation, well developed and very wide lunule and a crenulate margin. From *N. (N.) pandeyi* Maithani, just discussed, the species described here can be separated easily by its outline and mesial umbo. *A. venkatappayyai* Sahni and Prasad (1957, p. 431, text-figs. 1, 1a) has mesial umbones and very convex ventral margins but differs on account of its unequal dorsal margins, very coarse concentric ribs which are persistent throughout the surface and a crenulate margin. Besides, the form comes from a horizon as high as Tithonian-Neocomian.

A. equilatera Hudleston (Arkell, 1934, p. 237, pl. 33, fig. 10) has equal dorsal margins and mesial umbo but differs in being taller and more tumid, with longer dorsal margins and a conspicuously different ornamentation.

Two more specimens (Nos. H/84/g3/2 and H/47/f/10, both from Bed No. 15, and from SW of Lodai and N of

Boladi respectively) have been assigned provisionally to this new species, which have unequal dorsal margins (of which the antero-dorsal is concave), slightly different L/H ratio and a more anteriorly placed umbo.

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

Etymology : The species has been named in honour of Professor Dr. S. K. Agrawal, leader of the B.H.U. team investigating the Jurassic fauna of Kutch.

Neocrassina (Neocrassina) haboensis n. sp.
(Pl. I—11)

Material : Five left and four right valves.

Description : Shell of moderate size, trigonally sub-ovate, inequilateral, rather compressed. Umbo small, acute, prosogyrous, placed at about anterior-third of the shell-length. Antero dorsal margin straight to concave, postero-dorsal one gently convex and longer than the former; both slope equally from the umbo. Anterior and posterior ones small and convex; posterior one comparatively wider. Ventral margin symmetrically convex but for a shallow depression running obliquely from the umbo towards the postero-ventral corner of the shell; it is well marked in the dorsal half.

Surface ornamented with irregularly spaced, coarse, concentric ribs, prominent in the dorsal-half but weak and flattened ventrally.

Dentition in the right valve consists of a cardinal tooth bounded by two deep triangular pits at its either side and an elongated posterior lateral.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
Holotype H/28/i/97	42.0	84.5	low—RV

Remarks : All the nine specimens are broken here and there. Measurements of the holotype are at the last, entirely traceable, growth line.

The only species with which the present form bears some resemblance is *Astarte rexia* d'Orbigny (Cottreau, 1925, p. 145, pl. 38, figs. 15-17) which has, however, two oblique depressions over the surface in addition to its much salient, acute and more posteriorly placed umbo. *Astarte (Neocrassina?) cf. subdepressa* Blake & Hudleston (Agrawal, 1956b, p. 106, pl. 10, fig. 12) from the "Mebha Oolite (Callovo-Oxfordian)" of Jhura Hill is more ovate in outline and has stronger concentric ribbing. No other comparable form is known to the authors.

Horizon and Localities : Bed No. 15 (Dhrang Member—Lower Callovian), N of Boladi and S of Fulae.

Etymology : The trivial name is after the Habo Hill from where the specimens have been collected.

Neocrassina (*Neocrassina*) spp.
(Pl. I—9-10)

Material : One bivalved and one left valve specimen.

Description : The smaller specimen from Bed No. 1 is characterised by its trigonal outline, pointed prosogyrous umbones placed at anterior-fifth of the length, widely elongate but deep lunule, lanceolate but long escutcheon bounded by sharp carinae, 17 sharp, almost equidistant, raised concentric ribs ornamenting the surface, and crenulated internal margin.

The bigger specimen of more or less subovate outline is compressed and has its depressed prosogyrous umbo placed at about anterior-fourth of the shell-length. The lunule is small, narrow, and well excavated, while the escutcheon is long, slit-like. Its eroded surface has some remnants of very fine concentric threads. Dentition consists of two cardinals and one posterior lateral teeth.

Dimension :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/98/42 ..	19.5	82.0	51.3—BV
H/113/8 ..	26.8	91.4	20.1—LV

Remarks : The former specimen closely resembles *Astarte sakamotoensis* Tamura (1960, p. 286, figs. 1-2) from the Upper Jurassic of Japan, which, however, has fewer (6 to 10) and thicker concentric ribs. Another closely comparable form *A. cuneata* J. Sowerby (1818, p. 86, pl. 137, fig. 2) is distinguished by its larger size and smooth internal margin.

The latter specimen has its closest ally in *A. ovata* Smith (Arkell, 1934, p. 231, pl. 32, figs. 1-12; text-figs. 55-56) from which it differs in its more anteriorly placed, less prominent umbones and weakly developed teeth. *A. kenti* Cox (1965, p. 85, pl. 12, figs. 6-7) from the Bajocian (?) of Tanzania has an almost straight anterior margin, slightly more posteriorly placed umbo and a smaller posterior margin. *A. pindiroensis* Cox (1965, p. 86, pl. 13, figs. 4-5) differs only a little in having slightly less widely curved anterior margin and a little more posterior position of its umbo.

Horizons and Localities : Bed No. 7 (Jhikadi Member—Middle Callovian), N of Habae; and Bed No. 1 (Lodai Member—Oxfordian), E of Rudra Mata.

Subgenus *Pruvostiella* AGRAWAL, 1956a

Type Species : *Astarte* (*Pruvostiella*) *freneixae* Agrawal, 1956a. "Callovo-Oxfordian"; Kutch.

Remarks : Chavan (1969, in Moore and Others, p. N567) has regarded *Pruvostiella* as subjective synonym of *Neocrassina*. The type species of *Pruvostiella* did not show the hinge features to its author. Even till today not a single specimen of its type species could be found showing

the dentition. However, other species referred to under this subgenus, e.g. *Astarte unilaterialis* J. de C. Sowerby, *A. scyrtalis* Holdhaus, etc., show dentition similar to that of *Neocrassina*. Therefore, *Pruvostiella* is related to *Neocrassina* and not *Astarte* J. Sowerby. The external morphology, particularly the flat and depressed umbo, high tumidity in the dorsal region, presence of very coarse and angular concentric ribs in the dorsal part only, is enough to merit its subgeneric rank under the genus *Neocrassina*.

Neocrassina (*Pruvostiella*) *freneixae* AGRAWAL
(Pl. I—14)

Astarte (*Pruvostiella*) *freneixae* Agrawal, 1956a, p. 436 pl. 21, figs. 5-6.

Astarte (*Pruvostiella*) *freneixae* Agrawal; Maithani, 1968, p. 514, pl. 33, figs. 4-5, 8.

Astarte (*Pruvostiella*) *murthyi* Maithani, 1968, p. 515 (*pars.*), pl. 33, figs. 1-3.

Material : Five bivalved specimens.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/90/10 ..	39.1	97.2	55.5
H/94/1 ..	52.5	89.5	57.3

Remarks : The present specimens match well with the type specimens in outline. L/H ratio and ornamentation. The only difference is that the present examples are slightly compressed, in which respect, however, they are similar to specimens from south of Bhuj (Singh, 1961, p. 118, fig. 66) and examples in the G.S.I. collection (Type Nos. 17954-56) belonging to this species.

Maithani's *murthyi* (1968, p. 515) scarcely differs from the species under study in dimensional proportions, outline and ornamentation. However, the G. S. I. Type No. 17960 of *murthyi* is a specimen much different from the rest (Type Nos. 17957-59). It, in fact, belongs to *Neocrassina rajnathi* Agrawal, as pointed out earlier, (p. 50, this paper).

Horizons and Localities : Bed No. 2 (Rudra Mata member—Upper Callovian), E of Rudra Mata; and Bed No. 1 (Lodai Member—Oxfordian), E and NE of Rudra Mata, S of Kunaria and Kotai.

Neocrassina (*Pruvostiella*) cf. *freneixae* AGRAWAL
(Pl. I—15)

Material : Two bivalved specimens.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/98/26 ..	51.8	89.2	51.7
H/98/29 ..	46.9	89.1	52.0

Remarks : Both the present specimens approximate

the typical examples of *N. (P.) freneixae* Agrawal, just described, in outline and L/H ratio but they are slightly less inflated; in typical *freneixae* this parameter varies from 55-64 percent of the length of the shell. They can also be distinguished from *N. (P.) unilateralis* (J. de C. Sowerby), discussed ahead, by their taller outline and a more dorsal position of maximum inflation.

Horizon and Locality : Bed No. 1 (Lodai Member—Oxfordian), E of Rudra Mata.

Neocrassina (Pruvostiella) unilateralis (J. DE C. SOWERBY)
(Pl. I—18, Pl. II—6)

Astarte unilateralis J. de C. Sowerby, 1840 a, p. 327, pl. 21, fig. 14 and expl.

Astarte hermanni Oppel; Holdhaus, 1913, p. 440, pl. 99, figs. 7-11, 14.

Astarte unilateralis J. de C. Sowerby; Cox, 1965, p. 87, pl. 14, figs. 2-3.

Material : Nine specimens.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/1/70 ..	48.0	79.2	53.1—BV
H/98/27 ..	51.5	82.3	45.6—BV
H/98/20 ..	53.7	85.1	50.5—BV
H/15/43 ..	54.0	87.0	25.0—RV

Remarks : All the present specimens match well with those from Spiti (G. S. I. collection) and Kutch (BHU collection) in general shape, size and ornamentation. However, the L/H ratios in the present examples show a tendency to approach nearer that of *freneixae* but the latter is more inflated, more trigonal in outline and having its region of maximum inflation situated more dorsally. Representatives from Spiti show a little bulging of their anterior and unlike specimens from other areas figured in literature. But this feature alone does not seem enough even for a subspecific separation.

Singh (1961, p. 120, figs. 73a-c) recorded the species precisely for the first time from the Callovian and Oxfordian beds from south of Bhuj (in Kutch). Cox (1965, p. 88), too, had opined similarly, that the Kutch astartids (inclusive of forms like *A. major* J. de C. Sowerby, *A. soerbyana*, etc.) were in his possession at least till the writing of Cox's 1965 monograph.

Maithani's specimens of *unilateralis* (1968, p. 513, pl. 32, fig. 6), in fact, belong to *N. (N.) rajnathi* as mentioned earlier and hence, this is the first record of the species from the present area. It also confirms Singh's observation in regard to its stratigraphic range in Kutch.

Horizons and Localities : Bed No. 7 (Jhikadi Member—Middle Callovian), N of Jhikadi; Bed No. 4 (Rudra Mata Member—Upper Callovian, S of Lodai; Bed No. 2 (Rudra Mata Member—Upper Callovian), E of Rudra Mata; and Bed No. 1 (Lodai Member—Oxfordian), S and SW of Lodai, and E of Rudra Mata.

Neocrassina (Pruvostiella) panti n. sp.

(Pl. I—12-13, Pl. II—1)

Astarte scytalis Holdhaus; Cox, 1935, p. 180, pl. 19, figs. 4-5 (non Holdhaus).

Material : Four bivalved specimens.

Description : Shell of moderate size, ovately subquad-rangular in outline, and highly inequilateral. Umbo obtusely pointed, depressed, prosogyrous, situated a little more anteriorly to the anterior-quarter of the shell-length. Postero-dorsal margin arched and posterior one almost straight, the two making a rounded-off obtuse angle of about 135°. Ventral margin moderately arched, merging smoothly in the posterior and straight to feebly concave anterior one in smooth curves. Maximum inflation of the shell in dorsal-third region at about anterior-two-fifths of the shell-length. A weak, flattened ridge may extend from the umbo to the postero-ventral corner of the shell. Lunule ovate, wide and deep; exocutcheon elongated and deep; both bounded by sharp ridges.

Surface ornamented with coarse, equidistant, angular, concentric ribs confined between the umbo and region of maximum thickness beyond which they give way to weak rugae. Interior not seen.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
Holotype H/25/8 ..	47.9	83.5	58.5
Paratype H/106/17 ..	40.6	84.7	58.6

Remarks : The present specimens, which match well with those figured by Cox (1935, p. 180, pl. 19, figs. 4-5), and Singh (1961, p. 122, fig. 74) as *A. scytalis* in outline and inflation, are much taller and gibbose than the type specimens of the species (Holdhaus, 1913, p. 444, pl. 100, figs. 2-3). These differences, unconnected by intermediate forms, are sufficient enough to separate these specimens under a new name. Cox has not given the dimensions of his specimens and states that they are either equally or less gibbose. But a measurement of his figure 4 shows its inflation to be more than 52 per cent of the length, which is decidedly much more than that of the type specimens (maximum being 48%). Hence, at least his figured specimen is conspecific with the present new form.

N. (P.) freneixae Agrawal, discussed earlier, is still taller and more inflated with a bulging anterior border thereby producing a different outline. Further, the present species can be distinguished from *unilateralis*, also discussed above, by its different outline and a slightly greater thickness.

An isolated right valve (No. H/74/1; Pl. I—12) from Bed No. 5, SW of Lodai, approximates in general outline and ornamentation with the type specimens

but is much compressed (thickness of the RV—17.2% of the length). It most probably belongs to an undescribed form but its naming has been deferred due to its poor preservation and has been tentatively referred to here under the present species.

Horizon and Localities : Bed No. 1 (Lodai Member-Oxfordian), SW of Lodai, NW of Jhikadi and S of Fulae.

Etymology : The species has been named after Shri S. C. Pant, Director, Palaeontology Division, Western Region, Geological Survey of India in appreciation of his contributions to the Indian palaeontology.

Neocrassina (Pruvostiella) sowerbyana (HOLDHAUS)

Astarte sowerbyana Holdhaus, 1913, p. 443, pl. 99, figs. 12-13, 15; pl. 100, figs. 1.

Astarte sowerbyana Holdhaus ; Cox, 1965, p. 88, pl. 13, fig. 6.

Material : One right valve.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/74/3	48.8	78.1	17.6

Remarks : This specimen, though not satisfactorily preserved, agrees well with the type of the species in its outline, proportionate dimensions and region of maximum thickness.

Cox (1965, p. 88) has regarded *A. major* J. de C. Sowerby synonymous with *sowerbyana*, considering the former a junior homonym of *A. elegans major* Zieten. In all probability the two forms do not belong to the same genus. Further, *major* and *sowerbyana* can not be considered conspecific since the size, shape and ornamentation of these two forms are indeed different. Besides, *major* occurs at a horizon higher than that of the present find. Therefore, the two are deemed as different species.

Maithani's two specimens (G. S. I. Type Nos. 17952-53) referred to as *sowerbyana* (1968, p. 514, pl. 32, figs. 5-7), but of which one (No. 17952) has been figured as *A. (P.) major* J. de C. Sowerby (Maithani, 1968, pl. 32, fig. 5), are fragmentary and are nearer to *A. scytalis* Holdhaus, in outline. Thus, this Spiti Shale taxon remained unrepresented in Kutch until recorded by Kanjilal (1974, p. 353).

Horizon and Locality : Bed No. 5 (Jhikadi Member—Middle Callovian), SW of Lodai.

Neocrassina (Pruvostiella) spitiensis (STOLICZKA)
(Pl. II—2-4)

Astarte spitiensis Stoliczka, 1865, p. 91, pl. 9, fig. 1, text-fig. 9.

Astarte spitiensis Stol. Holdhaus, 1913, p. 444, pl. 100, figs. 4-8.

Astarte spitiensis Stol. ; Trechmann, 1923, p. 279, pl. 13, fig. 1.

Astarte spitiensis Stol. ; Marwick, 1953, p. 107, pl. 11, figs. 13, 15.

Astarte (Pruvostiella) spitiensis Stoliczka ; Agrawal, 1956b, p. 109, pl. 10, fig. 3.

Material : About two dozen specimens—all bivalved.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/124/48	59.4	85.7	42.8
H/124/45	60.2	86.2	43.9
H/96/18	70.5	86.4	41.0
H/124/50	63.9	86.9	48.5
H/124/47	58.4	87.7	42.0

Remarks : These specimens are trigonally ovate, with a rather straight postero-dorsal, and convex ventral margins. They agree satisfactorily with the specimens studied by Holdhaus, particularly the G. S. I. Type No. 10255 (Holdhaus, 1913, pl. 100, fig. 5), except for a slight variation in the curvature of anterior margin. This is the first record of the species from the present area.

Horizons and Localities : Bed No. 7 (Jhikadi Member—Middle Callovian), N of Jhikadi ; and Bed No. 6 (Jhikadi Member—Middle Callovian), NE of Rudra Mata.

Neocrassina (Pruvostiella) subtriangularis n. sp.
(Pl. I—17)

Material : Holotype only.

Description : Shell of medium size, subtrigonal and inequilateral. Umbones angular, pointing forward and placed at anterior-third of the shell-length. Antero-dorsal margin feebly concave, the postero-dorsal feebly arched, both converging at the umbo making an angle of about 110°. Anterior and posterior margins equally curved; ventral one symmetrically arched. Maximum thickness in the dorsal two-fifths region, slightly behind the umbones. Lunule lanceolate, deeply impressed; escutcheon elongated, well impressed; both limited by sharp ridges and traversed by oblique threads.

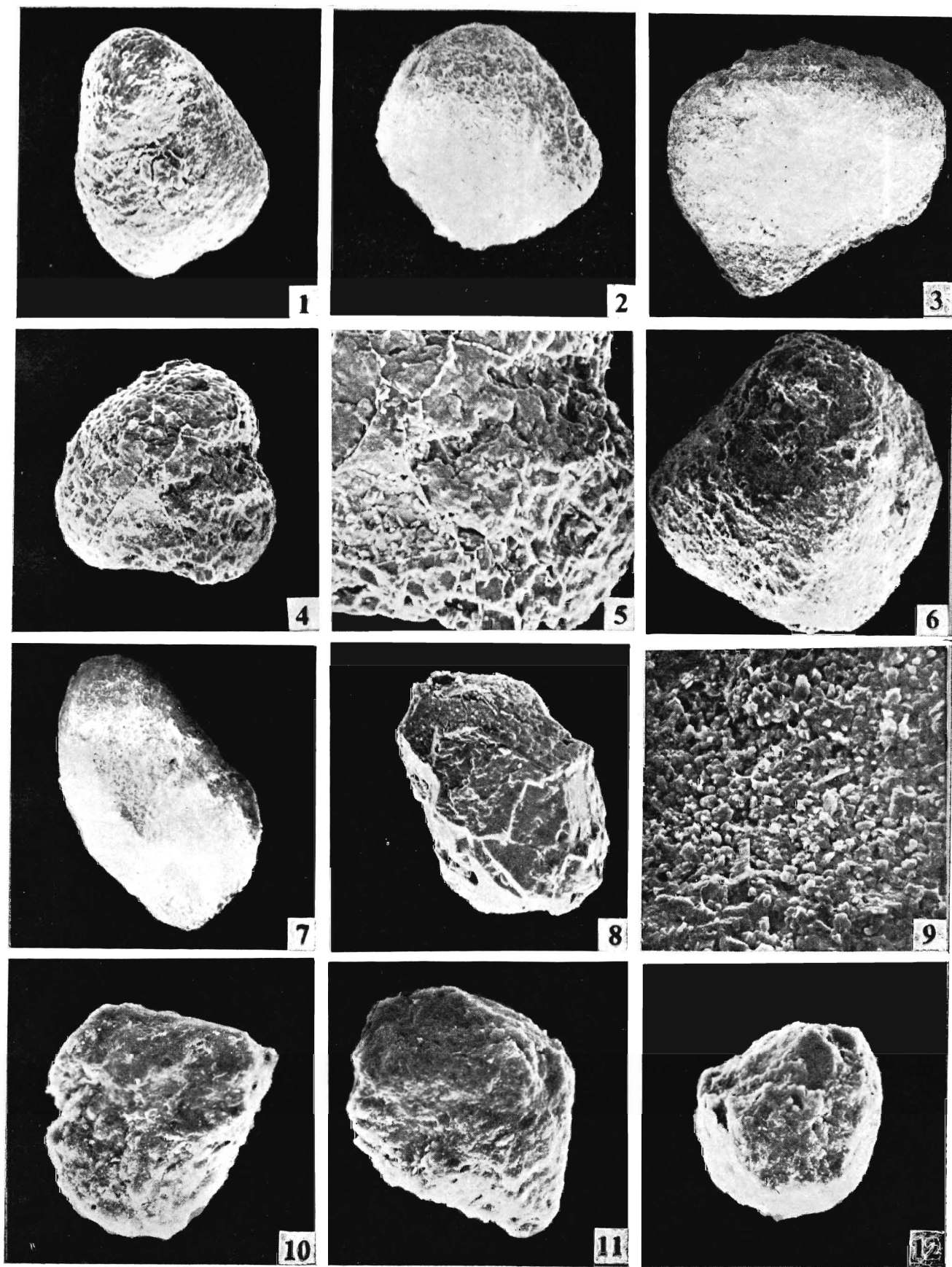
Surface ornamented with angular concentric ridges, separated by interspaces of equal width; these ridges are replaced by irregularly spaced comarginal rugae in the middle part of the surface and ultimately become indistinct in the ventral-third region.

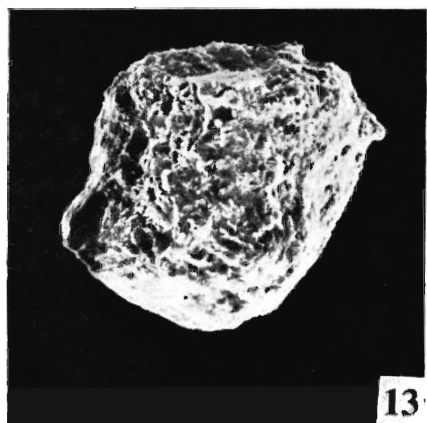
Dimensions :

sp. No	Length (mm)	Height (%)	Inflation (%)
H/63/5	45.8	75.3	50.0—BV

Remarks : Although this new species is based on an unique specimen, its peculiar outline readily distinguishes it from all known Jurassic taxa of *Pruvostiella*, justifying its distinct specific status.

Astarte higoensis Tamura (1959, p. 28, pl. 5, figs. 11-12) from Sakamoto Formatio (Tithonian) of Japan is somewhat similar in dimensional proportions and apical angle but differs from the present species by its rectangular outline, indistinct and more anteriorly placed umbo and a shallow lunule, besides higher horizon.

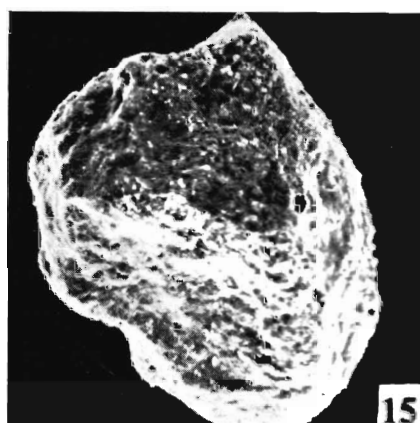




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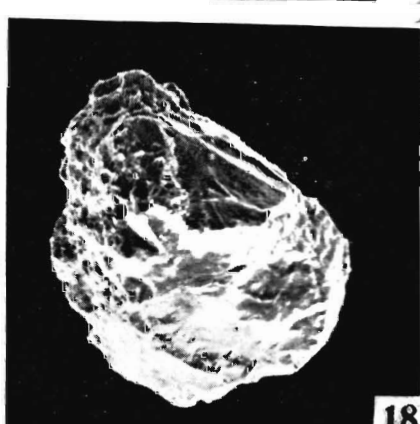
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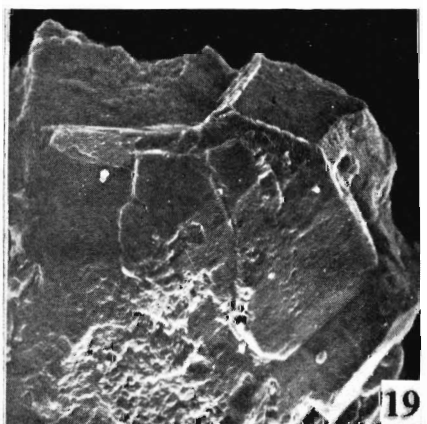
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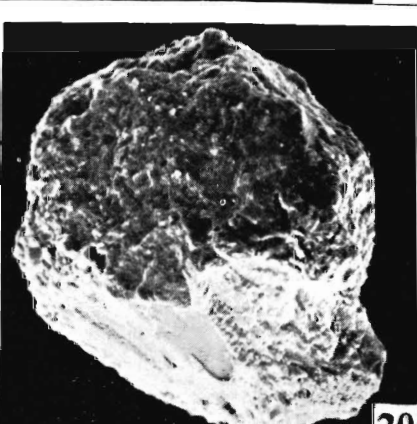
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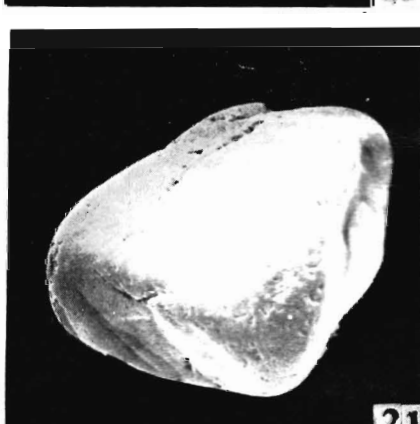
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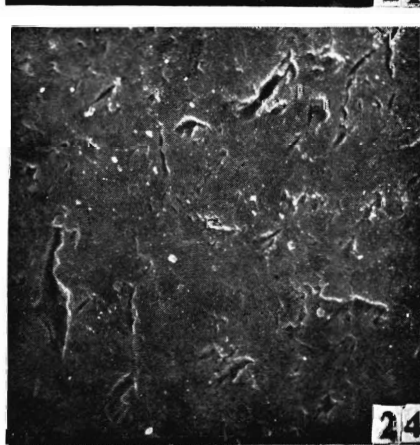
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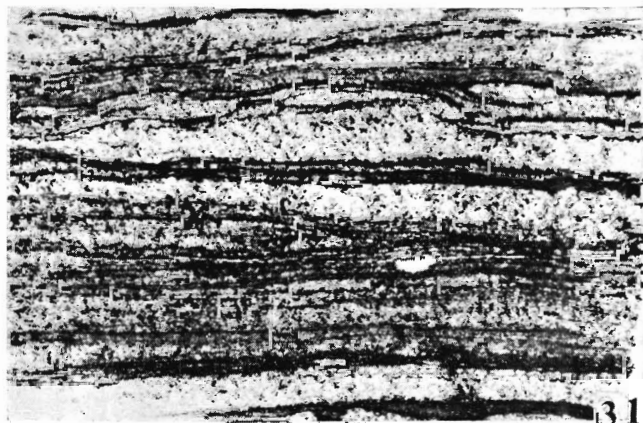
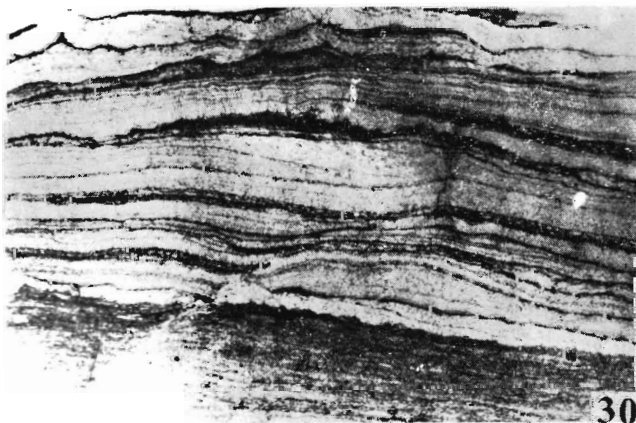
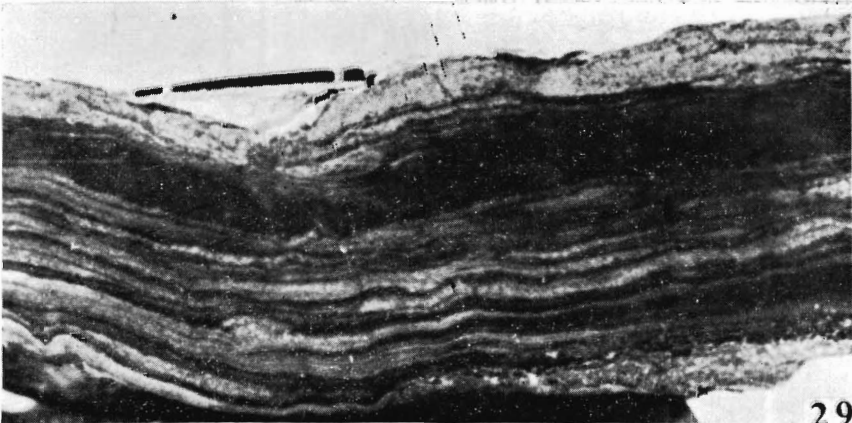
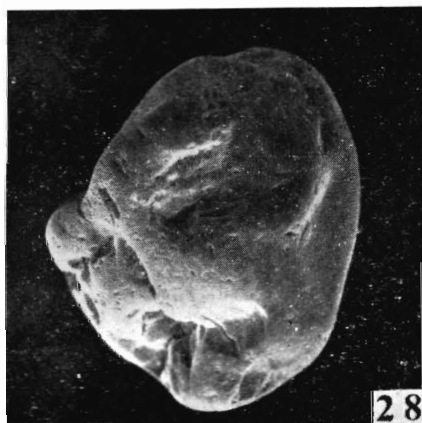
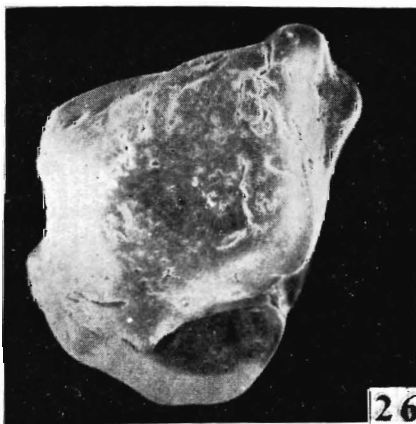
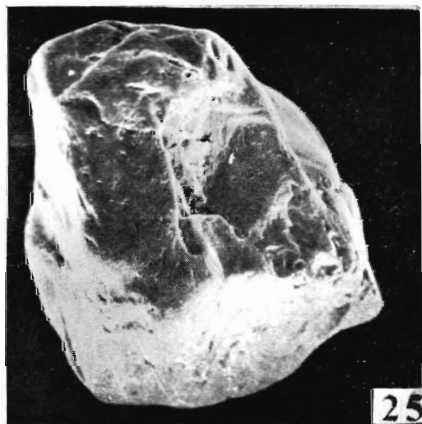
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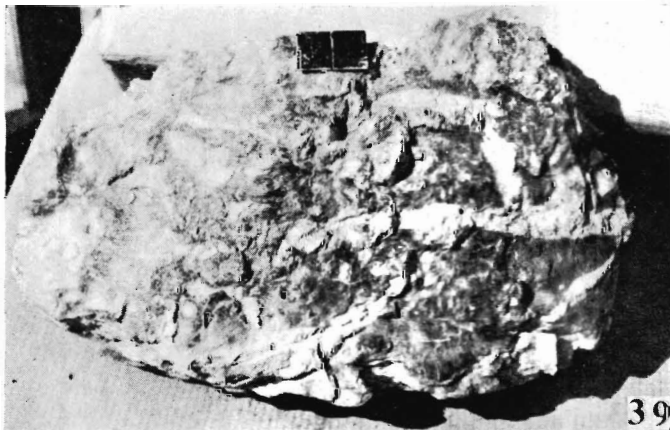
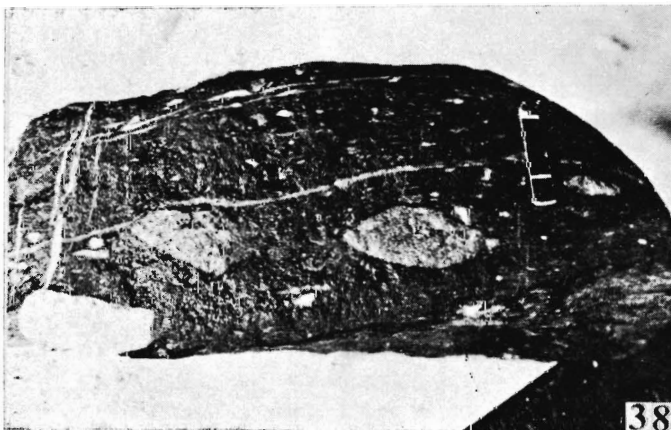
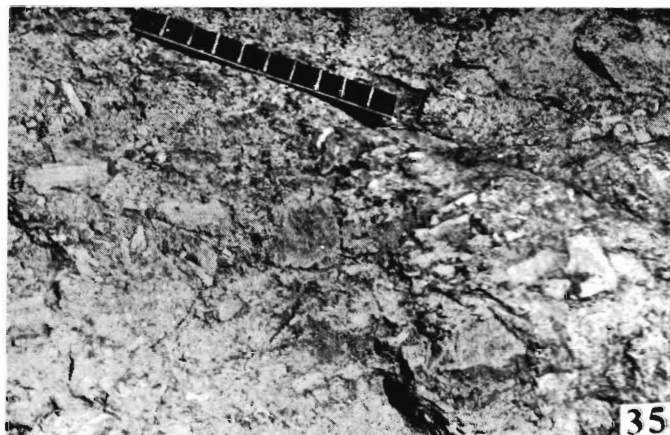
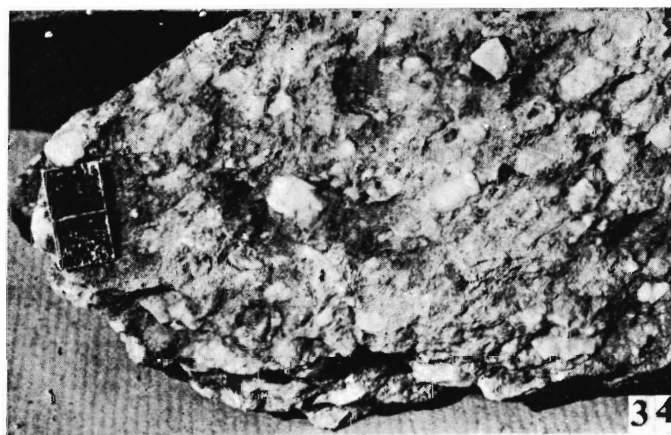


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Horizon and Locality : Bed No. 2 (Rudra Mata Member—Upper Callovian), SW of Lodai.

Etymology : The name refers to the subtrigonal outline of this species.

Subgenus *Coelastarte* BOEHM, 1893

Type Species : *Astarte excavata* J. Sowerby, 1819. Bajocian; England.

Remarks : Examples of *Coelastarte* were first collected in India from the Bela Island (Rai, 1972), followed by those from the Habo Hill (Kanjilal, 1974) and Mouwana (Kacker, 1977)—all in Kutch. However, the Bela and Mouwana forms are yet to be formally described and illustrated.

Neocrassina (*Coelastarte*) aff. *colteausia* (D'ORBIGNY)
(Pl. II—5)

Material : A left valve, attached on the inner side of a left valve of *N. (N.) pandeyi* Maithani.

Description : Shell rather small, subquadrate, thin, inequilateral, umbo minute, depressed, obtusely angular, prosogyrous, situated at about anterior-quarter of the shell length. Postero-dorsal margin straight, almost horizontal, meeting the gently arched posterior one in a broad curve. Ventral margin almost straight, joining the posterior one in a rounded-off right angle. Anterior margin mostly broken, but the growth lines suggest it to have been strongly convex with a little concavity below the umbo. A slightly swollen region runs from the umbo to the postero-ventral corner marking the maximum inflation of the shell.

Shell-surface smooth but for fine, comarginal growth-lines.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/84/g3/10a :	c. 30.0	66.7	10.0

Remarks : *A. (C.) colteausia* d'Orbigny (Arkell, 1936, p. 369, pl. 51, figs. 16-17) from the Corallian of England is its nearest ally, from which it differs in being less elongate, in having more posteriorly situated umbo and a broader postero-dorsal angle. The holotype of the species is not well preserved and not figured (Cottreau, 1929, p. 101). *A. aytonensis* Bean MS (Lycett, 1863, p. 78, pl. 40, fig. 13) from the Bathonian of England is another closely comparable species which is, however, more elongated, with slightly more posteriorly placed umbo, smaller postero-dorsal angle and more prominent ornamenting features. *A. (C.) rectangula* Arkell (1934, p. 248, pl. 33, fig. 16) from the Upper Oxfordian of England differs in its sinuate ventral margin.

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

Genus *Nicaniella* CHAVAN, 1945

Type species : *Astarte cummins* ZITTEL & GOUBERT, 1861. Sequanian; W. France.

Subgenus *Nicaniella* s.s.

Nicaniella (*Nicaniella*) *extensa* (PHILLIPS)
(Pl. II—8)

Astarte extensa (Phillips) ; Arkell, 1934, pl. 34, figs. 21-30.

Material : Eight left and two right valves.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/99/80	.. 11.0	81.8	23.6—LV
H/99/88	.. 12.0	89.2	25.0—RV
H/99/73	.. 11.0	90.9	32.7—LV

Remarks : All the specimens are well conformable to *extensa* which is a very variable species. Arkell (1934, p. 237) states : "lunule rather elongated and not sharply bounded", but in most of the present examples it is bounded by fairly sharp ridges. *Astarte* (*Nicaniella*) *extensa* (Phillips) *badiensis* Agrawal (1956b, p. 106, pl. 10, fig. 11) is distinctly more quadrate, more inflated and devoid of concentric striations in the interspaces.

This is the first record of the species from the present area. It has been recorded outside India from the Oxfordian and the Kimmeridgian horizons only. The present find from the Upper Callovian, therefore, connects the occurrence of its 'variety'—*badiensis* Agrawal in the Middle Callovian.

Horizons and Localities : Bed No. 4 (Rudra Mata Member—Upper Callovian), S of Lodai ; and Bed No. 2 (Rudra Mata Member—Upper Callovian), E of Rudra Mata.

Nicaniella (*Nicaniella*) *pisiformis* (J. DE C. SOWERBY)
(Pl. II—7)

Astarte pisiformis J. de C. Sowerby, 1840a, p. 327, pl. 21, fig. 15.

"*Astarte*" *pisiformis* J. de C. Sow. ; Agarwal, 1956b, p. 103.

Material : Several specimens associated with *Nuculoma wynnei* Cox, *Nuculana* (*Praesaccella*) *juriana* Cox, *Indoculana calloviensis* (Kanjilal & Singh), *Entolium partitum* (J. de C. Sowerby), *Meleagrinnella echinata* (Smith), etc. on different slabs.

Remarks : The present examples, though embedded in slabs, match very well with the specimens in B. H. U. collection from Jhura dome (Agrawal, 1956b, p. 103), Nara dome (Shukla, 1958, p. 164, pl. 10, figs. 1-2), Fakirwari-Walakhavas Tank area (Singh, 1961, p. 117) and Bela Island (Rai, 1972, p. 233, pl. 12, figs. 12-13) identified as this species, in their outline, gibbosity, position of umbo and ornamentation.

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

Horizons and Localities : Bed No. 13 (Dhrang Member—Lower Callovian), S. of Kotai ; Bed No. 4 (Rudra Mata Member—Upper Callovian), S of Lodai ; and Bed No. 2 (Rudra Mata Member—Upper Callovian), E of Rudra Mata.

Nicaniella (Nicaniella) nummus (SAUVAGE)

Astarte nummus Sauvage ; Arkell, 1934, p. 241, pl. 31, figs. 4, 4a ; pl. 34, figs. 37, 37a.

Material : One imperfect bivalved specimen and an isolated left valve.

Dimensions :

Sp. No.	Length (mm)	Height (%)	Inflation (%)
H/110/26 ..	13.5	94.1	17.8—LV

Remarks : From the L/H and L/I ratios, outline and ornamentation given by Arkell (1934, p. 241, pl. 31, figs. 4, 4a ; pl. 34, figs. 37, 37a) in the text, *A. extensa* (Phillips) and *A. nummus* Sauvage would hardly seem different species. However, a close observation of the figures shows that *nummus* is usually more flat, rather tall, with slightly greater number of concentrics which tend to fade ventrally and without any postero-dorsal ridge. It is on the basis of these features that the present individuals have been isolated from *extensa* and referred to *nummus*.

Though usually found in Corallian beds, the species also occurs in Callovian (Arkell, 1934), and therefore, the present record is not unusual. Previously the species was found (though unpublished) in Kutch from Bela Island only (Rai, 1972, p. 232, pl. 11, fig. 14b).

Horizons and Localities : Bed No. 4 (Rudra Mata Member—Upper Callovian), N of Paiya ; and Bed No. 2 (Rudra Mata Member—Upper Callovian), E of Rudra Mata.

JURASSIC ASTARTINAE OF KUTCH

Representatives of the subfamily Astartinae d'Orbigny are one of the most dominant groups of bivalves in the Jurassic rocks of Kutch mainland. These are distributed mainly in the Callovian and Oxfordian strata. In the Habo Hill, most of the fossiliferous beds contain one or the other form of this group (Table I). Some of the taxa, however, have been found to occur exclusively in certain bed or beds, e.g. *A. (A.) pandei* Agrawal in the Oxfordian, *N. (N.) rajnathi* Agrawal in Upper Callovian and Oxfordian, *N. (N.) pandeyi* Maithani in the Lower and Middle Callovian, *N. (P.) freneixae* Agrawal in the Upper Callovian and Oxfordian, *N. (P.) unilateralis* (J. de C. Sowerby) in the Middle and Upper Callovian and also Oxfordian, *N. (P.) spitiensis* (Holdhaus) in the Middle Callovian,

and *N. (N.) extensa* (Phillips) and *N. (N.) nummus* (Sauvage) in the Upper Callovian. Several of these taxa are found in other parts of Kutch as well and show a more or less similar stratigraphic position.

A. (A.) pandei, besides the present find, was also recorded from the Jhura dome (Agrawal, 1956b, p. 102) and east of Ler (Agrawal & Kachhera, 1979, Table I, p. 133) from beds yielding mayaitids. Since mayaitids are exclusively Oxfordian, *pandei* may be considered to broadly represent that horizon.

N. (N.) rajnathi was previously known from the Oxfordian only (Agrawal, 1956b, p. 104 ; Singh, 1961, p. 125 ; Maithani, 1968, p. 511 ; etc.). In the light of the present finds, this is to be considered to range between Upper Callovian and Oxfordian. Initially, *pandeyi* was recovered from a Lower Callovian bed only (=Bethonian of Maithani, 1968, p. 512). In Bela Island, it occurs in Bed No. 20 (Rai, 1972, p. 225) which is of (lower) Callovian age, (Singh & Rai, 1980, p. 72). The range of *pandeyi* has to be expanded as Lower to Middle Callovian instead of Lower Callovian only on the basis of the present observation.

Previously *freneixae* was known from the Oxfordian horizon only (Agrawal, 1956b, p. 108 ; Singh, 1961, p. 118 ; Maithani, 1968, p. 514 ; Agrawal & Kachhara, 1979, Table I, p. 134). In Habo Hill, its range is like that of *rajanathi*. *N. (P.) unilateralis* was recorded from the Upper Callovian and Oxfordian beds by Singh (1961, p. 120). In Kutch, this species has also been recorded from east of Ler (Agrawal & Kachhara, 1979, Table I, p. 134) from Bed Nos. 7, 5 and 2 which have been regarded by them as Callovian (1979, Table III, p. 143). The ammonoid assemblage in east of Ler (Agrawal & Kachhara, 1979, Table II) suggests that the beds in question are probably not older than the Middle Callovian and younger than the Upper Callovian. The present authors have collected this species (vide *supra*) from the Middle Callovian to Oxfordian beds. The precise horizons of J. de C. Sowerby's (1840a) and Holdhaus' (1913) specimens are not known. Cox (1965, p. 87) has recorded *unilateralis* from the Callovian? of Tanganyika. Thus, a Middle Callovian—Oxfordian age may be assigned to this species.

As mentioned earlier, the Spiti Shale astartid—*sowerbyana*—was first recorded from Kutch by Kanjilal (1974, pt 353). Although, Cox (1965, p. 88) considers *A. major* (recorded from a few places in Kutch by J. de C. Sowerby, 1840b) and *sowerbyana* synonymous, the present authors differ and regard them as different. The species in question has been collected from a bed yielding the ammonoids *Subkosmatia ramosa* Spath, an *Idiocyclaceras*, *Reineckeia (Reineckeia) crispa* (Spath), *R. (R.) ravana* Spath, *R. (R.) waageni* Till, etc.—an assemblage indicating a Middle Callovian age. In Tanganyika, however,

Table 1. Range-chart of the astartids from the Habo Hill and their ammonoid association.

Species	Lodai Member	Rudra Mata M.				Jhikadi M.					Dhrang M.				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. <i>A. (A.) pandei</i> Agrawal	*														
2. <i>A. (A.)</i> sp. indet.															*
3. <i>N. (N.) rajnathi</i> Agrawal	*		*												
4. <i>N. (N.) singhi</i> sp. nov.	*														
5. <i>N. (N.)</i> sp. indet.															*
6. <i>N. (N.) pandeyi</i> Maithani								*					*		*
7. <i>N. (N.) agrawali</i> sp. nov.															*
8. <i>N. (N.) haboensis</i> sp. nov.															*
9. <i>N. (N.)</i> spp.	*							*							
10. <i>N. (P.) freneixae</i> Agrawal	*	*													
11. <i>N. (P.)</i> cf. <i>freneixae</i> Agrawal	*														
12. <i>N. (P.) unilateralis</i> (J. de C. Sowerby)	*	*	*				*								
13. <i>N. (P.) panti</i> sp. nov.	*														
14. <i>N. (P.) sowerbyana</i> (Holdhaus)						*									
15. <i>N. (P.) spitiensis</i> (Holdhaus)		*													
16. <i>N. (P.) subtriangularis</i> sp. nov.		*													
17. <i>N. (C.)</i> aff. <i>cotteausea</i> (d'Orbigny)															*
18. <i>N. (N.) extensa</i> (Phillips)		*	*											*	
19. <i>N. (N.) pisiformis</i> (J. de C. Sowerby)		*	*											*	
20. <i>N. (N.) nummus</i> (Sauvage)		*	*												

- Bed No. 1. Mayaitids, *Alligaticeras obliquiplicatum* (Waagen), *Perisphinctes* (*Dichotomosphinctes*) *helenae* de Riaz, *Peltoceras* (*Peltoceras*) *semi-rugosus* (Waagen), *P. (Peltomorphites) aegoceroideus* (Waagen), etc.
- Bed No. 2. *Hecticocera* (*Sublunuloceras*) *lairensis* (Waagen) *plana* (Spath), *Obtusicoelites ushas* Spath, etc.
- Bed No. 3. *Hubertoceras omphalodes* (Waagen), *H. hubertus* Spath *densicostatus* Spath, *Subgrossowria intermedia* Spath, *Orionoids?* *anguinus* Spath, etc.
- Bed No. 5. *Reineckeia* (*Reineckeia*) *crispa* (Spath), *R. (R.) ravana* Spath, etc.
- Bed Nos. 7-5. *Subkossmatia* spp. and *Idiocycloceras* spp.
- Bed No. 7. *Eucycloceras eucyclum* (Waagen).
- Bed Nos. 15-12. Macrocephalitids, etc.

the form has been reported from the Upper Oxfordian and Upper Kimmeridgian beds (Cox, 1965, p. 88). From east of Ler the taxon has been found to occur in a bed immediately below the mayaitids—yielding horizon (Agrawal & Kachhara, 1979, Table I, p. 134). This bed, therefore, may be considered of Upper Callovian age. On the whole the species appears long ranging (from Middle Callovian to Upper Kimmeridgian) but in Kutch so far, it is known from Callovian only.

Agrawal (1956b, p. 109) described for the first time the Himalayan form, *spitiensis*, from his Bed No. 1 of the Jhura dome (Kutch) yielding the mayaitids. The second record was by Kanjilal (1974, p. 354) from the Middle Callovian beds of the Habo Hill. The earlier records from the Himalaya does not reveal the exact stratigraphic level of the taxon. The New Zealand examples of this species are from Bathonian and Callovian horizons (Trechmann, 1923; Marwick, 1953). Agrawal and

Kachhara have recorded the form from their Bed Nos. 14, 2 and 1 (1979, Table I, p. 134). The ammonoid evidence suggests the former two of these beds of Callovian and the last one of Oxfordian age respectively. Thus the stratigraphic range of *spitiensis* is long, from Bathonian to Oxfordian, but in Kutch no Bathonian representative has been found so far.

The form *N. (N.) extensa* was recorded for the first time from the Upper Callovian of Kutch by Kanjilal (1974, p. 358) although its variety *badiensis* was known from a Middle Callovian bed much earlier (Agrawal, 1956b, p. 106). Subsequently the taxon was reported by Agarwal and Kachhara (1979, Table I, p. 133), and Agrawal and Kacker (1980, Table 3, p. 639) from Callovian-Oxfordian, and Callovian beds respectively. Thus, in Kutch the form appears to range throughout the Callovian and Oxfordian, though elsewhere it is found in slightly younger horizons. *N. (N.) pisiformis* is a fre-

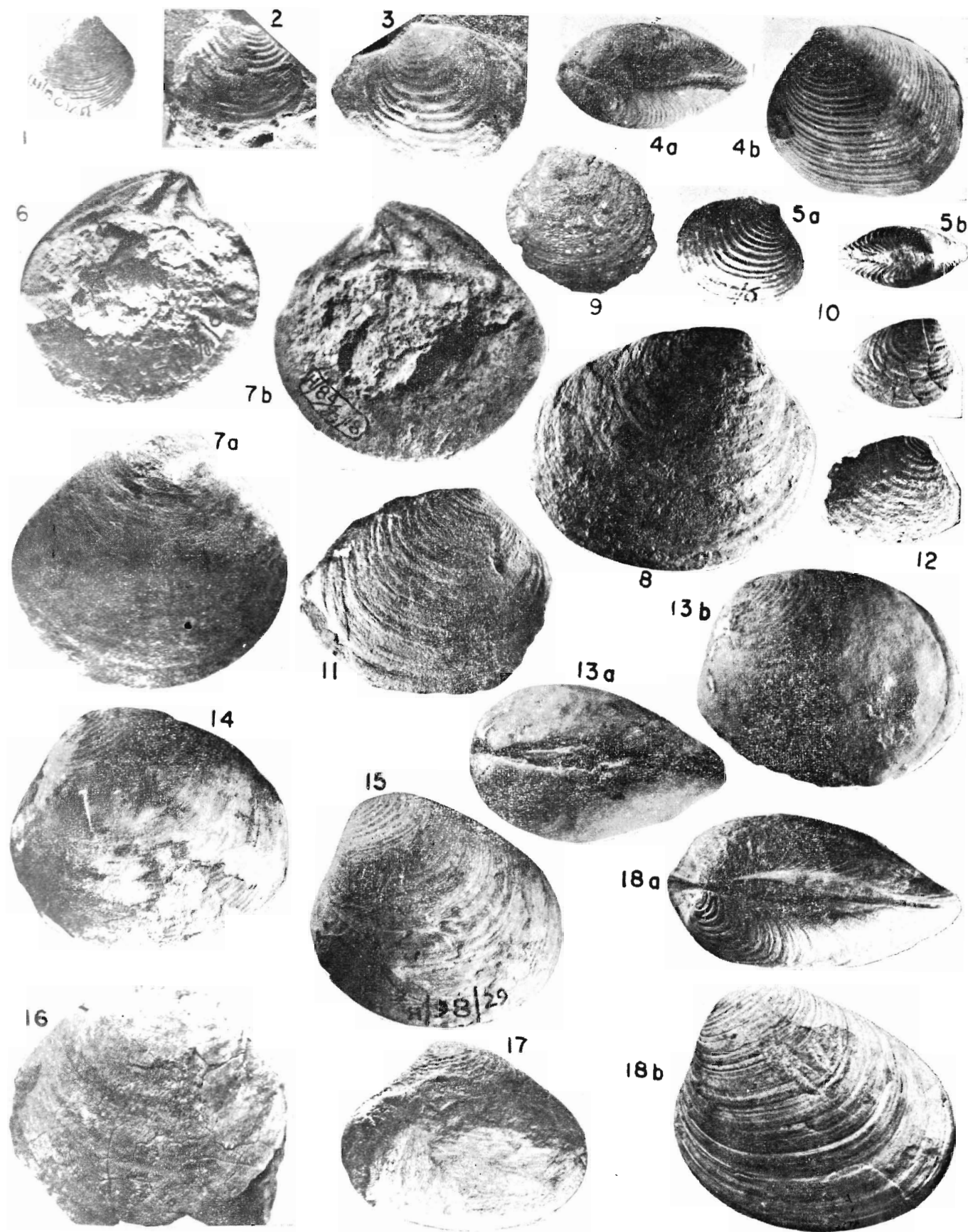
quently occurring astartid in Kutch found commonly in the Callovian beds. *N. (N.) nummus* was recorded from Kutch for the first time by Rai (1972, p. 232) from his basal Callovian beds, followed by Kanjilal (1974, p. 360) from the Upper Callovian beds, Agrawal and Kachhara (1979, Table I, p. 133), and Agrawal and Kacker (1980, Table 3, p. 639)—both from the Callovian horizons. Considering Krenkel's Callovian form *Astarte depressa* (1915, p. 319) as synonymous with *nummus* (Arkell, 1934, p. 241), the taxon's total range is from Callovian to Corallian, although in Kutch it has not been recorded outside the Callovian.

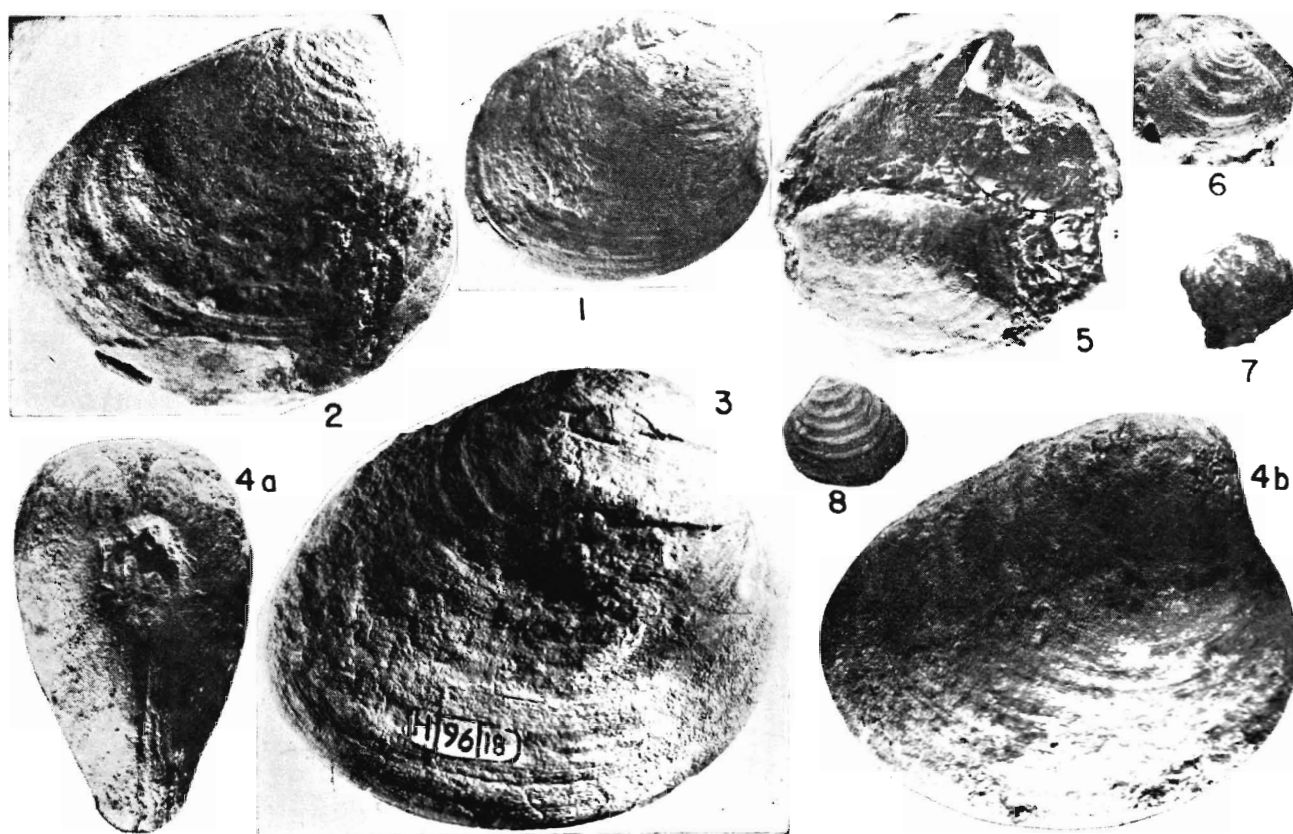
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EXPLANATION OF PLATES

All figures are in natural size unless otherwise stated.

PLATE I

1. *Neocrassina (Neocrassina) singhi* n. sp. : Sp. No. H/98/41 (Holotype); Bed No. 1 (Lodai Member—Oxfordian); E of Rudra Mata; R. V. external.
2. *Astarte (Astarte)* sp. indet. : Sp. No. H/28/i/105; Bed No. 15 (Dhrang Member—Lower Callovian); S of Fulae; RV external.
3. *Astarte (Astarte) pandei* Agrawal : Sp. No. H/29/11; Bed No. 1 (Lodai Member—Oxfordian); S of Kotai; L V external.
- 4, 5. *Neocrassina (Neocrassina) rajnathi* Agrawal : 4—Sp. No. H/98/34; Bed No. 1 (Lodai Member—Oxfordian); E of Rudra Mata; (a) dorsal view, (b) LV external. 5—Sp. No. H/90/6; horizon same as above; S of Kunaria; (a) RV external, (b) dorsal view.
- 6, 7, 8. *Neocrassina (Neocrassina) pandeyi* Maithani : 6—Sp. No. H/84/g₃/6; Bed No. 15 (Dhrang Member—Lower Callovian); SW of Lodai; LV internal. 7—Sp. No. H/84/g₃/18; horizon and locality same as above; (a) RV internal, (b) RV external. 8—S. No. H/84/g₃/32; horizon and locality same as above; RV external. Note the variability in the outline.
- 9, 10. *Neocrassina (Neocrassina)* spp. : 9—Sp. No. H/113/8; Bed No. 7 (Jhikadi Member—Middle Callovian); N of Habae; L V external. 10—Sp. No. H/98/42; Bed No. 1 (Lodai Member—Oxfordian); E of Rudra Mata; RV external.
11. *Neocrassina (Neocrassina) haboensis* sp. nov. : Sp. No. H/28/i/97 (Holotype); Bed No. 15 (Dhrang Member—Lower Callovian); S of Fulae; RV external.
- 12, 13. *Neocrassina (Pruvostiella) panti* n. sp. : 12—Sp. No. H/74/1 : Bed No. 5 (Jhikadi Member—Middle Callovian); SW of Lodai; RV external. 13—Sp. No. H/25/8 (Holotype); Bed No. 1 (Lodai Member—Oxfordian); S of Fulae; (a) dorsal view, (b) LV external.
14. *Neocrassina (Pruvostiella) freneixae* Agrawal : Sp. No. H/94/1 (Lodai Member—Oxfordian); NE of Rudra Mata; LV external.
15. *Neocrassina (Pruvostiella)* cf. *freneixae* Agrawal : Sp. No. H/98/29; horizon same as above; E of Rudra Mata; LV external.
16. *Neocrassina (Neocrassina) agrawali* n. sp. : Sp. No. H/84/g₃/40 (Holotype); Bed No. 15 (Dhrang Member—Lower Callovian); SW of Lodai; LV external.
17. *Neocrassina (Pruvostiella) subtriangularis* n. sp. : Sp. No. H/63/5 (Holotype); Bed No. 2 (Rudra Mata Member—Upper Callovian); SW of Lodai; LV external.
18. *Neocrassina (Pruvostiella) unilateralis* (J. de C. Sowerby) : Sp. No. H/98/20; Bed No. 1 (Lodai Member—Oxfordian); E of Rudra Mata; (a) dorsal view, (b) LV external.

PLATE II

1. *Neocrassina (Pruvostiella) panti* n. sp., Sp. No. H/106/17 (Paratype); Bed No. 1 (Lodai Member—Oxfordian); NW of Jhikadi; RV external.
- 2, 3, 4. *Neocrassina (Pruvostiella) spitiensis* (Stoliczka) : 2—Sp. No. H/124/48; Bed No. 7 (Jhikadi Member—Middle Callovian); N of Jhikadi; RV external. 3—Sp. No. H/96/18; Bed No. 6; (Jhikadi Member—Middle Callovian); NE of Rudra Mata; RV external (slightly crushed at the centre). 4—Sp. No. H/124/50; Bed No. 7 (Jhikadi Member—Middle Callovian); N of Jhikadi; (a) anterior view, (b) RV external.
5. *Neocrassina (Coelastarte)* aff. *cotteausea* (d'Orbigny) : Sp. No. H/84/g₃/10a; Bed No. 15 (Dhrang Member—Lower Callovian); SW of Lodai; LV external (attached to the inner side of an isolated left valve of *N. (N.) pandeyi* Maithani).
6. *Neocrassina (Pruvostiella) unilateralis* (J. de C. Sowerby) : A juvenile specimen, No. H/121/64; Bed No. 4 (Rudra Mata Member—Upper Callovian); S of Lodai; RV external.
7. *Nicaniella (Nicaniella) pisiformis* (J. de C. Sowerby) : Sp. No. H/32/113; Bed No. 13 (Dhrang Member—Lower Callovian); S of Kotai; LV external (about ×2).
8. *Nicaniella (Nicaniella) extensa* (Phillips) : Sp. No. H/99/80; Bed No. 2 (Rudra Mata Member—Upper Callovian); E of Rudra Mata; LV external (X1.7).